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**Frugal innovation principles as a response to the  
Covid-19 crisis in Western countries**

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***Frugal innovation principles as a response to the Covid-19 crisis  
in Western countries***

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## **Executive Summary**

The current thesis consists of a qualitative study that investigates whether Western countries have developed frugal innovations to respond the challenges posed by the ongoing Covid-19 crisis. First, the study provides a literature review to enable the reader to better understand how the topic of frugality has been addressed in the context of both emerging and developed countries. In a second stage, the study provides a theoretical conceptual framework to define frugal innovation, hence suggesting broader frugal attributes that can find application in Western countries. In the last stage, the study investigates whether the attributes provided in the conceptual framework have found application among the covid innovations developed in the West. To do so, a qualitative content analysis has been employed, relying on both deductive and inductive approach. At the end, the study comes to the following conclusion: the application of a frugal mindset in Western countries is confirmed and the model is assumed to fit properly to the definition of frugality in Western countries.

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## List of Abbreviations

AI	Artificial Intelligence
BoP	Base of the Pyramid
CI	Covid Innovation
FDA	Food and Drug Administration
FI	Frugal Innovation
ICU	Intensive Care Unit
NHS	National Health Service
RI	Reverse Innovation
SDGS	Sustainable Development Goals
WHO	World Health Organization

# 1. Introduction

## 1.1. Problem Background

The Covid-19 crisis, triggered by the worldwide spread of the disease SARS-CoV-2, has been defined as the worst pandemic our globalised society has ever faced. Unlike previous large-scale crises, Covid-19 has impacted on the entire socioeconomic system of our society, threatening public and economic health, and adversely impacting the psychological and social well-being of individuals and organizations all around the world (Dahlke et al., 2021).

Following the above-mentioned issue, firms have been called upon to respond the different challenges posed by the pandemic, which has meant many of them challenging their business models. More specifically, lack of time to assess innovative solutions, shortage of financial resources, demand-side constraints, the healthcare crisis itself, and national lockdowns resulting in worldwide supply chain damages (Harris et al., 2020; Corsini et al., 2021; Herstatt & Tiwari., 2020), have tested firms' abilities to operate under stress conditions (Harris et al., 2020). As a result, the current pandemic has proven to be a resource-constrained environment (Dosi et al., 2021), thus forcing organizations to ingeniously develop the ability of "doing more with less". In other words, according to Harris et al. (2020), being resourceful in a situation characterized by scarcity of resources has proven to be a vital skill to successfully battle the Covid crisis.

Following the above, the innovative solutions emerging as a response to the pandemic recall the principles of frugal innovations (hereinafter FIs) consisting of simple, good enough and low-cost solutions addressed to customers in resource-constrained environments. The concept of Frugal innovation (hereinafter FI) was initially developed with reference to emerging economies which represent a fertile ground given their greater constraints than developed countries, such as low incomes, institutional voids, and lack of adequate infrastructures (Zeschky et al., 2011). However, the growing presence of a frugal mindset in Western economies as a response to the modern challenges – including the ongoing pandemic - has demonstrated the need to redefine the boundaries of this concept (Tiwari & Herstatt, 2020; Hossain, 2021), which seems to be no longer confined to emerging markets (Corsini et al., 2021). Additionally, the presence of FI in developed economies is expected to increase even more in the wake of the ongoing pandemic and its resulting economic crisis, both of which are leading Western customers to demand affordable products and – simultaneously - companies to deliver fast and resource-efficient solutions (Tiwari & Herstatt, 2020). As a result, it is worth noting that the current Covid-19 emergency is highlighting the fragility of the economic and social system in developed countries, thus acting as an enabler of frugality.

## 1.2. Research gap

Until now, little research has been carried out to investigate the relevance of FI in Western economies, while there is a variation of research examining extensively the role of frugality in emerging economies. Therefore, most of the frugal attributes identified so far are contextualized with reference to emerging countries. Several authors have classified the frugal solutions developed so far in advanced economies as reverse innovations (hereinafter RIs), which aim to initially serve low-income countries and, at a later stage, capture a new market demand from developed countries by leveraging the low-price strategy (Hossain, 2013). This

concept ignores the backward process, i.e., the possibility that FIs could be developed in advanced countries and then transferred to poor countries. In other words, previous researchers have ignored the potential of Western countries in representing the hub of FI as well as emerging markets. However, the ongoing pandemic crisis has highlighted the need to start filling this gap given the relevance that FIs are assuming in developed countries, which have been hit hard by the pandemic, and consequently forced to adopt a frugal mindset. Given the above, the proposed study seeks to examine the following Research Questions:

- **RQ1:** *“What are the main attributes that characterize frugal innovations?”*
- **RQ2:** *“Do companies in Western economies apply the principles of frugal innovations in the wake of the Covid-19 crisis?”*

The first question is functional to the second one: it enables us to identify the main attributes that characterize FIs in both developing and developed countries, thus defining a framework that implies a more general application, as suggested by Vesci et al. (2021) & Weyrauch & Herstatt (2016). By doing so, the study seeks to provide a clear and comprehensive overview of what FIs are to better answer the second research question representing the core of our study.

Through the second research question, we aim to understand whether the innovations developed by Western countries as a response to the pandemic can be classified as FIs while keeping in mind the key attributes defined when answering the first research question.

The current study contributes to redefining the phenomenon of FI beyond its role in emerging countries, considering its growing application in Western economies as a response to the current crisis, thus advancing the theory concerning the FI phenomenon. This is done by considering a constrained context par excellence - the Covid-19 pandemic (Dosi et al., 2021) which has been identified as a new resource-constrained context whose impact is worldwide. By doing so, we contribute to extending the present knowledge about the phenomenon of frugality that is considered to be “novel” and in continuous evolution so far (Lehner & Gausemeier, 2016; Weyrauch & Herstatt, 2016), and therefore in need of constant updating. Furthermore, from a managerial perspective, the study may provide managers and practitioners with useful insights that can serve as support in addressing the development and improvement of frugal design practices in Western countries. The latter aspect is crucial given the increasing relevance of FI which, in addition to being an innovative response to the current pandemic, has been identified as a potential solution to growing global threats such as diseases, climate change, biodiversity loss, resource scarcity, and increasing inequalities among others (Harris et al., 2020; Matos et al., 2020).

### **1.3. Outline of the Thesis**

The paper is structured as follows. We begin with a literature review to understand the current knowledge with regard to FI; this section, namely chapter 2, consists of 4 sub-chapters. Sub-chapters 1 and 2 provide the reader with a theoretical background concerning the role of FIs in both emerging and Western countries. Sub-chapter 3 provides the reader with an outline of the ongoing pandemic situation, its related consequences in Western countries, and insights concerning the role that FI plays in such circumstances.

Finally, sub-chapter 4, after a detailed literature review, enhances the drawbacks arising from the theoretical framework, more specifically it recalls the purpose of our study, providing in-

depth information in addition to what has already been discussed in the introductory section “Research gap”.

We then proceed with the explanation of our “three-stage methodology” in chapter 3.

First of all, we provide details about the searching process, in other words, how we collected the reviewed studies that are relevant to our topic. Consequently, a brief explanation concerning the *conceptual framework* we employ to broadly define FI follows – the study mainly refers to the three criteria suggested by the model of Weyrauch & Herstatt (2016). Lastly, we outline the coding process employed to identify the presence of frugal attributes among the covid innovations developed in Western countries; details concerning the study sample and the coding approach used to analyse the covid innovations will be explained in the methodology section in more detail.

In chapter 4 we shift the reader’s focus to the conceptual framework that defines FI, thus answering the first research question, and developing theoretical insights that are relevant to proceed with the coding process.

In chapter 5 findings are displayed and discussed, thus answering the second research question.

Lastly, conclusions are drawn, together with the limitations of the study and suggestions for future research.

## **2. Literature Review**

### **2.1. Frugal innovations in emerging countries**

The resource-constrained solutions, namely FIs, have their roots within the context of emerging countries, whose population has been marginalized for a long time (Tiwari & Herstatt, 2020; Hossain, 2013). Indeed, given the numerous challenges characterizing those nations – such as political issues, resource scarcity, infrastructural and institutional voids – the customer base has not been initially considered a source of business opportunities (Agarwal et al., 2021; Bhatti & Ventresca, 2013). Only at a later stage, emerging countries have been recognized as a profitable market given the growing population and the availability of a low-priced workforce (Agarwal & Brem, 2012).

In the literature, FIs are seen as solutions whose aim is to reach the customers belonging to the base of the pyramid (hereinafter BoP) of emerging markets (Tiwari & Herstatt, 2020; Agarwal & Brem, 2012; Vesci et al., 2021; Tiwari & Herstatt, 2012a). In serving BoP markets, companies address their solutions to a consumer base whose daily income is on average \$2.50 (Hossain, 2021). Despite the low purchasing power of each individual, when considered as a whole, this market of over 4 billion people represents a fortune of trillions of dollars (Hammond et al., 2008; Nerurkar, 2020).

To serve emerging countries, Western companies cannot market the basic versions of their advanced products, as prices – despite commercial efforts – remain prohibitive (Simula et al., 2015) and do not fit the context-related needs of constrained customers (Tiwari & Herstatt, 2012a; Tiwari & Herstatt, 2012b; Mvulirwenande & When, 2020; Mishra, 2021). As a result, while innovation implies the development of advanced products at a higher cost in Western countries, companies have to rely on frugal principles to accommodate the needs of the “millions who don’t have millions” in emerging markets (Mukerjee, 2012, p.1). Developed nations

are less likely to represent the hub of frugal solutions, given their privilege of resource abundance and availability of modern equipment, both of which undermine their ability of “doing more with less” (Rosca et al., 2018, p.147). Conversely, emerging countries, as resource-poor environments, have greater potential in applying frugal principles given their well-developed ability to improvise and achieve more with fewer resources (Tiwari & Herstatt, 2020).

Following the aforementioned, Western companies are not able to fully understand and meet the needs of consumers in poorer countries given the different socio-economic backgrounds (Agarwal & Brem, 2012). As pointed out by Zeschky et al. (2014), the main challenge in developing FIs is not of technical nature, but rather lies in the ability to properly market innovations in poor contexts where customers express specific needs. This aspect explains the necessity of Western firms to invest in the local establishment of R&D units and subsidiaries to better understand the foreign contexts and the resulting needs (Dosi et al., 2021; Mukerjee, 2012; Hossain, 2017; Singhal, 2011, as cited in Agarwal & Brem, 2012).

In the light of the above, lack of resources turns out to be a crucial driver of frugality; in particular, focusing on the scarcity of financial resources, emerging countries are classified as “low-income markets” compared to advanced economies (Hossain et al., 2016), thus representing a fertile ground for resource-constrained solutions.

The belief that emerging countries – when compared with the Western ones - represent a “laboratory for frugal innovation” (Prathap, 2014, p.374) is supported by further reasonings. Among them, Hossain (2017) points out their central role in developing affordable solutions as they rely on low-cost human capital and larger markets. Secondly, FIs are perceived as “low-tech” solutions, thus less sophisticated products, therefore unable to meet high-demanding needs in advanced economies (Corsini et al., 2021). As a result, managers in Western companies are reluctant to adopt a frugal mindset when developing new products for the local market (Corsini et al., 2021; Hossain, 2013). In particular, they may fear the so-called “cannibalization effect”, thus frugal products competing in both their developed and emerging markets (Zeschky et al., 2011). Additionally, the rapid urbanization has intensified the existing infrastructural issues, thus leading to an increase in the size of the market consisting of potential customers (Simula et al., 2015).

Lastly, emerging markets are properly labeled as resource-constrained environments, thus they are more suitable for FIs development; despite the abundance of natural resources, they present countless challenges such as unskilled labor force, political instability, and infrastructural problems that make them economically weaker than Western markets (Agarwal et al., 2021; Prabhu, 2017). As a result, the most challenging environments are the ones triggering ingenuity, thus turning constraints into opportunities (Mvulirwenande & When, 2020).

## **2.2. The growing application of frugal innovations in Western countries**

Based on the reasonings provided in the previous section, emerging markets seem to play a pivotal role concerning the theme of frugality. In particular, India has been acclaimed as the emblem of frugality (Prathap, 2014). However, the authors – following some empirical investigations – argue that this common belief represents a myth, as their studies demonstrate that other countries, including some developed contexts, perform better than India with regard to frugal activities (Prathap, 2014). Indeed, as pointed out by Hossain (2013), FIs have

found their path to developed countries as well. This phenomenon is known as *reverse innovation* (hereinafter RI) and refers to the process whereby FIs - initially tailored for emerging contexts – are transferred to the poor in Western countries (Zeschky et al., 2014). RI aims to conquer a new market demand in developed countries by leveraging the low-price strategy initially deployed for serving low-income countries (Hossain, 2013). In this regard, Hossain et al. (2016) & Zeschky et al. (2014) value the growing number of Western customers that are value-oriented, hence interested in affordable solutions. The reason why Western consumers are becoming price-sensitive lies in the economic recession that is impacting the wealthier countries and consequently forcing governments to adopt austerity policies (Simula et al., 2015). Therefore, RI accommodates the needs of the Western market niche that is not interested in sophisticated and expensive solutions (Simula et al., 2015; Mishra, 2021).

The notion of RI itself represents a novelty with regard to innovation diffusion, as it emphasizes a reverse path whereby innovations are transferred from low to high-income countries; indeed, it “challenges the common belief that developed countries are the hubs and origins of innovation” (Hossain et al., 2016, p.133).

However, resource-constrained innovations, while being redeployed to developed countries, are modified according to context-related requirements (Winkler et al., 2020). Indeed, given the differences between emerging and developed markets – e.g., in terms of safety standards, legal requirements. and image expectations - authors suggest the introduction of the notion of “*second-degree frugal innovation*” to identify FIs in Western nations (Winkler et al., 2020, p.254).

Contrary to the mainstream approach that embraces the phenomenon of RI, Beise-Zee et al. (2021) argue that frugal principles already apply in the context of developed countries, and they are mainly implemented by small companies which are forced to carefully manage resources and price policies due to their scarce budgets. However, the authors point out that such innovations, despite implementing frugal principles, are not directly named as frugal, thus being neglected in the ongoing debate (Beise-Zee et al., 2021, p. 643).

The phenomenon of frugality is assumed to increase even more in developed nations as digitalization is leading the rich countries to effectively provide affordable and high-quality solutions, while also improving the manufacturing process and consequently exploiting resources more consciously (Tiwari & Herstatt, 2020). Miesler et al. (2020) emphasize the crucial role of technology as it “opens the door for established Western market firms to participate and lead this field with their expertise, technology leadership, and highly trained employees” (p. 2711). Therefore, the authors suggest the use of the notion of “*Advanced Frugal Innovations*” to better discriminate FIs employed in wealthy nations given their technological superiority. Further support is provided by Prabhu (2017), who points out that the availability of advanced technologies together with financial resources and qualified human capital allows developed societies to move toward frugal business models more easily.

According to several studies (Prathap, 2014; Hossain et al., 2016; Markiewicz, 2021; Weyrauch & Herstatt, 2016), FIs have found their way to rich countries given the economic recession and the increasing environmental concerns, both of which had led to consumers consciousness concerning price policies and resource exploitation. As a result, frugality has been identified as a pivotal approach in driving the whole society toward a “systemic change” (Prabhu, 2017, p.6), hence enabling the achievement of sustainability goals concerning eco-

conomic, social, and environmental issues (Mvulirwenande & When, 2020; Prahalad & Hart, 2010).

Concerning the economic distress identified as the main enabler of frugality, further support is provided by Simula et al., (2015): the crisis has led to a significant increase in unemployment rates and, along with resource scarcity resulting in a final increase in product prices, has weakened the welfare of Western countries.

In this regard, Hossain et al. (2016) clearly remark the necessity to recognize the existence of different market segments in developed countries. In this regard, while the words “markets” and “countries” could be indiscriminately used in the ongoing debate, Hossain et al. (2016) emphasize the importance of distinguishing the two concepts, as both low and high-income markets are present in developed countries. As a result, the presence of poor customers in rich countries is not an oxymoron, therefore the increasing demand for low-priced solutions in Western countries is reasonable (Simula et al., 2015). Therefore, by arguing that FIs are addressed to low-income markets, one should not exclude the possibility that they are addressed to Western countries where those markets exist.

However, limiting ourselves to economic constraints is reductive and underestimates the growing relevance of frugality in the West. Undoubtedly, low incomes do not represent the only reason why consumers start demanding more frugal solutions (Tiwari & Herstatt, 2020). On this matter, Simula et al. (2015) underline the crucial role of FIs in accommodating the growing need for simplicity among Western consumers, who are interested in avoiding the so-called “*over-engineered*” innovations, namely solutions that are technically sophisticated, hence difficult to use, and consequently less valuable to consumers. Additionally, according to Tiwari & Herstatt (2020), the call for simplicity is further motivated by conscious consumers who aim to reduce the environmental impact of their unhealthy consumption. As a result, FIs turn out to be a proper solution to sustainable issues (Markiewicz, 2021). This consideration is followed up by Saari et al. (2021) who draw attention to the recent and increasing Vegan trend that accommodates emerging frugal lifestyles in the West food industry where consumers try to accomplish their sustainable goals.

In broader terms, FIs represent a great opportunity to effectively address future health, economic, social, and environmental challenges (Lehner & Gausemeier, 2016). In particular, the ability to adopt a frugal mindset plays a crucial role in the current COVID-19 pandemic whereby “highly affordable, resource-efficient and high-quality solutions are demanded in all parts of the world” (Tiwari & Herstatt, 2020, p.1) including the wealthy nations struggling with the resulting economic recession (Beise-Zee et al., 2021).

## **2.3. The Covid-19 pandemic as an enabler of frugality in Western countries**

### **2.3.1. The Covid-19 outbreak: a new resource-constrained environment**

The academic literature reveals the key role of resource scarcity (or resource constraints) as a potential enabler of frugality - the shortage of financial, material, human, and natural resources trigger the demand for simple, affordable, and good enough solutions (Hossain et al., 2016; Ahuja, 2014; Markiewicz, 2021). Resource scarcity does not only affect the performance of organizations (Dubey et al., 2021) but also implies the inability of consumers to satisfy their needs, hence constraining their purchasing power (Bhatti & Ventresca, 2013). As

a result, Bhatti & Ventresca (2013) suggest using both terms “resource scarcity” and “resource constraints” indiscriminately.

The above considerations emerge to be even more critical in the light of the current Covid-19 pandemic, which has proved to be a fertile ground for testing frugal principles in Western countries (Vesci et al., 2021).

Following the study of Ploeg et al. (2021), the COVID-19 outbreak is leading to both “environment-level” and “firm-level” resource constraints, hence challenging the business environment both externally and internally (p. 97). In the first instance, using the words of Ploeg et al. (2021), firms have to develop “affordable and resource-efficient” solutions to cope with the “demand-side constraints” (p.98). Indeed, firms are called upon to deal with the health and economic impact of the pandemic on its stakeholders, such as (1) infected or increasingly price-sensitive consumers who cannot purchase the firms’ products, (2) supply chain disruptions, and (3) restrictive measures affecting consumers and business partners decisions (Kraus et al., 2020; Herstatt & Tiwari., 2020). In addition, firms are facing internal barriers resulting from the ongoing emergency – e.g., infected employees and extra costs incurred to ensure safety standards (Kraus et al., 2020; Ratten, 2020), thus being forced to look for cost-efficient innovations (Ploeg et al., 2021).

In the wake of the above, the ongoing Covid-19 pandemic has been properly identified as a resource-constrained context (Dosi et al., 2021), whose socio-economic impact has hit hard both emerging and developed countries. Undoubtedly, differences concerning the intensity of the impact itself have occurred, depending on the initial availability of resources Ratten (2020). Indeed, according to Ratten (2020), the abundance of resources is likely to lead organizations to a faster and more effective response. However, although characterized by resource abundance and a more favorable socio-economic scenario, Western countries have not been spared by the pandemic. Corsini et al. (2021) suggest that the Covid-19 outbreak “is turning high-income regions into resource-constrained environments” (p.196), thus forcing them to rely more than ever on frugality (Harris et al., 2020). Accordingly, a crucial consideration emerges: resource paucity does not exclusively affect low-income countries, but rather it is evolving into a global concern given the increased exposure to systemic crisis (Corsini et al., 2021; Doern et al., 2019; Matos et al., 2020). As a result, the issue concerning resource scarcity has been introduced in the agenda of Western countries to boost their frugality mindset (Bhatti & Ventresca, 2013).

The pandemic itself can be categorized as a “Black Swans”, namely an unexpected crisis involving substantial knock-on effects (Ansell & Boin, 2019, Ratten, 2020). According to Ansell & Boin (2019), an unexpected crisis cannot be compared to earlier shocks, rather it must be approached with strategies that consider the novelty of the crisis itself and its complexity. As a result, in times of adversity, companies might be required to question the original business models, in other words, thinking outside the box and start constructing knowledge that is far from their experience (Tidd, 2006). This is the case of several firms located in the West that had to “re-purpose their business”, thus changing their value proposition to better respond to the Covid-19 emergency (López et al., 2020). However, Prabhu (2017) remarks that such transition could be truly challenging for developed economies as they are tied to well-established “legacy systems” (p. 4). In this regard, Ratten (2020) points out the crucial role of a strong entrepreneurial spirit characterized by high-risk propensity and attitude of testing novel technologies.

Ratten (2020) and Lai et al., (2020) emphasize the most critical aspect of the current pandemic, namely its dynamic and uncertain nature, which does not allow companies to properly develop a plan of action. Furthermore, as the infection process is still ongoing, the uncertainty concerning its lasting undermines the opportunity to define the magnitude of its socio-economic impact and consequently develop an adequate recovery plan (Sneader & Singhal, 2020). Further support is provided by Dunleavy et al. (2021) who suggest the existence of a wicked situation. In different words, the pandemic represents a VUCA situation, as it is characterized by “Volatility, Uncertainty, Complexity, and Ambiguity” (Millar et al., 2018, p.5).

In the wake of the above, “doing more with less” has become imperative during these unprecedented times of adversity (Harris et al., 2020). Dosi et al. (2021) are on the same page, as they believe that FIs represent an opportunity to successfully battle adverse scenarios, including epidemics, and properly accommodate new needs emerging from the ongoing outbreak. The strategy of Western companies lies in the development of fast and affordable innovations (Prabhu, 2017), thus applying a flexible and frugal mindset to make the most of the constraints resulting from the pandemic (Dunleavy et al., 2021; Dubey et al., 2021). Further support is provided by Veschi et al. (2021) who state that many of the covid innovations launched so far reveal the application of frugal principles, as they represent good enough, affordable, and basic solutions developed in a resource-scarce setting.

Additionally, given the rapid spread of the virus, a timely response has been required, hence forcing firms to develop fast solutions with local resources and materials already available (Corsini et al., 2021; Veschi et al., 2021); this approach is typically employed by frugal innovators when trying to find ingenious solutions in challenging contexts (Agarwal., 2021). Lack of time proved to be the scarcest and most valuable resource in such critical circumstances (Corsini et al., 2021). Consequently, cooperation among innovators has been revealed as the most effective “weapon” in the race against time (Veschi et al., 2021). On this matter, Radjou & Prabhu (2014) & Lai et al., (2020) discourage the strategy based solely on an internal firm’s expertise and claim the relevance of a social network to enable affordable, prompt, and large-scale innovations in times of adversity.

A more detailed overview of the covid-19 impact is provided in the following section, to understand in depth what are the constraints currently leading to a resource-scarce setting, therefore representing a fertile ground for frugal activities.

### 2.3.2. An outline of the challenges posed by the Covid-19 pandemic

In December 2019, a severe and contagious acute respiratory syndrome was identified in China (Guan et al., 2020) and, more precisely, the city of Wuhan was acknowledged as the epicenter of the outbreak given a significant number of infected inhabitants (Ratten, 2020). The epidemic, whose spread was initially considered local, turned into a global pandemic within a few months and, as a result, on 11 March, Covid-19 was officially declared as a worldwide health emergency by the World Health Organization (hereinafter WHO) (Guan et al., 2020). Given the significant number of covid cases (Kraus et al., 2020), the pandemic has led to the collapse of healthcare systems in advanced countries, forcing them to cope with resource scarcity in terms of medical equipment and personnel (Harris et al., 2020; Car-teaux et al., 2021; Iwuoha & Jude-Iwuoha, 2020). In this regard, the sharing of resources among countries with different rates of hospitalization emerged to be crucial (Demertzis et al., 2020).

The pressure of the healthcare system forced authorities to introduce severe measures to flatten the epidemic curve (Kraus et al., 2020). Using the words of Santos (2020), restrictions aimed to “reduce the number of daily infections (i.e., decrease the peak of the curve) albeit prolonging the pandemic duration so as not to exceed the constraints of the healthcare system” (p.249). Specifically, authorities imposed social distance and travel restrictions, banned social gatherings, and implemented several lock-down measures which resulted in customers and workers being confined at home and businesses being closed down (Guan et al., 2020; Iwuoha & Jude-Iwuoha, 2020). Given the considerable economic impact of the pandemic (Echebarria Fernández, 2021), public subsidies have been required and - following the assertion of Kraus et al. (2020) - far exceeded the ones provided in the previous downturns affecting Western countries.

Given the above, the impact of the covid-19 disease moved beyond the health crisis, also exposing the weakness of our society's economic and social system (Harris et al., 2020).

#### 2.3.2.1. The economic impact

##### *The Demand Side Constraints*

According to several studies, Western countries have been hit hard by the pandemic, thereby experiencing an exceptional economic recession whose magnitude has been recognized to exceed the former impact of the Great Depression and the 2008 financial crisis (Sneader & Singhal, 2020, Chen et al., 2020; Conte et al., 2020; Demertzis et al., 2020).

Herstatt & Tiwari (2020) identify the economic crisis that flows from the ongoing pandemic as an enabler of frugality. Western customers are facing significant economic hardships due to the rising unemployment rate resulting from the current crisis (Iwuoha & Jude-Iwuoha, 2020; Kraus et al., 2020; Herstatt & Tiwari; 2020), therefore they are increasingly looking for low-cost solutions to meet their narrow budgets (Hossain, 2017). In this regard, Kraus et al. (2020) highlight a steep increase in the unemployment rate in some European and North American states.

In addition to unemployed people, active workers are also facing the implications of the pandemic. First of all, a significant number of employees found themselves working less due to the lockdown measures, thus having to accept a lower income (Herstatt & Tiwari; 2020). Secondly, the fragile situation of several companies - that are facing economic hardships due to lower consumption, supply-chain disruptions, and recourse scarcity - is still affecting employees with delays and difficulties in wage payments (Demertzis et al., 2020).

Given the above, an increase in poverty - as a consequence of the current outbreak - has been reported (Dubey et al., 2021; Harris et al., 2020), hence underlying the increasing demand for affordable solutions.

Furthermore, consumers are intentionally changing their consumption habits given the fear of Covid-19 transmission, mainly focusing on satisfying essential needs (Chen et al., 2020; Sneader & Singhal, 2020; Iwuoha & Jude-Iwuoha, 2020). This is clearly in line with frugality as it recalls the necessity to make use of products and services focused on core functionalities (Weyrauch & Herstatt, 2016), in other words, no-frills innovations (Rao, 2013) that accommodate the essential requirements of constrained consumers in every resource-scarce setting (Zeschky et al., 2011; Weyrauch & Herstatt, 2016).

As a result, industries have been impacted heterogeneously given consumers choices in times of crisis (Craven et al., 2020). It can be argued that the current demand constraints

have created winners and losers. More specifically, some industries have been severely impacted due to their reliance on physical interaction – strongly prohibited by current restrictions – or because they are considered non-essential in times of adversity (Craven et al., 2020; Kraus et al., 2020; Ratten, 2020). According to Craven et al. (2020), this is the case of tourism and hospitality sectors, in particular; Iwuoha & Jude-Iwuoha (2020) are on the same page by considering those industries to be the bigger losers from the current crisis. Conversely, the healthcare and pharmaceutical industry – delivering essential products/services - together with the businesses that rely more on the use of technology (e.g., those that enable remote working) are improving their performance (Kraus et al., 2020; Ratten, 2020).

Lastly, Demertzis et al. (2020) emphasize the crucial role of uncertainty itself – in the wake of the Covid-19 crisis, consumers are more uncertain about their economic and health expectations, and thus more likely to save money rather than consume. This aspect further exacerbates the existing demand constraints as it lowers budgets that can be potentially spent.

In the wake of the above considerations, Sneader & Singhal (2020) specify the relevance of FIs with reference to the lack of financial resources; they underline the crucial role of affordable solutions in accommodating the needs of a population whose income has worsened due to the current pandemic crisis. Therefore, following up on the demand-side constraints discussed above, FIs could represent a successful solution as they are “designed, produced, delivered and maintained to achieve the needs of underserved consumers in constrained environments” (Bhatti & Ventresca, 2013, p. 16).

Lastly, Craven et al. (2020) suggest firms to carefully consider the change of habits and incomes as they may represent the reference for a “new normality” in the post-pandemic era where frugality is assumed to play a critical role (Herstatt & Tiwari., 2020).

### *The Supply-side constraints*

The peculiarity of the current crisis lies in the parallel occurrence of both demand and supply constraints (Kraus et al., 2020; Demertzis et al., 2020; Maital & Barzani, 2020). Therefore, the pandemic has highlighted the economic sufferings of western companies as much as consumers.

The lower income of Western consumers affects the supply, leading to lower revenues for many companies (Demertzis et al., 2020). However, internal dynamics are challenging Western firms even more. First of all, in compliance with current regulations, companies are coping with an increase of internal extra costs to ensure safety and hygiene requirements (Kraus et al., 2020; Ratten, 2020), thereby protecting employees at their workplace and safeguarding consumers in their purchase process.

Secondly, companies are dealing with resource scarcity in terms of human capital, due to the necessity to accomplish social distance regulations (Guan et al., 2020; Ratten, 2020) and to infected employees confined at home (Bergsen, 2020; Kraus et al., 2020).

Lack of personnel together with the shutdown of activities caused by lock-down measures and economic recession, are both leading to issues concerning productivity, thus affecting the supply chain system (Ratten, 2020; López et al., 2020; Dubey et al., 2021; Kraus et al., 2020). Supply-chain disruptions have led to a decrease in outputs followed by an increase in prices (Maital & Barzani, 2020; Iwuoha & Jude-Iwuoha, 2020), thus compromising the normal functioning of several businesses.

In such a critical situation, firms have started to question their severe reliance on the supply chain system (Herstatt & Tiwari., 2020), and consequently their business model by implementing short-term strategies to contain losses (Kraus et al., 2020). In particular, according to López et al. (2020), several companies have repurposed their business, namely addressing their production process to a different output – e.g., enabling the manufacture of healthcare products in short supply such as protective coveralls, masks, sanitizers, and ventilators (Dubey et al., 2021). This is the case of several large western companies as Giorgio Armani Group and Mey, Kraus et al., (2020, p.1069) note. The pandemic has exposed the fragility of the western healthcare system, hence demonstrating that advanced countries have deficiencies as well as emerging countries. Further support is provided by Miesler et al., (2020) who point out the existence of “remote areas” in western countries where people do not have access to drugs.

According to López et al. (2020), “repurposing” must be considered a technological and organizational challenge that can involve considerable costs and does not always guarantee success. Several firms have proved to fail while repurposing their business as they failed to (1) meet the required quality standards, (2) develop a proper-functioning solution, and (2) deliver a fast solution (López et al., 2020).

Given the above, the pandemic has raised awareness which is likely to impact the future way of doing business:

*“This crisis has shown how dependent we are all today on globally available products, processes and supply chains and how fragile many industries are when suddenly products and services are no longer produced, offered and demanded” (Herstatt & Tiwari., 2020, p.21.).*

As a result, companies have been called upon to find ingenious solutions to make the most out of their local resources and deliver prompt solutions (Vesci et al., 2021). In particular, the speed with which the virus spreads along with its knock-on effects requires an equally rapid and coordinated response (Sneader & Singhal, 2020). Being rapid and ingenious in constrained environments – e.g., repurposing a business or creatively exploiting existing resources - represents a trait of frugal mindsets (Harris et al.; 2020).

Mishra (2021) considers FIs to be the most appropriate response to a fast-evolving pandemic characterized by resource paucity, particularly when it comes to lower reliance on disrupted supply chains Further support is provided by Dubey et al. (2021) who refer to FIs as the best solutions organizations can rely on to face all the covid-related issues. According to Bhatti & Ventresca (2013), FIs provide firms with the opportunity to “cut” their production costs – this aspect is crucial for companies given their adverse economic situation outlined above.

In conclusion, “doing fast and more with less” becomes a real mantra in the face of the COVID-19 pandemic.

#### 2.3.2.2. Social and ethical concerns

In addition to the challenges mentioned in the previous section, the Covid 19-crisis has raised concerns about social and ethical aspects (Dubey et al.; 2021; Herstatt & Tiwari., 2020). In particular, the increasing concerns on sustainability issues have been identified as a consequence of the current pandemic crisis (Dubey et al.; 2021). Today’s society has progressed slowly so far toward the achievement of the so-called “sustainable development goals” (hereinafter SDGS), thus fostering the persistence of a fragile economic, social and environmental system that has consequently enabled the rapid spread of the virus and its challenges (van Zanten &

van Tulder, 2020). Consequently, a society that does not prioritize the issue of sustainability cannot be able to build a resilient system and thus better cope with the current shock (van Zanten & van Tulder, 2020; Matos et al.; 2020; Miesler et al., 2020). Corsini et al. (2021) and Dubey et al., (2021) consider FIs as valuable solutions to support countries in achieving SDGS. In this regard, Dubey et al. (2021) and Dunleavy et al. (2021) clearly emphasize the relevance of frugality in developing sustainable innovations that can support countries in containing the impact of the covid crisis and better addressing the post-pandemic needs.

Herstatt & Tiwari (2020) particularly draw attention to environmental sustainability arguing that FIs are specifically suitable to the covid-related challenges as they minimize the use of resources, thus positively affecting the environment. Consequently, FIs can be considered eco-friendly and sustainable solutions whose use is bound to become even more crucial in dealing with the post-pandemic situation (Corsini et al., 2021). As a result of lockdowns, western consumers may have started questioning the ecological sustainability of their habits, such as traveling frequently by public transportation (Herstatt & Tiwari, 2020); they may have also started to adopt a frugal lifestyle in terms of their consumption habits (Saari et al., 2021). Additionally, Herstatt & Tiwari (2020) suggest that FIs may simply emerge to accommodate the need for “voluntary simplicity” reinforced even more with the current outbreak. Given the lower incomes and lockdown measures resulting from the current corona crisis, western consumers have turned down non-essential purchases (Kraus, et al., 2020). As a result, some may have started to appreciate more the frugal life based on simple and good- enough products that lead them to learn to cope with scarce resources, thus not resorting to unhealthy consumption (Herstatt & Tiwari, 2020). FIs, being tailored to constrained environments, aim to address real and pressing needs, rather than what consumers “desire” (Dosi et al., 2021). In light of this consideration, FIs emerge to be a suitable response in times of adversity given their basic-functionality principle based on essential features (Dosi et al., 2021; Herstatt & Tiwari, 2020; Simula et al., 2015; Weyrauch & Herstatt, 2016).

Given the above, FIs are not necessarily the result of a compulsory choice tied to economic or environmental hardships, as they can emerge even from a voluntary choice:

*“[...] the global society seems to be experiencing the fourth renaissance of frugality that we call ‘Frugality 4.0’. The Frugality 4.0 paradigm is likely to be boosted by voluntary simplicity that seems to be setting-in in certain segments of the society. In conjunction with need for products, services, technologies and business models that are financially affordable, ecologically responsible and continue to provide technological excellence, Frugality 4.0 may well turn into a global mega-trend.” (Herstatt & Tiwari, 2020, p. 25)*

Herstatt & Tiwari (2020) are the first to suggest a new paradigm of frugality that considers the post-pandemic era, as the current crisis will have long-term consequences leading to “new normality”, thereby reshaping future lifestyles, consumer habits, and the way of doing business (Sneader & Singhal, 2020).

In the wake of the Covid-19 implications discussed so far, the concept of frugality gradually moves away from the mainstream approach – FIs are no longer simply seen as solutions that meet the needs of the BoP (Corsini et al., 2021), but rather also accommodate the need for “voluntary simplicity” (Herstatt & Tiwari, 2020) or the need to ensure a sustainable development or frugal lifestyle in developed economies (Herstatt & Tiwari, 2020; Winkler et al., 2020; Markiewicz, 2021; Prabhu, 2017; Agarwal et al., 2021). Consequently, FIs turn out to be a

global concept that can be relevant to any resource-constrained environment (Corsini et al., 2021).

## **2.4. Shortcomings of the current literature**

As shown in the above-literature review, the concept of FI has been initially developed in the context of emerging countries, and only at a later stage, it has been discussed with reference to Western countries under the terminology of RI. There is a lack of literature investigating whether Western countries can represent the hub of frugality as well as emerging countries. However, in the light of the ongoing pandemic, some researchers have begun to question the role of frugality in Western countries as a response to the current challenges and the post-pandemic needs. Unfortunately, concerning the application of frugal principles during the pandemic, the investigation is superficial: empirical research is lacking, and qualitative studies – apart from being scares – mainly focus on a description of the pandemic itself and its challenges as seen above. We believe this gap is mainly justified by the novelty of the topic itself, therefore we aim to contribute with more insights to connect the topic of frugality with the Covid-19 crisis - while keeping our focus on Western countries. To do so, we consider it appropriate to integrate the literature review with a content analysis (more details follow in the methodology section).

The reader can see that the reviewed studies - when discussing the role of frugality in the context of the outbreak - are recent, hence they signal the novelty of the issue itself which needs further investigation given its infancy state. Our study aims to fill this gap, meaning contributing to expanding the evidence of frugality in a developed context. However, we do so to understand whether developed economies can take on the role of frugal innovators themselves, thus without the need to learn lessons of frugality from emerging contexts (Bhatti et al., 2017), namely not relying merely on RI. In simple words, we are questioning whether Western countries can develop from the ground up their FIs with no need to rely on innovations from emerging countries.

To the best of our knowledge, only Corsini et al. (2021) & Harris et al. (2020) have moved toward the same direction, hence trying to find evidence of the employment of frugal principles among the covid innovations (Hereinafter CI), namely the ingenious solutions developed during the pandemic.

As the reader can imagine, two studies are not enough, hence the current thesis contributes to further investigating the issue. Although the purpose of our study is the same, namely investigating the employment of a frugal mindset as a response to the pandemic, the approach differs from Corsini et al. (2021) & Harris et al. (2020).

Corsini et al. (2020) rely on 2 case studies – relatively one from India and one from Italy, with a clear focus on the role of the maker community. Differently, Harris et al. (2020) have considered a list of 10 covid innovations from different countries around the world and analyzed them based on the frugal innovation approach applied.

Our study approaches the issue differently.

First, before investigating whether Western countries developed FIs as a response to the Covid-19 crisis, it is crucial to understand what FIs are. Therefore, a step backward is needed: it consists in the introduction of a conceptual framework defining FI. To do so, the current study mainly relies on the model of Weyrauch & Herstatt (2016) as it provides a broad defini-

tion that can find application in developed countries as well. More detail follows in the next chapter.

Secondly, Western countries represent the focus, hence emerging countries are considered. Lastly, while analyzing the CIs, we do not look at the frugal innovation approach (e.g., repurposing the business) rather at the attributes of FIs, namely the characteristics of a frugal product and/or service introduced in the conceptual framework. This aspect matters because – as noted by Weyrauch & Herstatt (2016) - identifying key attributes is crucial to better differentiate FIs from other low-cost innovations.

### **3. Attributes of frugal innovations: a conceptual framework**

#### **3.1. Substantial cost reduction**

While defining FIs, Weyrauch & Herstatt (2016) identify the substantial cost reduction as the main characteristic attribute, whereby the terminology “substantial” implies the following labels: “much lower price, significantly lower costs, and ultra-low cost” (p.6). The attribute itself considers the customer’s point of view, hence it refers to the costs incurred by the customer while purchasing and/or using the frugal technology (Weyrauch & Herstatt, 2016).

Concerning the purchasing costs, a frugal solution is considered as such if its price is lowered by at least one-third (Weyrauch & Herstatt, 2016). Rao (2013) suggests even a more significant threshold: frugal technologies could potentially lead to a cost reduction of 80% on average - namely between 57% and 97% (Rao, 2013; Weyrauch & Herstatt, 2016, p.8) - compared to ordinary solutions. An additional high threshold has been remarked by Brem & Wolfram (2014) likewise: costs can be reduced by up to 90%. All these considerations indicate the existence of a substantial cost reduction.

Concerning the operating costs, Herstatt & Tiwari (2020) note that FIs also imply lower costs of “usage, maintenance, and disposal” that contribute to determining the “financial tenability of an innovative solution” (p.26).

When considering both aspects, namely the purchasing and operating costs, Tiwari & Herstatt (2012a) identify the low cost of ownership as being crucial in ensuring FIs’ success.

Following the above, the attribute of substantial cost reduction can relate (1) to the purchasing price solely, (2) to the operating costs barely, (3) or both, i.e., the total cost of ownership (Weyrauch & Herstatt, 2016). By doing so, Weyrauch & Herstatt (2016) specifically express the intention to provide a definition that is as broad as possible, thus being in line with the purposes of our study.

As a result, differently from existing and conventional innovations, frugal technologies offer an advantageous cost that better meets the needs of constrained customers whose purchasing power is low (Lehner & Gausemeier, 2016; Zeschky et al., 2011; Simula et al., 2015; Hossain et al., 2016).

The Substantial cost reduction attribute, although being defined under the consumer perspective, also indirectly implies the point of view of the companies developing frugal solutions (Weyrauch & Herstatt, 2016). Indeed, firms need a business model that is characterized by low manufacturing costs to offer affordable solutions (Zeschky et al., 2011); consequently, resource-saving materials are needful in the production process (Zeschky et al., 2011; Hossain, 2017, as cited in Hossain, 2021; Weyrauch & Herstatt, 2016). Additionally, the perfor-

mance of FIs is required (intentionally) to not exceed the standard threshold of quality to ensure low manufacturing costs (Weyrauch & Herstatt, 2016).

To sum up, FIs can be defined as cheaper alternatives to existing technologies or new affordable solutions whose aim is to address the needs of price-sensitive consumers (Hossain et al., 2016; Bollyky, 2015).

In the light of the aforementioned considerations and the literature review provided in chapter 2, the current thesis considers “substantial cost reduction” to be an appropriate and broad terminology in defining the economic nature of FIs. Conversely, the terminology “affordable”, despite being widely used in the literature, could potentially lead to misunderstandings, such as the mere consideration of the consumer perspective (Weyrauch & Herstatt, 2016). In different words, affordability may simply recall the purchasing power of consumers, i.e., whether the technology is affordable for them, hence omitting the perspective of the manufacturers and the service providers.

Lastly, our study considers the terminology “cost” to be appropriate as it correctly implies both purchasing price or operating costs and, in the best-case scenario, the total cost of ownership incurred by consumers when purchasing and using the product/service.

As a result, our study embraces the work of Weyrauch & Herstatt (2016), thus supporting the use of “substantial cost reduction” as it represents a broad attribute, hence being in line with the purposes of the thesis. However, such a feature, despite representing the primary focus of frugality, is not sufficient to qualify FIs. Indeed, as suggested by Weyrauch & Herstatt (2016), other complementary dimensions must be considered.

### **3.2. Concentration on core functionality**

The model of Weyrauch & Herstatt (2016) identifies the attribute concentration on core functionalities to be crucial in differentiating FIs from other conventional solutions. Dosi et al. (2012) & Mishra (2021) are on the same page as they argue that the principle of basic functionality is suitable for accommodating the essential needs of resource-constrained consumers. In this regard, a careful assessment of the real needs is required, to successfully identify the essential features that need to be considered in the design process (Agarwal & Brem, 2012).

As a result, frugal innovators come up with a solution whose design is simple and responds to essential needs (Simula et al., 2015). In this regard it is worth considering that simplicity does not merely consist in removing non-essential features, rather it implies solutions that are “redesigned innovatively while keeping in mind the user requirements” (Vadakkapat et al., 2015, p.1). Among the constrained consumer’s needs, reduction complexity is acknowledged to be crucial (Tiwari & Herstatt, 2020; Weyrauch & Herstatt, 2016; Markiewicz, 2021; Zeschky et al., 2011; Schumacher, 1973). In today’s society, feature fatigue is a major concern, meaning that consumers try to avoid complex products that might be difficult to use (Tiwari & Herstatt, 2020).

Consequently, FIs - also identified as no-frills innovations (Rao, 2013) - imply technologies that are intuitive, user-friendly, and comfortable (Agarwal & Brem, 2012; Brem, 2017; Singh et al., 2020). Additionally, FIs need to be designed in a way to ensure the accessibility of the solution itself, e.g., being portable and mobile (Miesler et al., 2020). In other words, accessibility is a required function as it ensures the innovation to overcome the infrastructural barriers.

ers that inhibit consumers' access to the product or service, hence ensuring proper functioning despite the environmental scarce settings (Herstatt & Tiwari, 2020). In this regard, accessibility is not considered in economic terms but rather in technical terms, i.e., the product/service is accessible when it is viable in a constrained environment.

On the other hand, the removal of non-essential features contributes to creating additional value as follows. First, it is in line with the attribute of substantial cost reduction Weyrauch & Herstatt (2016), as it leads to substantial savings (Rao, 2013; Markiewicz, 2021). Secondly, given the more conscious use of resources, no-frills innovations are crucial in fostering a more sustainable and eco-friendly approach (Rao, 2013; Brem & Wolfram, 2014; Dandonoli, 2013). The latter aspect is relevant as the minimalist approach is a consequence of the resource paucity that characterizes the contexts where FIs are developed (Cunha et al., 2014). Given the absence of advanced features, FIs have been interpreted at the real beginning as "low-tech solutions" or "technologically less advanced solutions" compared to conventional innovations (Agnihotri, 2015; Corsini et al., 2021). However, this is in line with the very beginning school of thought as FIs have been conceived meet satisfy the basic needs of constrained consumers rather than sophisticated markets (Radjou & Prabhu, 2014). However, given the increasing role of technology in fostering frugality (Miesler et al., 2020), the labels do not apply nowadays, and they are excluded from the model of Weyrauch & Herstatt (2016) as well.

In the wake of the above, the label "simple design" should be interpreted carefully: it refers to a technology that is easy to manufacture and meets the basic needs of consumers.

However, a solution whose simple design is based on a limited set of functions may be interpreted as a low-quality innovation (Zeschky et al., 2011). In this regard, Winkler et al. (2020) suggest considering the aesthetics dimension in the design process to influence the performance perceived by consumers. The technology's image has the potential to increase consumers' confidence, hence generating trust in the purchase process (Luchs et al., 2012). Further support is provided by Singh et al., (2020) who identify aesthetics design as one of the most essential attributes as it successfully enables widespread use of FIs. Constrained consumers - in both Western and emerging countries - are willing to buy "products that do not carry the stigma of being a poor people's product" (Tiwari & Herstatt, 2012a, p.250). Therefore, enhancing the appearance of a product emerges to be critical in meeting consumers' quality expectations. This consideration becomes even more critical if we consider the popularity of FIs in Western countries where high standards of quality are required (Trienekens & Zuuglorbier, 2008; Tiwari & Herstatt, 2012a).

Although the aesthetics dimension is not identified as crucial in defining FIs, innovators that are able to find a balance between basic functionality and the aesthetics of innovation are likely to succeed in the commercialization of FIs. As a result, our study agrees with the attribute "concentration on core functionality" and suggests to not overestimate the aesthetics dimension while keeping the design straightforward as "simple and aesthetics innovations" (Hossain, 2017) are likely to nurture scalability.

### **3.3. Optimized performance level**

The proper functioning of a product as an essential attribute is supported by extensive literature with the following labels: "robustness", "user-friendly", "accuracy", "acceptable quality", "durability", "safety", "adaptability", "good functionality at a low price", "good-enough", and

“meet the required standards” (Weyrauch & Herstatt, 2016; Lehner & Gausemeier; 2016, Mukerjee, 2012; Palepu & Srinivasan, 2008, as cited in Tiwari & Herstatt, 2012a; Ploeg et al., 2021; Agarwal & Brem, 2012; Agarwal et al., 2017; George et al., 2012).

While evaluating the performance of frugal solutions, the value-cost ratio must be considered - FIs are classified as such if they provide high value in terms of performance relative to their lower price and basic functionalities (Brem & Wolfram, 2014; Farooq, 2017).

The performance of FIs could potentially exceed the quality standards met by conventional and non-frugal solutions, depending on the specific context (Tiwari & Herstatt, 2012c; Tiwari et al., 2017). There are environments whose constraints can be overcome only with higher performances (Weyrauch & Herstatt, 2016). As a result, “the performance level must optimally fit the intended purpose and the specific requirements of the environment in which the frugal innovation will be used” (Weyrauch & Herstatt, 2016, p. 9). According to Vadakkepat et al. (2015), innovations are categorized as frugal when they are “meaningful in the user context”, thus carefully considering the consumer’s requirements (p.1).

As a result, FIs do not compromise quality to lower the costs, but rather they ensure to customers the right performance given the context-specific requirements (Tiwari et al., 2017). Using the words of Farooq (2017) “products and services should not be of inferior quality but must be affordable with high quality” (p. 326).

Given the above, a good performance is essential in complementing the economic dimension previously discussed. Indeed, companies that focus solely on lowering costs run the risk of developing a technology that is perceived as inferior (Miesler et al., 2020). Proper functioning is required to guarantee the success of a product or service, hence favoring its scalability (López et al., 2020). This aspect emerges to be particularly relevant when considering Western countries, hereby predominant legal, quality and safety standards are required to be met (Tiwari & Herstatt, 2012a).

### **3.4. Intrinsically sustainable value**

While defining FIs, Weyrauch & Herstatt (2016) identify sustainability as an additional although not essential attribute, thus excluding it from their conceptual framework. However, the attributes explained so far imply an intrinsic sustainable value which emerges to be crucial in differentiating FIs from other low-cost innovations (Agnihotri, 2015; Brem & Wolfram, 2014). FIs move beyond the mere cost advantage, as they represent valuable solutions contributing to the environmental and societal well-being (Brem, 2017). Hossain (2017) further emphasizes the social value of FIs.

In the first instance, the necessity of “doing more with less” leads to a more conscious use of resources, thus contributing to sustainability in terms of environmental safeguard (Herstatt & Tiwari, 2020). Resource minimization affects the whole development process (Dandonoli, 2013; Markiewicz, 2021) and results in an efficient and resilient supply chain system (Rosca et al., 2018).

The minimization of resources represents a defining element of FIs. According to Herstatt & Tiwari (2020) “being wasteful violate the very principle of frugality” (p.26). As a result, the production process mainly relies on the use of local and cheap resources that are readily available (Markiewicz, 2021; Rosca et al., 2017; Sharma & Iyer, 2012) to be resourceful in a constrained environment (Harris et al.; 2020). This approach leads to a simple and cost-

effective design that better copes with the resource paucity and infrastructural issues characterizing constrained environments (Sharma & Iyer, 2012).

Given the above, FIs are acknowledged for their ecological nature as they are characterized by an eco-design, thus being identified as intrinsically eco-friendly solutions involving a low carbon footprint (Weyrauch & Herstatt, 2016; Rosca et al., 2017; Gupta & Wang, 2009, as cited in Brem & Wolfram, 2014; Markiewicz, 2021).

In addition to environmental protection, sustainability also concerns the well-being of society as a whole, namely it refers to the simultaneous creation of economic and social benefits (Rosca et al., 2017; Mvulirwenande & When, 2020). With this in mind, frugal solutions - deliberately and/or inherently – positively contribute to general welfare (Herstatt & Tiwari, 2020). They represent inclusive low-cost technologies (George et al., 2012) that accommodate the basic needs of a market that otherwise would remain marginalized given its constrained and challenging context (Kahle et al., 2013).

In addition to representing a mechanism for poverty relief (Schumacher, 1973), FIs improve the quality of living standards, e.g., by ensuring access to low-cost healthcare for the poorest (Rosca et al., 2017; Kahle et al., 2013).

To sum up, FIs enhance sustainability value creation (Hristov et al., 2019) as they “create significant positive and/or significantly reduced negative impacts for the environment and/or society” (Bocken et al., 2014, p.44).

In the wake of the above considerations, our study considers intrinsically sustainable value as a characteristic attribute – in other words essential – of frugality.

**Table 1: Frugal Innovations attributes**

<b>FIs Attributes</b>	<b>Sub-features</b>	<b>Source</b>
<b>Substantial cost reduction</b>	Much lower price, significantly lower costs, ultra-low costs	<i>Weyrauch &amp; Herstatt (2016)</i>
	Lower costs of usage, lower costs of disposal, lower costs of maintenance	<i>Herstatt &amp; Tiwari (2020)</i>
	Low cost of ownership	<i>Herstatt &amp; Tiwari (2012a)</i>
	Advantageous cost	<i>Lehner &amp; Gausemeier (2016); Zeschky et al. (2011); Simula et al. (2015); Hossain et al. (2016)</i>
	Affordable, cheap	<i>Hossain et al. (2016) &amp; Bollyky (2015)</i>
	Low manufacturing costs	<i>Zeschky et al. (2011)</i>
	Resource-saving materials	<i>Zeschky et al. (2011); Hossain, (2017) as cited in Hossain, (2021); Weyrauch &amp; Herstatt (2016)</i>
<b>Concentration</b>	Simple design	<i>Weyrauch &amp; Herstatt (2016) &amp; Simula et al. (2015)</i>

<b>on core functionalities</b>	Basic functionality	<i>Dosi et al. (2012) &amp; Mishra (2021)</i>
	Essential features	<i>Agarwal &amp; Brem (2012)</i>
	Reduction complexity	<i>Tiwari &amp; Herstatt (2020); Weyrauch &amp; Herstatt (2016); Markiewicz (2021); Zeschky et al. (2011); Schumacher (1973)</i>
	Intuitive, user-friendly, comfortable	<i>Agarwal &amp; Brem (2012); Brem (2017); Weyrauch &amp; Herstatt (2016); Singh et al. (2020)</i>
	No-frills	<i>Rao (2013)</i>
	Accessibility	<i>Miesler et al. (2020) &amp; Herstatt &amp; Tiwari (2020)</i>
	Portable and mobile	<i>Miesler et al. (2020)</i>
<b>Optimized performance level</b>	Robustness, user-friendly, accuracy, acceptable quality, durability, safety, adaptability, good functionality at a low price, good enough, meet the required standards	<i>Weyrauch &amp; Herstatt (2016); Lehner &amp; Gausemeier (2016); Mukerjee (2012); Palepu &amp; Srinivasan (2008) as cited in Tiwari &amp; Herstatt (2012a); Ploeg et al. (2021); Agarwal &amp; Brem (2012); Agarwal et al. (2017); George et al. (2012)</i>
	High value-cost ratio	<i>Weyrauch &amp; Herstatt (2016); Farooq (2017); Brem &amp; Wolfram (2014)</i>
	High performance	<i>Weyrauch &amp; Herstatt (2016); Tiwari &amp; Herstatt (2012c); Tiwari et al. (2017)</i>
	Right performance, meaningful in the user context	<i>Tiwari et al. (2017); Farooq (2017); Vadakkepat et al. (2015)</i>
<b>Intrinsically sustainable value</b>	Societal well-being, quality living standards, poverty relief; serving marginalized consumers	<i>Rosca et al. (2017); Mvulirwenande &amp; When (2020); Herstatt &amp; Tiwari (2020); Schumacher (1973); Kahle et al (2013)</i>
	Minimization of resources, local resources, available resources	<i>Dandonoli (2013); Markiewicz (2021); Rosca et al. (2017); Sharma &amp; Iyer (2012)</i>
	Eco-design, eco-friendly, low-carbon footprint, environmental safeguard	<i>Weyrauch &amp; Herstatt (2016); Rosca et al. (2017); Gupta &amp; Wang (2009) as cited in Brem &amp; Wolfram (2014); Markiewicz (2021);</i>

Source: Own work based on the developed conceptual framework

## 4. Methodology

### 4.1. Article searching process & literature review

The proposed study employed a qualitative approach to investigate whether Western countries have developed frugal solutions to face the challenges posed by the pandemic.

First of all, in order to provide the reader with extensive knowledge on the overall topic of FIs, a literature review of 85 articles was performed.

This stage is crucial as it enables the reader to comprehensively understand what FIs are and what is the role they play in both emerging and Western contexts according to previous studies.

In this regard, both earlier and recent studies were considered. In particular, the present-day studies were crucial as they move beyond the context of emerging markets, advocating the growing development of a frugal mindset in Western countries, particularly in the face of the recent pandemic crisis and its related challenges. To do so, a wide time span emerged to be appropriate: studies ranging from January 2011 to November 2021 were considered.

The publications were sorted from multiple sources: Google Scholar, Scopus, JSTOR, SAGE Journals, and the Hohenheim Electronic Library Catalogue (HohSearch).

In order to narrow down the literature relevant to the analysis, the key phrase "*frugal innovations*" – the central topic of the current study – was combined with the following keywords: "*definitions*", "*covid-19*", "*covid pandemic*", "*Western countries*", "*developed economies*", and "*BoP markets*". Furthermore, the keywords "*frugality 4.0*" and "*frugal lifestyle*" were searched singularly. Differently, the main key phrase of the study (*frugal innovations*) could not be used singularly in the search engines as it could lead to a considerable amount of data – yet redundant and misleading – demanding excessive and unfeasible work due to the time constraints to which such thesis is subject.

Additionally, the literature review was limited to open access studies written in English.

Furthermore, given the considerable number of articles, a title and abstract screening were processed to narrow the relevant contents. In this regard, it is crucial to underline that the topic of FI itself has been acknowledged for being too broad, and therefore sometimes unclear (Hossain, 2017). With this in mind, narrowing down the field of study is crucial to enable the reader to better understand the landscape of frugality.

Lastly, redundant sources were excluded, hence leading to a total of 85 articles. The number – yet considerable – is reasoned by the wide time span that was considered and, particularly, the necessity to discuss different aspects of the topic: the development of FI in both emerging and Western countries, the covid-19 crisis, its impact in the West and the related role of frugality.

## **4.2. Development of a conceptual framework**

In order to understand how FIs have been defined so far by researchers, an extensive literature review was carried out at this stage as well, based on the articles retrieved through the search process described above. An approach similar to Winkler et al. (2020) was employed: the study selected an existing model and disused it through further literature.

In order to accomplish the final goal, namely investigating the role of frugality in the West, it was necessary to rely on a concept that could find a general application, as suggested by Vesci et al. (2021). As a result, the model developed by Weyrauch & Herstatt (2016) emerged to be the most appropriate; furthermore, it is acknowledged for its accuracy, and thus widely accepted and cited by several authors when referring to the theme of frugality (Winkler et al., 2020; Miesler et al., 2020; Tiwari & Herstatt, 2020; Beise-Zee et al., 2021; Singh et al., 2020).

Weyrauch & Herstatt (2016) define innovations as frugal when they simultaneously meet the following criteria: substantial cost reduction, concentration on core functionalities, and optimized performance level (p.10).

The reviewed literature enabled the current study to identify an additional frugal feature, hence adapting the model of Weyrauch & Herstatt (2016) from three to four core frugal attributes. More details follow in chapter 4 where the conceptual framework is developed.

However, following the above, it is worth noting that the described approach could involve some drawbacks. The current work is based on existing theories and this approach could be criticized for being mostly “descriptive”, thus being based on low critical judgment and biased from subjective perspective and knowledge of other authors (Tranfield et al., 2003).

Nevertheless, the approach employed in the current thesis is sufficient as it is considered appropriate when dealing with an extensive and diverse knowledge base (Tranfield et al., 2003). Furthermore, the conceptual framework we employ is good enough as (1) it is based on a recognized valid work (Weyrauch & Herstatt, 2016) and, although functional to our final purpose, (2) defining FIs does not represent the main focus of the current research.

### **4.3. The content analysis approach**

#### **4.3.1. The Sampling criteria**

The following stage of the study consisted of a content analysis aiming to identify the presence of frugal attributes among the CIs. More specifically, a qualitative content analysis represents a research methodology that allows to interpret text data and proceed with a classification of common themes into categories (Hsieh & Shannon, 2005; Soiferman, 2010).

To begin with, the proposed study relied on the data provided by the Chair for Innovation Management (from the University of Hohenheim) and used by the Chair itself in a former work.

The aforementioned dataset consisted of 707 covid innovations classified by different sectors. To narrow down the relevant CIs, the following selection criteria were applied.

First, the study was limited to the healthcare industry counting a total of 135 CIs. To be concise as much as possible, the innovations simultaneously classified into other sectors besides healthcare were excluded. As a result, the sample was restricted to 74 CIs.

The selection criterion concerning the specific industry is based on logics that go beyond the mere necessity to analyze a narrow – hence manageable – sample. Indeed, the healthcare sector is acknowledged for representing a fertile ground for FIs (Brem & Wolfram, 2014). The existing literature indicates countless examples of frugal healthcare in emerging countries (Simula et al., 2015; Hossain, 2021), in some cases crossing borders and reaching the developed countries as RIs (Weyrauch & Herstatt, 2016; Agarwal & Brem, 2012). Miesler et al. (2020) provide further support by pointing out the growing necessity for affordable and good enough solutions in the developed medical system. According to Hossain (2017), one-third of the frugal innovations cited in the literature is addressed to health needs.

As a result, the healthcare industry represents a fertile ground for FIs, so it is worthwhile to analyze its related innovation. In particular, the current pandemic has been classified as a healthcare crisis before an economic one, leading to the collapse of both developing and developed healthcare systems (Kraus et al., 2020; Harris et al., 2020). Given this, it is rele-

vant to understand how companies have faced the challenges posed at the real beginning to a hard-hit sector.

After selecting the relevant industry, further criteria were set out.

As Western countries represent the focus of the study, the 74 healthcare innovations were further filtered by specific geographic areas. So, the analysis was restricted to innovations initially developed in the United States of America, the United Kingdom, and European countries, regardless of the extent of their geographical diffusion.

As a result, 26 CIs were not considered, thus leading to a sample of 48 remaining innovations.

At this stage, it is crucial to dive into the discussion concerning the type of content/data that have been analyzed. The dataset consisted of CI descriptions retrieved from web sources such as articles, magazines, blogs, and websites of Western companies. With regard to this aspect, we provide the reader with a detailed description of each of the innovations considered in the analysis (as shown in Appendix B); the specific descriptions were retrieved through the MAXQDA software and, to facilitate the understanding of the reader, the references with regard to the coded segments are displayed alongside. Additionally, a list of references concerning the sources used in the analysis is indicated in Table X (as shown in Appendix C).

Each of the descriptions was based on written and/or audio-visual messages. The latter refers to videos that were transcribed (when available) to provide additional insights to the text data; in this case, latent content was not considered in the analysis so as not to fall into the trap of excessive interpretation (Elo & Kyngäs, 2008). Additionally, reviews from customers or external press - when indicated in the web source itself - were considered, as it is crucial to account for the stakeholder's perspective when valuing FIs and their related benefits/challenges (Weyrauch & Herstatt, 2016).

Furthermore, the innovations whose descriptions were written in other languages than English were not considered in the coding process.

Lastly, articles whose content was not available or not sufficiently descriptive were excluded from the analysis as well. The lack of information represents a limitation affecting any qualitative study based on a content analysis approach (Azungah, 2018). The expression "not sufficiently descriptive" refers to web sources merely consisting of interactive applications or pages with no written text referring to the specific innovation, and descriptions consisting in a short paragraph. The reasons for excluding insufficiently descriptive innovations is as follows: the study aims to guarantee an approach that is objective as much as possible, hence avoiding superficial or absent descriptions that cannot be interpreted and organized according to themes. The study's approach is in line with the recommendations of Graneheim & Lundman (2004) who clearly remark the necessity to rely on data that are "large enough to be considered a whole and small enough to be possible to keep in mind as a context for the meaning unit" (p.106).

In the wake of the above, the final sample considered in the coding process consisted of 35 CIs descriptions developed in Western countries.

The qualitative content analysis was conducted using MAXQDA 2020 (VERBI Software, 2019).

#### 4.3.2. The coding approach

The study employed a hybrid approach consisting of both deductive and inductive analysis, which is appropriate as it contributes to validating and broadening existing theories (Hsieh & Shannon, 2005). Indeed, the current analysis tests the validity of the generic definition of FIs provided by the literature and verifies whether the recent (and scarce) studies calling for frugality as a response to the covid crisis are well-founded.

By focusing on Western countries, there is the potential to expand a theory that is currently mainly focused on emerging countries.

Following the above, the deductive coding was undertaken first.

The majority of the codes<sup>1</sup> were determined through a deductive approach; the reason lies in the existence of a pre-defined conceptual framework that provided us with key terms whose generic definition simplified their identification. Indeed, relying on a pre-defined coding scheme is suitable when existing theories and models are available (Hsieh & Shannon, 2005; Azungah, 2018).

The analysis aimed to identify four main themes, namely the core attributes introduced in chapter 3: substantial cost reduction, concentration on core functionality, optimized performance level, and intrinsically sustainable value. In order to simplify their identification, different subdimensions were defined. In particular, the ones referring to the *substantial cost reduction*, *concentration on core functionality*, and *intrinsically sustainable value*, were determined deductively based on the pre-defined conceptual framework. Indeed, many of the “frugal labels” introduced in Table 1 (chapter 3) were considered synonymous with each other, therefore the current analysis clustered them in a limited set of codes. By doing so, the analysis followed Elo & Kyngäs (2008) who suggest avoiding a large number of categories to not excessively fragment the subject matter with the risk of compromising the quality of the overall analysis. Further support is provided by Hsieh & Shannon (2005) who clearly point out the necessity to not fall into the trap of “over-categorising” which may lead to difficulties in the understanding of the overall topic.

In order to identify frugal attributes among text data, direct expressions consisting of the same or similar words were sought. Whenever this approach could not be feasible due to a lack of explicit words, text data were interpreted, so themes were indirectly derived from sentences. The interpreting approach is often necessary when relying on data referring to healthcare topics (Hsieh & Shannon, 2005). In this regard, the reviewed literature was used to validate and provide a quality interpretation of the text data, as suggested by Soiferman (2010). With this in mind, more details follow.

#### 4.3.3. Building the Code System

Starting with *substantial cost reduction*, the code “*low-cost innovation*” (Table A1, as shown in Appendix A) was conceived to be broad as much as possible and include at least one of the economic aspects mentioned in our conceptual framework, namely (1) the purchasing price solely, (2) the operating costs barely (3) or both, i.e., the total cost of ownership (Weyrauch & Herstatt, 2016). Those elements were identified through several concepts such

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<sup>1</sup> When performing content analysis, the codes represent tools that identify key themes among text data (VERBI Software, 2019). In the current study, they represent the keywords that define the covid innovations, in other words, the attributes of the innovations.

as: innovations leading to savings (CI2, Appendix B), payments limited to shipping costs (CI3, Appendix B), and cost-effective remote care (CI 5 & CI 7, Appendix B). To continue, other relevant innovations were identified under the code low-cost innovation, such as considerable discounted services ensuring smooth communication between patient and healthcare professionals (CI13, Appendix B), technologies safeguarding from inflated prices (CI11, Appendix B), and solutions making patients save money by comparing telemedicine prices (CI25, Appendix B). In some of the CI descriptions, direct references were provided through explicit words such as: affordable ventilators (CI18, Appendix B), low-cost ventilators and cost-effective medical devices (CI32, Appendix B).

Concerning the innovations where information on the price incurred by the final customers were not available, references about production costs (or cost-saving production processes) were considered as a proxy – the cost incurred by the manufacturer or service provider is indirectly implied by the price (Weyrauch & Herstatt, 2016). In this regard, we coded innovations whose production of medical equipment was based on cheap and already available materials such as “bed sheets” and plastic (CI13 & CI19, Appendix B) or available equipment such as 3D printers used in simple and fast production processes, i.e., cutting pieces of plastics to make face shields (CI33, Appendix B).

The above-mentioned approach found support in Zeschky et al. (2011) & Hossain (2017, as cited in Hossain, 2021) who acknowledged the crucial role that low manufacturing processes play in lowering the final price of frugal innovations. In this regard, the interpretation employed in this study is further supported by Sharma & Iyer (2012) as they believe that minimising resources during the production process leads to cost advantages.

Lastly, through inductive coding two proxies of the terminology “substantial” were identified: “*No-cost solution*” and “*External funds/resources*”,

The code *No-cost solution is self-explanatory*, hence it referred to costless innovations by looking at the customer perspective; the code was linked to donated medical equipment (CI8, CI10 & CI11, Appendix B), medical services provided free-of charge through app (CI16 & CI20, Appendix B) or through volunteering activities (CI24, Appendix B).

Differently, the code *External funds/resources* looked at the manufacturer/service provider perspective; it was applied to innovations financially financed through fundraising campaigns (CI3, CI11 & CI32, Appendix B) or supported by donations of available medical equipment (CI11 & CI21, Appendix B).

The use of such codes as proxies of “substantial reduction” found support in further literature that provide examples of free- of charge and subsidised FIs (Haudeville & Wolff (2016), Tran & Ravaud (2016), Khan, R. (2016) & Gambhir (2012).

Proceeding with the attribute *concentration on core functionality* – three codes were determined deductively and labelled as “*simple*”, “*essential functions/information*” and “*accessible*” (Table A1, as shown in Appendix A).

The attribute *simple* clustered all the above-mentioned features (Table 1) such as: simple design, reduction of complexity and no-frills; they all refer to the innovations’ design, i.e., how the solution looks like, or its design process (Vadakkapat et al., 2015). As a result, the attribute *simple* was assigned to solutions like: innovations conceived through drawing on a piece of paper (CI1, Appendix B), cloth masks with a “plastic window” to show facial expressions – developed through home-made craft skills (CI3, Appendix B), protective devices merely

printed with 3D machines (CI5, Appendix B), streamlined software (CI13, Appendix B), medical devices easily made and replicable (CI18, Appendix B), and solutions consisting of a flat plastic design (CI19, Appendix B) among others. Additionally, the specific word “simple” was searched and matched with different solutions (CI26, CI27 & CI32, Appendix B). Lastly, synonymous were coded as well, such as the word “straightforward” (CI12, Appendix B)

When referring to the attribute *essential functions/information* the already mentioned basic functionality principle emerged (Dosi et al., 2012; Mishra, 2021), according to which constrained people prefer technologies that better answer their essential needs in times of crisis and not their superfluous wishes (Dosi et al., 2021). In this regard, synonyms and self-explanatory words were coded, mainly when healthcare services or products providing vital examinations (CI7, Appendix B) or information labelled as necessary/critical (CI2 & CI13, Appendix B), pivotal (CI4, Appendix B), and “important” (CI32, Appendix).

Given the worldwide impact of the disease, flattening the epidemic has been identified as the main priority in the pandemic era (Kraus et al., 2020; Santos, 2020). As a result, preventing infections has proved to be the most pressing need expressed by the whole healthcare system and society (Dahlke et al., 2021). In such circumstances providing healthcare assistance remotely or at home has proved to be vital (CI5, CI17, Appendix B).

The last attribute, labelled with the word “*accessible*”, consisted of all the solutions able to provide patients with the opportunity to bypass the constraints that inhibit adequate access to care (Tiwari & Herstatt, 2012b; Herstatt & Tiwari, 2020). As a result, it was explained through the following sub-dimensions: “*user-friendly, comfortable, small/portable, and non-hospital settings*” (Table Y) – the latter one was determined inductively.

Beginning with the code *user-friendly*, the ability to ease access to healthcare through the intuitiveness of healthcare solutions (Agarwal & Brem, 2012) and the principle of learnability (Singh et al., 2020) were considered. With this in mind, the coded innovations were those identified respectively as easy to use (CI7, CI13, & CI16, Appendix B), instructive and comprehensive (CI2 & CI4 Appendix B), and smart (CI5, Appendix B).

The code *comfortable* was linked to descriptions where the word was used explicitly (CI27 & CI31, Appendix B). Additionally, innovations were coded as comfortable when improving the patient experience with the technology; more specifically, innovations that were adjusted to the requirements of the users, thus being more pleasant/enjoyable, were coded (CI3, CI19, CI27, CI31 & CI32, Appendix B).

Concerning the following attribute - *small/portable* - the study from Miesler et al. (2020) provided insights that were crucial to the analysis, as the authors acknowledge that technologies when reduced in size are easily accessible. Medical devices - in the specific case ventilators and tests detecting for covid infections with explicit references to size reduction were considered (CI6 & CI32, Appendix B).

The last attribute concerning accessibility represents an exception as it was identified through an inductive approach. The specific attribute, denominated *no-hospital settings*, coded all the innovations providing remote care during the covid emergency, hence making the health service accessible to people quarantined at home (Kraus et al., 2020) and accommodating the need to reduce contagious (Santos, 2020) by limiting access in presence to hospitals and clinics which are considered to be the most infectious sites in the midst of the emergency (Etherington, 2020). With this in mind, explicit words and phrases were found, thus leading to coding innovations providing remote care with the support of rapid self-tests,

smartphones and telemedicine (CI6, CI5 & CI7, Appendix B), and care services delivered in other locations other than hospitals such as: home (CI26, Appendix B), tents, community centers and schools (CI29, Appendix B), and, finally, in sites with no electronic health records (CI29, Appendix B).

Concerning the third core attribute – *intrinsically sustainable value* - the analysis tried to detect (deductively) for both dimensions of inclusiveness and resource-efficiency (Table A1, as shown in Appendix A).

Starting with “*inclusive*” innovations, the code referred to those solutions addressing the needs of the marginalised communities (Kahle et al., 2013), hence people whose needs have remained underserved or not properly served during the health crisis. In particular, we coded innovations especially conceived for differently abled people who have been “looked over” (CI3 & CI31, Appendix B), innovative services supporting the economically constrained communities (CI11, Appendix B) and the unemployed medical staff (CI16, Appendix B), and, finally, services provided to the vulnerable and underserved (CI17 & CI29, Appendix B).

The attribute “*resource-efficient*” simply recalls the minimization of resources principle, irrespective of whether the resources are intentionally minimized to pursue environmental goals; what matters the most in such a constrained environment (namely the ongoing pandemic) is proving to be resourceful (Herstatt & Tiwari, 2020). In this regard, a clarification is worthwhile: with the expression “resources” we did not mean “money” but rather “material resources” (such as raw materials and equipment) as the former were already considered while discussing the low-cost innovation attribute; indeed, saving financial resources impact the cost of innovation.

Innovations were coded as resource-efficient when specific words underlying the eco-friendliness of the innovations appeared (Rosca et al., 2017; Gupta & Wang, 2009, as cited in Brem & Wolfram, 2014; Markiewicz, 2021) such as: the production of cleanable and reusable masks and other protective equipment (CI1, CI3 & CI33, Appendix B) and production of handmade masks (CI21, Appendix B). Secondly, the code resource-efficient was linked to solutions relying on the use of available resources as already suggested by Dandonoli (2013), Markiewicz (2021), Rosca et al. (2017), and Sharma & Iyer (2012). More specifically, the following solutions were considered: protective equipment produced through available machinery like 3D printers (CI10, CI33, Appendix B) and available raw materials like pieces of cloth and plastic (CI3 & CI19, Appendix B). The minimization of resources was also expressed through several more concepts: conversions of non-medical products into medical devices including ventilators (CI12, Appendix B), optimization of existing disposable masks (CI27, Appendix B), and re-allocation of already existing resource and medical equipment through donations (CI11, CI21, Appendix B). Lastly, innovative solutions aiming to alleviate the use of ICU beds, ICU ventilators and other clinical resources were considered as well (CI12, CI15, CI17 & CI18, Appendix B).

At this stage, the focus shifts to the last attribute of the conceptual framework: *the optimized performance*. In this case, different dimensions of performance emerged from the text data, namely: “*robustness*”, “*quality care*”, “*safe*”, “*higher-performance*”, “*helpful*”, “*fast*” and “*meeting regulatory requirements*” (Table A1, as shown in Appendix A).

All the dimensions were determined inductively, thus emerging from the text data rather than being pre-determined (Elo & Kyngäs, 2008). As pointed out by Winkler et al. (2020), the op-

timized performance attribute is the most complicated one to define as it is influenced by the context in which it is analysed.

As a result, the concept can differ depending on the specific unit of analysis. Therefore, technologies in the healthcare sector are considered of good quality based on criteria that can be specific to the industry itself (Miesler et al., 2020).

Starting with *robustness* – although acknowledged in our conceptual framework as well – the aspect emerged inductively from the text data, in relation to medical devices rather than services. This aspect was expressed through a few concepts, i.e., resistance to the access of microorganisms (CI31, Appendix B) and liquids (CI14 & CI31, Appendix B).

Proceeding with *quality care*, CI descriptions were coded when explicitly indicating the word “quality” (CI7, CI11, CI22 & CI27, Appendix B) or expressions such as “accuracy” (which has been already recognized as a measure of quality in Weyrauch & Herstatt, 2016) appearing in CI6 (as shown in Appendix B). Additionally, border concepts were classified, such as the capability to ensure the required oxygen supply, thus facilitating the breath (CI12 & CI32, Appendix B), a good system in tracking or diagnosing the infection (CI6 & CI7 Appendix B), ensuring remote care of comparable quality to the in-presence care (CI5 & CI7, Appendix B), and finally lifesaving solutions (C1, CI2, C15, C18, Appendix B).

Concerning the dimension *safe*, self-explanatory phrases were found, particularly when describing healthcare remote services aiming to reduce infections in hospitals (CI5 & CI7, Appendix B), medical equipment ensuring protective effectiveness (CI27 & CI31, Appendix B), and finally, services and/or products ensuring the safety of medical data (CI15, Appendix B).

Then we come at the attribute *higher performance*, identified through expressions emphasizing the exceeding the expected performance (CI2 & CI32 Appendix B) or the performance offered by conventional solutions, hence moving beyond the traditional offer of healthcare technologies (CI5, CI7, CI27 & CI31, Appendix B).

The following attribute *helpful* mainly referred to the services that are able to do their job properly in such challenging time, thus providing the required assistance/information to patients or healthcare professionals in order to learn how to effectively cope with the disease.

More precisely, the code clustered all the CI descriptions where specific terms appeared: useful, helpful, easing questions, instructive, handy (CI2, CI4, CI3, CI16, CI20, CI22 & CI26, Appendix B).

Concerning the attribute *Fast*, the code was identified easily among the descriptions thanks to direct indication on the time employed to produce the medical devices (masks, visors, face-shields) or delivering the healthcare service (e.g., consultations); in particular, fairly expressions were coded: “hours”, “minutes” and “seconds” (CI1, CI6, CI7, CI8, CI10, CI16, CI21, CI32 & CI33, Appendix B). In other cases, adverbs and adjectives implying the attribute fast were identified, more precisely the following words were coded: timely (CI2, Appendix B), time-saving (CI7, Appendix B), quickly (CI15, CI19 & CI23, Appendix B), instantly (CI17, Appendix B) and rapidly (CI29 & CI32, Appendix B).

Further support in favour of the study’s interpretation is provided by Dosi et al. (2021) who clearly remark the necessity to provide fast solution in the current ever-changing crisis.

Lastly, we concluded with *meeting regulatory requirements*. The attribute is self-explanatory, and it was expressed through key concepts: technologies approved/authorized by the FDA (CI1, CI6, CI31, Appendix B) or other European regulatory bodies (CI15 & CI31, Appendix B), and services ensuring transparent conditions on the quality stock (CI11, Appendix B). This

aspect – namely external authorisations - is a relevant indicator of quality according to Mishra (2021).

While reading through the descriptive articles, other themes were identified and coded inductively: “*AI, experimental, triggered privacy concerns (in-vivo<sup>2</sup>), not especially browser friendly (in-vivo), costly solution, tech solution, no-tech solution, unclear tech level, aesthetics and scalable*” (Table A1, as shown in Appendix A)

At this final stage of the methodology section, it is appropriate to focusing on the codes that have not be identified in-vivo, therefore deserving a brief explanation of the coding criteria applied.

*AI* referred to the potential application of Artificial intelligence as a response to the covid-19 (CI30, Appendix B). The code *Experimental* was linked to innovations yet not tested/launched (CI23 & CI30, Appendix B).

The attribute *Tech-solutions* was coded with reference to innovations implying a technological nature from the simplest to the most sophisticated one, hence considering digital cutting machines (CI8, CI10, CI19, CI33, Appendix B), software and app (CI13, CI16, CI17, CI20, CI29, Appendix B), online platforms (CI2, CI11, CI21, CI25, CI26, CI28, Appendix B), advanced levels of telemedicine (CI5, CI7, CI29, Appendix B) and AI (CI30, Appendix B).

The other side of the coin was considered as well through the code *No-Tech solution*; innovations were coded when merely relying of human and animal skills (CI9, C23, CI24, Appendix B). Solutions of dubious interpretation were classified as *Unclear Tech level* given the lack of explicit indications (CI3 & CI22, Appendix B).

*Aesthetics*, although being discussed in the reviewed literature, was not deductively established as it was defined an important but yet not essential attribute according to the conceptual framework; however, it explicitly emerged through the reading of text data directly mentioning the visual appealing (CI32, Appendix B) and referring to the exterior design as indicator of trust (CI31, Appendix B),

Lastly, the theme of scalability emerged: the words referring to mass production of healthcare devices and services (CI19, CI27, CI32, CI33, Appendix B) and indications of considerable figures (CI1, CI6. CI7, CI8, CI11, CI20, CI21 & CI31, Appendix B) were coded. In some descriptions, the explicit word “scalable” emerged and was straightforward to be recognized (CI29, Appendix B).

A better overview of the whole discussed code system is summarized in Table A1 (as shown in Appendix A).

Before proceeding to the next sections, a consideration is noteworthy of attention to better avoid misinterpretations: many of the core attributes consist of different dimensions of analysis that are not mutually exclusive and do not necessarily have to coexist at the same time. In simple words - just to provide an example for clarification purposes - when the safety dimension emerged and the fast criterion (and others) did not, the quality attribute was nevertheless code. What really matters when defying FIs, is the simultaneous occurrence of the core criteria identified in the conceptual framework discussed in chapter 3.

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<sup>2</sup> The In-Vivo coding is a tool provided by Maxqda which provides the opportunity to select a specific word or phrase and directly code it (VERBI Software, 2019). This approach can represent the first step towards a broader coding process that aims to identify new categories (Manning, 2017).

## 5. Findings and Discussion

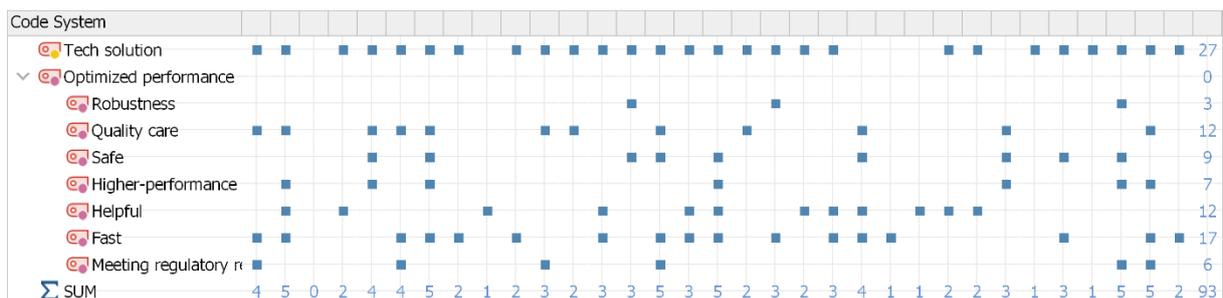
Before proceeding with the analysis it is appropriate to provide a clarification that facilitates the understanding of the data: frequencies are calculated on the number of innovations (so, documents rather than coded segments).

By looking at Table A2 (as shown in Appendix A), one can immediately identify which attributes – and to what extent – characterize the innovative response to the Covid-19 crisis in Western countries. The most significant figures relate to both optimized performance and the technological nature of the innovation itself.

More precisely, nearly 91% of CIs “do their job” despite the challenging constraints, thus serving patients and healthcare professionals properly. The significant result is not surprising as it is in line with the considerations of Tiwari & Herstatt (2020) & López et al. (2020) who have pointed out that providing quality innovations has become imperative during the pandemic. However, the high value may also be linked to the industry considered in the analysis. Indeed, the healthcare system requires solutions whose effectiveness cannot be compromised (Bhatti et al., 2017). Not only that, but it also became easier for Western economies to provide quality solutions in the healthcare sectors given the support of digitalization (Tiwari & Herstatt, 2020; Miesler et al., 2020). The technological advancement of innovations developed in the West is further supported by Simula et al. (2015).

Following the above, the pivotal role of technology emerges from the findings of the current study as well. More than half of the innovations are of technological nature (81,80%), ranging from the low-tech to the high-tech levels (e.g., implementation of AI and use of advanced telemedicine). In particular, when examining the occurrences of both codes “*optimized good performance*” and “*tech solutions*”, it can be clearly observed that they appear simultaneously in 27 out of 33 CIs (Figure 1), hence suggesting a possible correlation between the two attributes as already advanced by the above-mentioned literature.

**Figure 1:** Tech solution and optimized performance occurrences per covid Innovation (MAXQDA 2020)



**Note:** Each column corresponds to an innovation. The attributes considered in the analysis are displayed in the rows. For each innovation, a square is indicated if the attribute is present, otherwise not. The attribute tech solution appears together with one or more performance dimensions in 27 out of 33 innovations. If this state condition does not occur, the sum of the attributes (column sum) is less than 2.

However, one aspect is worth stressing emphasizing: the current study is qualitative, therefore it does not provide tools that can measure phenomena exactly, such as a possible correlation between the attributes; however, it may suggest clues for future quantitative studies that can investigate the issue further.

As a result, the current study is limited to the acknowledgment of the objective evidence that emerge from the results: technology has found considerable application in the pandemic response strategies applied in the West. Such observation supports the considerations of Kraus et al. (2020) & Ratten (2020) who have already pointed out the increasing relevance of digitalization in the covid era.

Additional attributes follow with lower percentages - yet significant given their occurrence in more than half of the innovations - namely: the *concentration on core functionality* and the *intrinsically sustainable value* attribute, with 66,70% and 63,60% respectively.

Concerning the principle of basic functionality (alias concentration on core functionality), the attribute *accessibility* is leading with the 51,50% - of particular relevance are user-friendly innovations, hence medical solutions that are intuitive and easy to use and learn for both practitioners and patients. In this regard, Simula et al., (2015) & Tiwari & Herstatt (2020) have already highlighted a growing trend in developed countries, namely the increasing difficulty to market products that are feature-rich. Such tendency increased further in the pandemic era, where less-sophisticated solutions have proved to be more effective in providing a rapid response (Carteaux et al., 2021).

63,60% of the CIs can be classified as sustainable solutions. However, the willingness to contribute to environmental sustainability through the minimization of resources - the so-called frugality by choice mentioned by Herstatt & Tiwari (2020) - is not reflected among the CIs. In other words, the resource-efficient solutions developed during the pandemic merely recall the idea of forced frugality, hence the necessity to cope with a resource-scarce environment. Therefore, being resource-efficient – in the current case – does not mean pursuing intentionally a frugal lifestyle. As a result, there is no evidence from the analysis that could support the paradigm of frugality 4.0 advanced by Herstatt & Tiwari (2020). However, this “gap” could be simply the result of the selection criterion applied with regard to the industry. A different industry (e.g., food or fashion industry) may have the potential to provide insights advancing the paradigm of frugality 4.0.

So far, when it comes to efficient medical devices, minimizing resources is not a voluntary choice but rather a compulsory choice given the circumstances.

Moving forward, the *substantial cost reduction* attribute is also well-founded, accounting for about 61% of innovations. In this regard, it is crucial to point out that the high value is due to the inclusion of free and subsidized innovations (already explained in the methodology), as less than half of the innovations can be categorized merely as low-cost innovations (36,40%). In this respect, Dahlke et al. (2021) underlined a positive trend with regard to donations, triggered by a growing need to support the most constrained people.

Lastly, nearly half of CIs (45,40%) is scalable, thus aimed at wide-ranging dissemination nationally and/or globally. In the latter case, scalability is reached through direct mass production or – in some limited cases – through open innovation (e.g., sharing the design of the innovation as done in CI18, Appendix B). The latter aspect has been identified as effective in speeding up innovativeness in times of crisis (Vesci et al., 2021; Lai et al., 2020). Sharing an innovation design also implies the attribute *resource-efficient* as the design of the innovation is adapted to the local context and the available resources (Corsini et al., 2021).

The large-scale deployment of innovations is motivated by the necessity to support global needs arising from a pandemic whose impact is worldwide (Bhatti et al., 2017).

The remaining terms seem to represent isolated cases among the innovations. As a result, it can be argued that the intention to identify key themes through a more inductive approach did not lead to significant results, except for the attribute “tech-solution” and “scalable”.

The low occurrence of the attribute *aesthetics* (9,10%) is surprising, although it finds wide support in the literature (Winkler et al., 2020; Luchs et al., 2012; Singh et al., 2020; Tiwari & Herstatt, 2012a; Hossain, 2017) it does not find concrete application in the current sample of analysis. However, at the same time, other attributes besides aesthetics could be effective and valuable to patients and healthcare workers in conveying a message of quality/safety.

In the specific case, meeting regulatory requirements is certainly a crucial aspect. By looking at the figures in Table 1 one could see that “meeting regulatory requirements” is present two times more than aesthetics (21,20%). According to Mishra (2021), safety certificates or any regulatory authorizations indirectly convey a message of quality to the customers.

The results so far show that frugal attributes have found application in some of the innovative responses employed in the West and, in addition, reveal other recurrent attributes such as tech-solution and scalable (more detail will follow on this aspect).

However, at this stage, in order to define a FI as such, the simultaneous occurrence of the four core attributes identified in the conceptual framework is required.

Therefore, Table A2 (as shown in Appendix A) does not provide sufficient information in identifying FIs. In this respect, Table A3 (as shown in Appendix A) provides considerable support. From the data shown in Table A3 (as shown in Appendix A) it is already possible to answer the second research question, i.e., whether the analysed covid innovations (in the West) apply frugal principles, hence whether they develop frugal innovations by meeting simultaneously the 4 core attributes identified in the conceptual framework.

As a result, the total of FIs developed in the Western countries equals 10 (CI2, CI5, CI7, CI10, CI11, CI16, CI18, CI19, CI32, CI33, Appendix B). In other words, almost 1/3 of the covid innovations are frugal.

At this stage, the reader has already identified the FIs.

Therefore, from now on we will refer to a sample of 10 innovations (the frugal ones) in order to better investigate frugality in the West and understand how frugal principles are applied.

First of all, in Western countries, remote care telemedicine is considered a cost-effective healthcare service as it provides quality care at a low-cost, thus representing an adequate alternative to conventional care performed in hospital settings. More specifically, economic benefits refer to money saved from traveling clinics (customer perspective) and the saving of expensive treatment (both customer and healthcare system perspective). The latter is the result of timely intervention that is supposed to help avoid costly and riskier treatments (Miesler et al., 2020) – a relevant aspect given the current healthcare emergency.

The cost-effectiveness of home telemedicine finds support in the studies of Bhatti et al. (2017) who also introduced examples of frugal innovation concerning healthcare services that support patients in reducing waiting times and expensive traveling to healthcare facilities (p.1917). Miesler et al. (2020) are on the same page as they believe that solutions favouring care in non-hospital settings imply a decrease in costs.

Other than that, from the analysed text data emerges that medical devices - such as ventilators and face shields - have been produced while relying on existing and cheap materials,

thus enabling a cost-saving production process – a typical attitude of a frugal mindset. In this regard, when discussing the production process, the usefulness of 3D printers also emerged; these machines have already been recognised by Corsini et al. (2021) as enabling a frugal response in terms of products that are easy to produce, fast, and cheap, and therefore better suited to the current ever-changing crisis. Indeed, some of the analyzed cases consisted merely of “printing and cutting” plastic pieces to produce protective care devices for few hours or - in some cases - even minutes.

Overall, 80% of the identified FIs have led to savings from the patient and/or healthcare perspective (Table A4, as shown in Appendix A).

Although less dominant, donations and external funding systems have facilitated the development of virtually free solutions.

Affordable healthcare services – as mentioned above – are relevant in the West, particularly for patients who struggle to cope with the high insurance costs characterizing the healthcare systems in developed nations (Miesler et al., 2020).

The cost dimension discussed so far shows a clear theoretical connection to a more responsible and conscious use of resources – further emphasized by Sharma & Iyer (2012) - since many of the solutions are produced with existing available resources or aim to reduce the use of critical care resources; the latter aspect is particularly evident with remote medical services that aim to provide a rapid treatment in order to avoid the inappropriate use of ICU sources. As expected from theory, Figure 2 shows that the two attributes go hand in hand with each other in 9 out of 10 FIs. An exception is made for the solution CI16 whose sustainable value is represented by the attribute *inclusive* (which is not present in the Figure 2, given the temporary intention to consider only the aspect of resources minimization).

**Figure 2:** Resource-efficient and substantial cost reduction occurrences per FI (MAXQDA 2020)

Code System	CI2	CI5	CI7	CI10	CI11	CI16	CI18	CI19	CI32	CI33	SUM
✓ Inherently sustainable value											0
✓ Resource-efficient	■	■	■	■	■		■	■	■	■	9
✓ Substantial cost reduction											0
✓ Low-cost innovation	■	■	■		■		■	■	■	■	8
✓ No-cost solution				■	■	■					3
✓ External funds/resources					■				■		2
Σ SUM	2	2	2	2	4	1	2	2	3	2	22

**Note 1:** Each column corresponds to a frugal innovation. The attributes considered in the analysis are displayed in the rows. For each innovation, a square is indicated if the attribute is present, otherwise not. The attribute resource-efficient appears together with one or more cost dimensions in 9 out of 10 innovations. If this state condition does not occur, the sum of attributes (column sum) is less than 2, as per CI16.

Indeed, it is clear from Table A5 (as shown in the appendix A) that the resource minimisation played a pivotal role in the development of the FIs. 90% of the FIs have relied on and made conscious use of already existing resources.

More specifically, CIs such as remote care, counselling services and teaching course on the use of medical devices, aimed at relieving the pressure on healthcare facilities, thus ensuring a more efficient allocation of critical resources to the patients and healthcare workers who really need life-saving devices.

Moreover, medical devices were produced with available materials/components, and by repurposing existing equipment (initially employed in the production of a different output). This approach echoes the considerations of López et al. (2020) who emphasised the strategy of “repurposing” (i.e., converting the production process toward the development of critical

items) implemented by companies whose businesses have been severely affected by the pandemic. CI10 (as shown in Appendix B) provides a specific example in this regard: it is about the conversion of a 3D machine initially used in the food industry and then redeployed to the production of face shields. Consequently, there are innovations that have demonstrated the ability to reframe a challenging situation into an opportunity – and this represents an attitude typical of frugal innovators, as already pointed out by Tiwari & Herstatt (2012b), Herstatt & Tiwari (2020) & Mvulirwenande & When (2020).

Additionally, the approach adopted by the frugal innovators in the sample can be classified as frugal as it is based on a “making do” approach” (Corsini et al., 2021; Mishra, 2021; Dunleavy et al., 2021), thus performing a bricolage activity (Mishra, 2021; Baker et al., 2003).

Finally, there is a direct reference to the production of reusable protective devices (CI33, Appendix B) which implicitly assume the eco-friendly nature of the solution considered to be a frugal characteristic by different authors (Rosca et al., 2017; Gupta & Wang, 2009, as cited in Brem & Wolfram, 2014; Markiewicz, 2021).

Surprisingly, the attribute *inclusive* does not have a high frequency among CIs, as it represents only the 20%. As well-known from theory (George et al., 2012; Kahle et al., 2013) the democratic nature of FIs - which are seen as an instrument for poor relief and providing solutions to the unserved communities - emerges to be even more critical in addressing a crisis that further increase existing inequalities (Matos et al., 2020; Ratten, 2020).

However, the attribute, although being not significant, relates to innovations whose intent is in line with the thoughts of George et al. (2012) & Kahle et al. (2013); indeed, we have evidence of CIs implying services provided by unemployed healthcare professionals (CI16, Appendix B) and healthcare services that provide medical equipment to the poor through subsidy systems (CI11, Appendix B).

As discussed above, the minimal use of resources indirectly implies the ability to provide fast solutions in such a challenging time. Looking at Table 6 (as shown in appendix A), one could clearly see that the attribute *Fast* is leading the performance of FIs (70%). The result is in line with the literature that clearly see frugality as the fastest and most effective approach to respond the challenges posed by the pandemic (Tiwari & Herstatt, 2020; López et al., 2020; Corsini et al. 2021; Veschi et al., 2021).

The attribute *quality care* follows very closely as it characterizes 60% of the FIs and refers to solutions consisting of life-saving devices, hence providing a sufficient level of oxygenation. Furthermore, the remote healthcare services provided in the West are considered to be of quality as they ensure a performance that is fairly close to that of conventional in-person care; it is always appropriate to consider the performance based on the circumstances, hence the context itself and its limitation, and in this case, we are referring to services operating at a distance with all their associated issues to consider. However, this (expected) gap between in-presence and remote care quality could be further minimized in the near future as digitalization progresses; future research addressing this theme could be of interest to further explore the theme of frugal healthcare.

According to Mishra (2021), the quality of a frugal product cannot be compromised, especially when referring to the healthcare sectors where solutions are aimed at vital needs (Mishra, 2021). Following this reasoning, the result concerning quality care is surprisingly low as it signals that not all FIs can be identified as quality solutions.

However, it is worth noting that this gap is justified by interpretation issues: 40% of FIs were not coded as “quality solutions” given the lack of a specific indication on the quality dimen-

sion. Therefore, the outcome must be considered carefully, as it does not necessarily mean that the remaining 40% are not quality solutions. As a result, with this limitation in mind, the result could be considered “good enough” since the attribute is already present in more than half of the FIs.

The attribute of *higher performance* also deserves our attention. A frequency below 50% may indicate that outperforming innovations are not “the rule”, but rather “the exception” whose exceeding performance is required by specific constrained contexts, as already acknowledged by Tiwari & Herstatt, 2012c; Tiwari et al., 2017; Weyrauch & Herstatt, 2016 & Vadamakapat et al., 2015.

That said, the result is still significant. However, this high value could be motivated as follows: the code relates to telemedicine innovations (CI5 & CI7, Appendix B) whose quality performance – as mentioned above – is pushed forward by digitalization (Etherington, 2020). Another unexpected outcome relates to the code *safety*: in view of the unprecedented health crisis, one of the major concerns people have expressed so far is protecting themselves from the disease, so the need for safety has been recognized straightforward (Dahlke et al., 2021; Kraus et al., 2020; Ratten, 2020). However, it does not find great application in the current sample (20%). Again, this discrepancy among literature and results could lie in the type of text data that have been used (limitations will be explained in the next section).

Looking at Table 1, the predominant role of the attribute user-friendly emerges, occurring in 80% of CIs. The attribute *Simple* follows with a high frequency as well (60%).

Both attributes are present in more than half of CIs and refer to services and products that can be easily used by healthcare workers regardless of their background, easy-to-use and easy-to-produce medical devices, and services that are easy to access/use thanks to clear and interactive platforms among others.

With regard to a possible correlation between the two attributes, namely user-friendly and simple, both appear simultaneously in 4 out of 10 CIs (CI2, CI19, CI32, CI33, Appendix B).

This unexpected low result may be due to the fact that many of the CIs in the sample are services, therefore assessing their simplicity is not easy as this attribute refers to the design and/or procedure by which the solution is conceived.

When referring to the principle of core functionality, the literature mainly emphasises the relevance of simplicity, user-friendliness, and essential functionality (Agarwal & Brem, 2012; Brem, 2017; Weyrauch & Herstatt, 2016; Singh et al. 2020, Simula et al. (2015)). Therefore, the outcome of the analysis and the reviewed literature is on the same page with regard to simplicity and user-friendliness.

With regard to *essential functions/information*, the outcome is lower than expected but yet high. Lastly, few innovations have the attributes *Comfortable*, *Non-hospital settings*, *Small/Portable*. The remarkably low value of the latter can be easily explained: the attribute small/portable mainly refers to physical products, however, most of the analyzed FIs consist in healthcare services; this aspect could contribute to a lower outcome with reference to small/portable.

Generally speaking, the conceptual model providing a broad definition of frugality was successfully applied; in other words, the main core attributes (and their related subdimensions)

were applied as a response to the Covid-19 crisis by Western countries. Therefore, we identified some covid innovations that could properly be labelled as frugal solutions. However, we believe it is relevant to discuss results that emerge also outside the conceptual model. As mentioned above, the analysis revealed the presence of “external” attributes that are as recurrent as the four core attributes of the conceptual framework. More precisely, this is the case of the attribute “tech-solution” and “scalable” (Table 2)

**Table 2:** Overall Frequencies among FIs (MAXQDA 2020)

<b>Attribute</b>	<b>Percentage</b>
Optimized performance	93,90%
Tech-solution	81,80%
Concentration on core functionalities	66,70%
Intrinsically sustainable value	63,60%
Substantial cost of reduction	60,60%
Scalable	45,45%

The table shows the predominant role of technology in leading frugality.

As already mentioned in the methodology section, the technological nature of the various CIs differs from low to high tech solutions. It is important to assess this dimension, as FIs have been often defined as less sophisticated solutions with a low-tech value (Corsini et al., 2021), by generating scepticism in Western countries and thus a greater reluctance to adopt a frugal approach (Corsini et al., 2021; Hossain, 2013; Zeschky et al., 2011).

However, at the same time the growing relevance of digitalisation as a response to the pandemic has been acknowledged (Kraus et al., 2020).

In this regard the contribution of Miesler et al. (2020) emerges to be crucial, as the authors believe that technology plays a crucial role in driving the entrance of Western countries in the frugal market. However, the authors also point out the necessity to distinguish the frugal solutions emerging from developed markets from those in Emerging contexts, due to the different level of technology.

Given that the results of the current study have revealed an increasing role of technology (one could think about telemedicine) among covid innovations, the suggestion of Miesler et al. (2020) – namely the introduction of a different concept of frugality to consider the advanced technological nature of frugal innovations developed in the West – could potentially lead to new insights.

This consideration is particularly relevant when considering the continuous technological progress moving toward new dimensions.

The latter attribute, namely “scalable” also emerges to be crucial. Many of the solutions analysed in the current study proved to be scalable, and therefore aimed for mass production.

In the literature concerning frugality, there is a divergence of thoughts among researchers on the role that scalability plays with regard to frugality.

According to Singh & Saxena (2020) & Hossain (2017), FIs are aimed at niche markets, hence they cannot be scalable. Differently, Weyrauch & Herstatt (2016) acknowledge the

existence of such scalability as an attribute, but they do not include it in their conceptual model, so the attribute is classified as non-essential.

Differently, other authors consider the attribute itself to be crucial while addressing the issue of frugality, particularly when focusing on the cost dimension as scalability is acknowledged for driving costs down (Mishra, 2021).

The role of scalability has also emerged to be crucial in the current pandemic in addressing global needs and contributing to the affordability dimension of frugality (Kraus et al., 2020; Carteaux et al., 2021). In a few words, more investigation with regard to the role of both attributes could have the potential to provide useful insights and further redefine the definition of frugality.

## **6. Conclusion, limitations and future research**

The study was conducted with the aim to investigate whether Western countries applied the principles of frugalities, in other words, whether they developed Frugal Innovation as a response to the challenges posed by the ongoing Covid-19 crisis.

The concept of frugality has its roots in the context of emerging markets, and it is well recognised as an approach aimed to meet the needs of constrained communities facing a wide range of economic and social challenges, such as lack of adequate infrastructure, resource scarcity, political issues, and institutional voids among others.

Given the above, the definition has been contextualised in the context of emerging markets, hence ignoring the potential application of frugality in developed countries as well.

However, as discussed extensively in the theoretical background, the current pandemic has forced western firms to test the principles of frugality.

Indeed, it is acknowledged that the crisis has turned western countries into constrained environments. As a result, the ability of doing more with less has become a real mantra. In other words, firms have been forced to rely on a bricolage approach, hence trying to make the most out of the scarce resources.

The Covid 19 crisis did not merely affect the social and health habits, but it also severely impacted economies all over the world, including the advanced ones.

As a result, growing demand for low cost and good enough products has been recognized, thus forcing Western firms to adapt their business and adopt a frugal approach, in order to provide quality solutions, yet affordable, to constrained customers.

As a result, we decided to investigate whether frugality has been applied or not in the West, and, to do so, we selected a set of covid innovations and investigated the presence of frugal attributes through a content analysis approach.

The model of Weyrauch & Herstatt (2016) have enabled the study to start from an already pre-defined set of attributes. However, the literature review has revealed the need to adapt the model by adding the criterion of sustainability. Indeed, this criterion turned out to be crucial and has been grounded in several covid innovations.

The study yields two main findings.

First, we confirmed the employment of a frugal mindset in the West as a response to the covid 19 crisis. In this regard, 9 Frugal innovations have been identified. The four criteria indicated in the conceptual model, namely substantial cost reduction, concentration on core functionalities, intrinsically sustainable value and optimized performance have found applica-

tion in the West. However, the conceptual model we applied run the risks to underestimate two potential attributes that were not considered so far, namely the role of technology and scalability. Given the positive outcomes with regard to tech and scalable frugal innovations, we suggest future researchers to address the gap, as it may enable to further explore the definition of frugality. In particular, ignoring the increasing relevance of technology as a response to the current challenges would not be a proper choice, given its predominant role in society, particularly in developed economies.

The study has its own limitations.

The first is represented by the dataset itself. We only considered one industry, namely the healthcare, however it would be appropriate to further investigate different sectors.

Different sectors could lead to different results, as several attributes, particularly those related to performance, are context related.

Some data text could not be properly interpreted. The main reason is the following: we only relied on a specific set of online resource, however a future good approach could address the study by comparing different sources – in other words, comparing several articles with regard to the same topic/CI could help to detect more attributes, as the content of some sources could be limited and/or not available.

Furthermore, a content analysis is always subject to a certain degree of subjectivity.

Therefore, quantitative studies could close this gap and provide better insights.

An additional drawback was the following: we could not investigate properly the correlation among attributes, so we just relied on the visual tools provided by MAXQDA.

As a result, empirical future investigations can provide more objective outcomes, as they rely on criteria that can specifically measure phenomena.

Lastly, our approach was more deductively, and this could create some biases, therefore future investigation should be able to reframe the issue in a more inductive way. In our case this was not possible, as we already had to rely on a pre-defined conceptual model.

This study serves as a starting point for future empirical work and qualitative work based on a more inductive approach.

## Bibliography

- Agarwal, N., & Brem, A. (2012, June). Frugal and reverse innovation - Literature overview and case study insights from a German MNC in India and China. In *2012 18th International Conference on Engineering, Technology and Innovation*, 1-11. <https://doi.org/10.1109/ICE.2012.6297683>
- Agarwal, N., Grottke, M., Mishra, S., & Brem, A. (2017). A systematic literature review of constraint-based innovations: State of the art and future perspectives. *IEEE Transactions on Engineering Management*, *64*(1), 3 -15. <https://doi.org/10.1109/TEM.2016.2620562>
- Agarwal, N., Oehler, J., & Brem, A. (2021). Constraint-Based Thinking: A Structured Approach for Developing Frugal Innovations. *IEEE Transactions on Engineering Management*, *68*(3), 739–751. <https://doi.org/10.1109/TEM.2020.3042929>
- Agnihotri, A. (2015). Low-cost innovation in emerging markets. *Journal of Strategic Marketing*, *23*(5), 399–411. <https://doi.org/10.1080/0965254X.2014.970215>
- Ahuja, S. (2014). Cost vs. value+ empathy: a new formula for frugal science. *Design Management Review*, *25*(2), 52–55. <https://onlinelibrary.wiley.com/doi/pdf/10.1111/drev.10284>
- Ansell, C., & Boin, A. (2019). Taming Deep Uncertainty: The Potential of Pragmatist Principles for Understanding and Improving Strategic Crisis Management. *Administration and Society*, *51*(7), 1079–1112. <https://doi.org/10.1177/0095399717747655>
- Azungah, T. (2018). Qualitative research: deductive and inductive approaches to data analysis. *Qualitative research journal*, *18*(4), 383 – 400. DOI: 10.1108/QRJ-D-18-00035
- Beise-Zee, R., Herstatt, C., & Tiwari, R. (2021). Guest Editorial: Resource-Constrained Innovation and Frugal Engineering. *IEEE Transactions on Engineering Management*, *68*(3), 643 – 652. <https://doi.org/10.1109/TEM.2020.3040580>
- Bergsen, P. (2020). A new political economy for Europe post-COVID-19. *European View*, *19*(2), 131–137. <https://doi.org/10.1177/1781685820968301>
- Bhatti, Y. A. & Ventresca, M. (2013). How can 'frugal innovation' be conceptualized? Said Business School Working Paper Series, Oxford, 1- 26. Available at: <http://ssrn.com/abstract=2203552>.
- Bhatti, Y., Taylor, A., Harris, M., Wadge, H., Escobar, E., Prime, M., ... Udayakumar, K. (2017). Global lessons in frugal innovation to improve health care delivery in the United States. *Health Affairs*, *36*(11), 1912–1919. <https://doi.org/10.1377/hlthaff.2017.0480>
- Baker, T., Miner, A. S., & Eesley, D. T. (2003). Improvising firms: Bricolage, account giving and improvisational competencies in the founding process. In *Research Policy*, *32*, 255–276. Elsevier B.V. [https://doi.org/10.1016/S0048-7333\(02\)00099-9](https://doi.org/10.1016/S0048-7333(02)00099-9)
- Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, *65*, 42-56. <https://doi.org/10.1016/j.jclepro.2013.11.039>

Bollyky, T. J. (2015). *New, Cheap, and Improved: Assessing the Promise of Reverse and Frugal Innovation to Address Noncommunicable Diseases*. Council on Foreign Relations. <http://www.jstor.com/stable/resrep24177>

Brem, A. (2017). Frugal innovation-past, present, and future. *IEEE Engineering Management Review*, 45(3), 37–41. <https://doi.org/10.1109/EMR.2017.2734320>

Brem, A., & Wolfram, P. (2014). Research and development from the bottom up- introduction of terminologies for new product development in emerging markets. *Journal of Innovation and Entrepreneurship*, 3(1), 1–22. <https://doi.org/10.1186/2192-5372-3-9>

Carteaux, G., Pons, M., Morin, F., Tuffet, S., Lesimple, A., Badat, B., ... & Dessap, A. M. (2021). Continuous positive airway pressure for respiratory support during COVID-19 pandemic: a frugal approach from bench to bedside. *Annals of intensive care*, 11(1), 1-14. <https://doi.org/10.1186/s13613-021-00828-2>

Chen, S., Igan, D. O., Pierri, N., Presbitero, A. F., Soledad, M., & Peria, M. (2020). *Tracking the economic impact of COVID-19 and mitigation policies in Europe and the United States*. IMF Working Paper 2020(125). <https://doi.org/10.5089/9781513549644.001>

Conte, A., Lecca, P., Salotti S. and Sakkas S. (2020). The territorial economic impact of COVID-19 in the EU. A RHOMOLO Analysis. Territorial Development Insights Series, JRC121261, European Commission. <https://ec.europa.eu/jrc/sites/jrcsh/files/jrc121261.pdf>

Corsini, L., Dammicco, V., & Moultrie, J. (2021). Frugal innovation in a crisis: the digital fabrication maker response to COVID-19. *R&D Management*, 51(2), 195–210. <https://doi.org/10.1111/radm.12446>

Craven, M., Liu, L., Mysore, M., & Wilson, M. (2020). COVID-19: Implications for business. *McKinsey & Company*, 1–8. <https://covid19.bangkokhealth.com/wp-content/uploads/2021/01/Key-criteria-for-the-ethical-acceptability-of-COVID-19-human-challenge-studies-2.pdf>

Cunha, M. P. E., Rego, A., Oliveira, P., Rosado, P., & Habib, N. (2014). Product innovation in resource-poor environments: Three research streams. *Journal of Product Innovation Management*, 31(2), 202-210. <https://doi.org/10.1111/jpim.12090>

Dahlke, J., Bogner, K., Becker, M., Schlaile, M. P., Pyka, A., & Ebersberger, B. (2021). Crisis-driven innovation and fundamental human needs: A typological framework of rapid-response COVID-19 innovations. *Technological Forecasting and Social Change*, 169. <https://doi.org/10.1016/j.techfore.2021.120799>

Dandonoli, P. (2013). Open innovation as a new paradigm for global collaborations in health. *Globalization and Health*, 9(41), 1–5. <https://doi.org/10.1186/1744-8603-9-41>

Demertzis, M., Sapir, A., Tagliapietra, S., & Wolff, G. B. (2020). An effective economic response to the coronavirus in Europe. *Bruegel*, (6), 1–10. <https://www.bruegel.org/2020/03/economic-response-coronavirus/>

Doern, R., Williams, N., & Vorley, T. (2019) Special issue on entrepreneurship and crises: business as usual? An introduction and review of the literature. *Entrepreneurship & Regional Development*, 31(5-6), 400-412, <https://doi.org/10.1080/08985626.2018.1541590>

Dosi, C., Cocchi, N., & Vignoli, M. (2021). Ten transform emergency now! - Facing covid 19 with open and frugal innovation. *Proceedings of the Design Society*, 1, 2971–2980. <https://doi.org/10.1017/pds.2021.558>

Dubey, R., Bryde, D. J., Foropon, C., Tiwari, M., & Gunasekaran, A. (2021). How frugal innovation shape global sustainable supply chains during the pandemic crisis: lessons from the COVID-19. *Supply Chain Management*. <https://doi.org/10.1108/SCM-02-2021-0071>

Dunleavy, L., Preston, N., Bajwah, S., Bradshaw, A., Cripps, R., Fraser, L. K., ... Walshe, C. (2021). 'Necessity is the mother of invention': Specialist palliative care service innovation and practice change in response to COVID-19. Results from a multinational survey (CovPall). *Palliative Medicine*, 35(5), 814–829. <https://doi.org/10.1177/02692163211000660>

Echebarria Fernández, J. ORCID: 0000-0001-9339-689X (2021). A Critical Analysis on the European Union's Measures to Overcome the Economic Impact of the COVID-19 Pandemic. *European Papers - A Journal on Law and Integration*, 5(3), 1399 -1423. DOI: 10.15166/2499-8249/437

Elo, S., & Kyngäs, H. (2008). The qualitative content analysis process. *Journal of advanced nursing*, 62(1), 107-115. <https://doi.org/10.1111/j.1365-2648.2007.04569.x>

Etherington, D. (2020, April 2). Forward launches 'forward at home' primary care service to address covid-19 healthcare crunch. *TechCrunch*. <https://techcrunch.com/2020/04/02/forward-launches-forward-at-home-primary-care-service-to-address-covid-19-healthcare-crunch/amp/>

Farooq, R. (2017). A conceptual model of frugal innovation: Is environmental munificence a missing link? *International Journal of Innovation Science*, 9(4), 320–334. <https://doi.org/10.1108/IJIS-08-2017-0076>

Gambhir, A., Singh, S., Duckworth, S., & Sotiropoulos, A. (2012). Frugal Innovation: Learning from Social Entrepreneurs in India. *The Guardian-Public Leaders Network*. Available at SSRN: <https://ssrn.com/abstract=2026330>

George, G., Mcgahan, A. M., & Prabhu, J. (2012). Innovation for Inclusive Growth: Towards a Theoretical Framework and a Research Agenda. *Journal of Management Studies*, 49(4), 661–683. <https://doi.org/10.1111/j.1467-6486.2012.01048.x>

Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today*, 24(2), 105–112. <https://doi.org/10.1016/j.nedt.2003.10.001>

Guan, D., Wang, D., Hallegatte, S., Davis, S. J., Huo, J., Li, S., ... & Gong, P. (2020). Global supply-chain effects of COVID-19 control measures. *Nature Human Behaviour* 4(6), 577–587. <https://doi.org/10.1038/s41562-020-0896-8>

Hammond, A. L., Kramer, W. J., Katz, R. S., Tran, J. T., & Walker, C. (2008). The Next 4 Billion. *Development Outreach*, 10(2), 7–26. [https://doi.org/10.1596/1020-797x-10\\_2\\_7](https://doi.org/10.1596/1020-797x-10_2_7).

Harris, M., Bhatti, Y., Buckley, J., & Sharma, D. (2020). Fast and frugal innovations in response to the COVID-19 pandemic. *Nature Medicine*, 26(6), 814-817. <https://doi.org/10.1038/s41591-020-0889-1>

Herstatt, C., & Tiwari, R. (2020). Opportunities of frugality in the post-corona era. *International Journal of Technology Management*, 83(1–3), 15–33. <https://doi.org/10.1504/IJTM.2020.109276>

Hossain, M. (2013). Adopting Open Innovation to Stimulate Frugal Innovation and Reverse Innovation. *SSRN Electronic Journal*, 1-9. <https://doi.org/10.2139/ssrn.2197782>

Hossain, M. (2017). Mapping the frugal innovation phenomenon. *Technology in Society*, 51, 199–208. <https://doi.org/10.1016/j.techsoc.2017.09.006>

Hossain, M. (2021). Frugal innovation: Unveiling the uncomfortable reality. *Technology in Society*, 67, 101759. <https://doi.org/10.1016/j.techsoc.2021.101759>

Hossain, M., Simula, H., & Halme, M. (2016). Can frugal go global? Diffusion patterns of frugal innovations. *Technology in Society*, 46, 132–139. <https://doi.org/10.1016/j.techsoc.2016.04.005>

Hristov, I., Chirico, A., & Appolloni, A. (2019). Sustainability Value Creation, Survival, and Growth of the Company: A Critical Perspective in the Sustainability Balanced Scorecard (SBSC). *Sustainability*, 11(7), 2119. <https://doi.org/10.3390/su11072119>

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative health research*, 15(9), 1277-1288. <https://doi.org/10.1177/1049732305276687>

Haudeville, B., & Wolff, D. (2016). How could standardization support the production and diffusion of frugal innovations? *Journal of Innovation Economics & Management*, 21(3), 27–37. <https://doi.org/10.3917/jie.021.0027>

Iwuoha, J. C., & Jude-Iwuoha, A. U. (2020). COVID-19: Challenge to SDG and Globalization. *Electronic Research Journal of Social Sciences and Humanities*, 2 (III), 103 – 115. <https://ssrn.com/abstract=3670330>

Kahle, H. N., Dubiel, A., Ernst, H., & Prabhu, J. (2013). The democratizing effects of frugal innovation: Implications for inclusive growth and state-building. *Journal of Indian Business Research*, 5(4), 220-234. <https://doi.org/10.1108/JIBR-01-2013-0008>

Khan, R. (2016). How frugal innovation promotes social sustainability. *Sustainability*, 8(10), 1034. <https://doi.org/10.3390/su8101034>

Kraus, S., Clauss, T., Breier, M., Gast, J., Zardini, A., & Tiberius, V. (2020). The economics of COVID-19: initial empirical evidence on how family firms in five European countries cope with the corona crisis. *International Journal of Entrepreneurial Behaviour and Research*, 26(5), 1067–1092. <https://doi.org/10.1108/IJEER-04-2020-0214>

Lai, A. F. W., Enjiu, P. T., Chan, T. Y. S., & Chia, C. L. K. (2020). Frugal innovation in the pandemic: finding the solution from within. *British Journal of Surgery*, 107(9), e323-e323. <https://doi.org/10.1002/bjs.11778>

Lehner, A.-C., & Gausemeier, J. (2016). A Pattern-Based Approach to the Development of Frugal Innovations. *Technology Innovation Management Review*, 6(3), 13–21. <https://doi.org/10.22215/timreview971>

López-Gómez, C., Corsini, L., Leal-Ayala, D., and Fokeer, S. (2020). COVID-19 Critical Supplies: The Manufacturing Repurposing Challenge. United Nations Industrial Development Organisation. <https://www.unido.org/news/covid-19-critical-supplies-manufacturing-repurposing-challenge>. Accessed 11.12.21

Luchs, M. G., Brower, J., & Chitturi, R. (2012). Product choice and the importance of aesthetic design given the emotion-laden trade-off between sustainability and functional performance. *Journal of Product Innovation Management*, 29(6), 903-916. <https://doi.org/10.1111/j.1540-5885.2012.00970.x>

Maital, S., & Barzani, E. (2020). The Global Economic Impact of COVID-19: A Summary of Research. *Samuel Neaman Institute for National Policy Research*, 2-12. [https://www.neaman.org.il/EN/Files/Global%20Economic%20Impact%20of%20COVID-19\\_20200322163553.399.pdf](https://www.neaman.org.il/EN/Files/Global%20Economic%20Impact%20of%20COVID-19_20200322163553.399.pdf)

Manning, J. (2017). In Vivo Coding. In *The International Encyclopedia of Communication Research Methods* (pp. 1–2). <https://doi.org/10.1002/9781118901731.iecrm0270>

Markiewicz, J. (2021). Frugal innovations in rail transport. *Procedia Computer Science*, 192, 3243–3251. <https://doi.org/10.1016/j.procs.2021.09.097>

Matos, S.V., Schleper, M.C., Gold, S. and Hall, J.K. (2020). The hidden side of sustainable operations and supply chain management: unanticipated outcomes, trade-offs and tensions. *International Journal of Operations & Production Management*, 40(12), 1749-1770. DOI:10.1108/IJOPM-12-2020-833

Miesler, T., Wimschneider, C., Brem, A., & Meinel, L. (2020). Frugal Innovation for Point-of-Care Diagnostics Controlling Outbreaks and Epidemics. *ACS Biomaterials Science and Engineering*, 6(5), 2709–2725. <https://doi.org/10.1021/acsbomaterials.9b01712>

Millar, C. C. J. M., Groth, O., & Mahon, J. F. (2018). Management innovation in a VUCA world: Challenges and recommendations. *California Management Review*, 61(1), 5–14. <https://doi.org/10.1177/0008125618805111>

Mishra, O. (2021). Design Thinking and Bricolage for Frugal Innovations during Crisis. *Journal of Innovation Management*, 9(3), 1-26. DOI: [https://doi.org/10.24840/2183-0606\\_009.003\\_0002](https://doi.org/10.24840/2183-0606_009.003_0002)

Mukerjee, K. (2012). Frugal Innovation: The Key To Penetrating Emerging Markets. *Ivey Business Journal*, 76(4), 1–4. Retrieved from <http://iveybusinessjournal.com/publication/frugal-innovation-the-key-to-penetrating-emerging-markets/>

Mvulirwenande, S., & Wehn, U. (2020). Analysing frugal innovation incubation programmes: A case study from the water sector. *Prometheus*, 36(2), 95–115. <https://www.jstor.org/stable/10.13169/prometheus.36.2.0095>

Nerurkar, O. (2020). Bop 3.0 Opportunity Identification and Sustainable Business Model Innovation Conceptual Framework. *International Journal of Management*, 11(12), 511-520. <https://doi.org/10.34218/ijm.11.12.2020.047>

Ploeg, M., Knobens, J., Vermeulen, P., & van Beers, C. (2021). Rare gems or mundane practice? Resource constraints as drivers of frugal innovation. *Innovation: Organization and Management*, 23(1), 93–126. <https://doi.org/10.1080/14479338.2020.1825089>

Prabhu, J. (2017). Frugal innovation: Doing more with less for more. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 375(2095), 1–22. <https://doi.org/10.1098/rsta.2016.0372>

Prahalad, C. K., & Hart, S. L. (2010). The fortune at the bottom of the pyramid. *Revista Eletrônica de Estratégia & Negócios*, 1(2), 1-23. <https://doi.org/10.19177/reen.v1e220081-23>

Prathap, G. (2014). The myth of frugal innovation in India. *Current Science*, 106(3), 374–377. <https://www.jstor.org/stable/24099897>

Radjou, N., & Prabhu, J. (2014). What Frugal Innovators Do. *Harvard Business Review*, 1–7.

Rao, B. C. (2013). How disruptive is frugal? *Technology in Society*, 35(1), 65–73. <https://doi.org/10.1016/j.techsoc.2013.03.003>

emerges, V. (2020). Coronavirus (covid-19) and entrepreneurship: changing life and work landscape. *Journal of Small Business and Entrepreneurship*, 32(5), 503–516. <https://doi.org/10.1080/08276331.2020.1790167>

Rosca, E., Arnold, M., & Bendul, J. C. (2017). Business models for sustainable innovation – an empirical analysis of frugal products and services. *Journal of Cleaner Production*, 162, S133–S145. <https://doi.org/10.1016/j.jclepro.2016.02.050>

Rosca, E., Reedy, J., & Bendul, J. C. (2018). Does Frugal Innovation Enable Sustainable Development? A Systematic Literature Review. *The European Journal of Development Research*, 30(1), 136–157. <https://doi.org/10.1057/s41287-017-0106-3>

Saari, U. A., Herstatt, C., Tiwari, R., Dedehayir, O., & Mäkinen, S. J. (2021). The vegan trend and the microfoundations of institutional change: A commentary on food producers' sustainable innovation journeys in Europe. *Trends in Food Science and Technology*, 107, 161-167. <https://doi.org/10.1016/j.tifs.2020.10.003>

Santos, J. (2020). Using input-output analysis to model the impact of pandemic mitigation and suppression measures on the workforce. *Sustainable production and consumption*, 23, 249-255. <https://doi.org/10.1016/j.spc.2020.06.001>

Schumacher, E. F. (1973). *Small is Beautiful: Economics as if People Mattered*. (1st ed.). London: Blond & Briggs

Sharma, A., & Iyer, G. R. (2012). Resource-constrained product development: Implications for green marketing and green supply chains. *Industrial Marketing Management*, 41(4), 599–608. <https://doi.org/10.1016/j.indmarman.2012.04.007>

Simula, H., Hossain, M., & Halme, M. (2015). Frugal and reverse innovations - Quo vadis? *Current Science*, 109(9), 1567–1572. <https://doi.org/10.3390/designs4030037>

Singh, R., Seniaray, S., & Saxena, P. (2020). A framework for the improvement of frugal design practices. *Designs*, 4(3), 37. <https://doi.org/10.3390/designs4030037>

Sneader, K., & Singhal, S. (2020). Beyond Coronavirus: The Path to the Next Normal. *McKinsey & Company*, 1–8. Retrieved from <https://www.mckinsey.com/industries/healthcare-systems-and-services/our-insights/beyond-coronavirus-the-path-to-the-next-normal>

Soiferman, L. K. (2010). Compare and Contrast Inductive and Deductive Research Approaches. *Online Submission*.

Tidd, J. (2006). A review of innovation models. *Imperial College London*, 16. DOI: 10.13140/RG.2.2.30295.57762

Tiwari, R., & Herstatt, C. (2012a). Frugal Innovation: A Global Networks' Perspective. *Die Unternehmung*, 66(3), 245–274. <https://doi.org/10.5771/0042-059x-2012-3-245>

Tiwari, R., & Herstatt, C. (2012b). *India - A Lead Market for Frugal Innovations? Extending the Lead Market Theory to Emerging Economies*. TIM/TUHH Working Paper No. 67 <http://dx.doi.org/10.2139/ssrn.1998411>

Tiwari, R., & Herstatt, C. (2012c). Assessing India's lead market potential for cost-effective innovations. *Journal of Indian Business Research*, 4(2), 97-115. DOI: 10.1108/17554191211228029

Tiwari, R., & Herstatt, C. (2020). 'Pushing the envelope' – transcending the conventional wisdom on frugal innovation. *International Journal of Technology Management*, 83 (1.2,3), 1–14.

Tiwari, R., Fischer, L., & Kalogerakis, K. (2017, March). *Frugal innovation in Germany: A qualitative analysis of potential socio-economic impacts*. (Working paper No. 96). Retrieved from: <http://hdl.handle.net/10419/156688>

Tran, V. T., & Ravaud, P. (2016). Frugal innovation in medicine for low resource settings. *BMC medicine*, 14(1), 1-3. <https://doi.org/10.1186/s12916-016-0651-1>

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. *British Journal of Management*, 14, 207-222. <https://doi.org/10.1111/1467-8551.00375>

Trienekens, J., & Zuurbier, P. (2008). Quality and safety standards in the food industry, developments and challenges. *International journal of production economics*, 113(1), 107-122. DOI: 10.1016/j.ijpe.2007.02.050

Vadakkepat, P., Garg, H. K., Loh, A. P., & Tham, M. P. (2015). Inclusive innovation: getting more from less for more. *Journal of Frugal Innovation*, 1(1),1-2. <https://doi.org/10.1186/s40669-015-0002-6>

van Zanten, J. A., & van Tulder, R. (2020). Beyond COVID-19: Applying “SDG logics” for resilient transformations. *Journal of International Business Policy*, 3(4), 451-464. <https://doi.org/10.1057/s42214-020-00076-4>

Vesci, M., Feola, R., Parente, R., & Radjou, N. (2021). How to save the world during a pandemic event. A case study of frugal innovation. *R&D Management*, 51(4), 352–363. <https://doi.org/10.1111/radm.12459>

VERBI Software. (2019). MAXQDA 2020 [computer software]. Berlin, Germany: VERBI Software. Available from [maxqda.com](http://maxqda.com).

Weyrauch, T., & Herstatt, C. (2016). What is frugal innovation? Three defining criteria. *Journal of Frugal Innovation*, 2(1), 1 – 17. <https://doi.org/10.1186/s40669-016-0005-y>

Winkler, T., Ulz, A., Knöbl, W., & Lercher, H. (2020). Frugal innovation in developed markets – Adaption of a criteria-based evaluation model. *Journal of Innovation & Knowledge*, 5(4), 251–259. <https://doi.org/10.1016/j.jik.2019.11.004>

Zeschky, M. B., Winterhalter, S., & Gassmann, O. (2014). From cost to frugal and reverse innovation: Mapping the field and implications for global competitiveness. *Research Technology Management*, 57(4), 20–27. <http://dx.doi.org/10.1186/s40669-016-0005-y>

Zeschky, M., Widenmayer, B., & Gassmann, O. (2011). Frugal Innovation in Emerging Markets. *Research -Technology Management*, 54(4), 38–45. <https://doi.org/10.5437/08956308x5404007>

UNIVERSITY OF HOHENHEIM  
Faculty of Business, Economics and Social Sciences  
Chair for Innovation Management  
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Free Scientific Thesis to Obtain the Academic Degree  
Master of Science

***Frugal innovation principles as a response to the Covid-19 crisis  
in Western countries***

**Appendix**

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## Appendix

### **i. Appendix A: Content analysis results**

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### **iii. Declaration of originality**

#### iv. Appendix A: Content analysis results

**Table A1:** The Code System

Code System	Coding Approach	Frequency
AI	Inductive	1
Experimental	Inductive	1
Triggered privacy concerns	Inductive (in-vivo)	1
not especially browser friendly	Inductive (in-vivo)	1
Costly solution	Inductive	1
Tech solution	Inductive	27
No-Tech solution	Inductive	3
Unclear Tech level	Inductive	2
Aesthetics	Inductive	3
Scalable	Inductive	15
Concentration on core functionality	Deductive	22
Essential functions/information	Deductive	6
Accessible	Deductive	17
Comfortable	Deductive	5
Small/Portable	Deductive	2
Non-hospital settings	Inductive	5
User-friendly	Deductive	12
Simple	Deductive	13
Intrinsically sustainable value	Deductive	21
Inclusive	Deductive	7
Resource-efficient	Deductive	16
Optimized performance	Deductive	30
Robustness	Inductive	3
Quality care	Inductive	12
Safe	Inductive	9
Higher-performance	Inductive	7
Helpful	Inductive	12
Fast	Inductive	17
Meeting regulatory requirements	Inductive	7
Substantial cost reduction	Deductive	0
Low-cost innovation	Deductive	12

No-cost solution	Inductive	8
External funds/resources	Inductive	4

Source: Adapted from MAXQDA 2020

**Table A2:** Attributes Frequencies

<b>Attribute</b>	<b>Percentage</b>
Optimized performance	90.90%
<i>Fast</i>	51.50%
<i>Quality care</i>	36.40%
<i>Helpful</i>	36.40%
<i>Safe</i>	27.30%
<i>Higher performance</i>	21.20%
<i>Meeting regulatory requirements</i>	21.20%
<i>Robustness</i>	9.10%
Concentration on core functionality	66.70%
<i>Accessible</i>	51,50%
<i>User-friendly</i>	36.40%
<i>Comfortable</i>	15.20%
<i>Non-hospital settings</i>	15.20%
<i>Small/Portable</i>	6.10%
<i>Simple</i>	39.40%
<i>Essential functions/information</i>	18.20%
Tech solution	81.80%
Intrinsically sustainable value	63.60%
<i>Resource-efficient</i>	48.50%
<i>Inclusive</i>	21.20%
Substantial cost reduction	60.60%
<i>Low-cost innovation</i>	36.40%
<i>No-cost solution</i>	24,20%
<i>External funds/resources</i>	12,10%
Scalable	45.50%
Aesthetics	9.10%
No-Tech solution	9.10%
Unclear Tech level	6.10%

Costly solution	3.00%
not especially browser friendly	3.00%
AI	3.00%
Experimental	3.00%
Triggered privacy concerns	3.00%

Source: Adapted from MAXQDA 2020

**Note:** The frequencies are expressed in percentages, and they indicate how many times the attributes appear in the analysed sample, namely the 33 covid innovations (unit of analysis).

**Table A3:** Frugal innovations identification

	<i>Concentration on core functionality</i>	<i>Intrinsically sustainable value</i>	<i>Optimized performance</i>	<i>Substantial cost reduction</i>	<i>Frugal innovation</i>
<i>CI1</i>	1	1	1	0	
<i>CI2</i>	1	1	1	1	FI
<i>CI3</i>	1	1	0	1	
<i>CI4</i>	1	0	1	0	
<i>CI5</i>	1	1	1	1	FI
<i>CI6</i>	1	0	1	1	
<i>CI7</i>	1	1	1	1	FI
<i>CI8</i>	0	0	1	1	
<i>CI9</i>	0	0	1	0	
<i>CI10</i>	1	1	1	1	FI
<i>CI11</i>	1	1	1	1	FI
<i>CI12</i>	1	1	1	0	
<i>CI13</i>	1	0	1	1	
<i>CI14</i>	0	1	1	0	
<i>CI15</i>	1	1	1	0	
<i>CI16</i>	1	1	1	1	FI
<i>CI17</i>	0	1	1	0	
<i>CI18</i>	1	1	1	1	FI
<i>CI19</i>	1	1	1	1	FI
<i>CI20</i>	0	0	1	1	
<i>CI21</i>	0	1	1	1	
<i>CI22</i>	0	0	1	0	
<i>CI23</i>	0	0	1	0	
<i>CI24</i>	0	1	1	1	
<i>CI25</i>	1	0	1	1	
<i>CI26</i>	1	0	1	1	
<i>CI27</i>	1	1	1	0	
<i>CI28</i>	0	0	1	1	
<i>CI29</i>	1	1	1	0	
<i>CI30</i>	0	0	0	0	
<i>CI31</i>	1	1	1	0	
<i>CI32</i>	1	1	1	1	FI
<i>CI33</i>	1	1	1	1	FI

**Note:** Code System Browser adapted from MAXQDA 2020. The rows of the table indicate the covid innovations, while the columns correspond to the core attributes of the conceptual framework. Each intersection between row and column there is a value that equals 1 or 0. Reading by column, the value 1 indicates the presence of the selected attribute with regard to a specific covid innovation, 0 otherwise

**Table A4:** Substantial cost reduction results (MAXQDA 2020)

<b>Substantial cost reduction</b>	<b>Percentage</b>
Low-cost innovation	80%
No-cost solution	30%
External funds/resources	20%

**Table A5:** Intrinsically sustainable value results (MAXQDA 2020)

<b>Intrinsically sustainable value</b>	<b>Percentage</b>
Resource-efficient	90%
Inclusive	20%

**Table A6:** Optimized performance results (MAXQDA 2020)

<b>Optimized performance</b>	<b>Percentage</b>
Fast	70%
Quality care	60%
Higher-performance	40%
Helpful	20%
Safe	20%
Meeting regulatory requirements	20%
Robustness	10%

**Table A7:** Concentration on core functionalities

<b>Concentration on core functionalities</b>	<b>Percentage</b>
User-friendly	80%
Simple	60%
Essential functions/information	40%
Comfortable	20%
Non-hospital settings	20%
Small/Portable	10%

## v. Appendix B: Covid Innovations descriptions

**Table B1:** List of online sources

COVID INNOVATION	ONLINE SOURCE
CI1	Gosk, S. (Reporter), Hommema, L. (interviewee), & Hommema, K., (interviewee). (2020, April 14). Search for Solutions. [Report Transcript]. <i>In Young couple creates new system to clean and reuse N95 masks</i> . Today. <a href="https://www.today.com/video/young-couple-creates-new-system-to-clean-and-reuse-n95-masks-82015813597">https://www.today.com/video/young-couple-creates-new-system-to-clean-and-reuse-n95-masks-82015813597</a>
CI2	Helmet Based Ventilation. (n.d.). <i>Helmet-Based Ventilation for Acute Respiratory Failure</i> . <a href="https://www.helmetbasedventilation.com/online-course">https://www.helmetbasedventilation.com/online-course</a> Savickaite, A. (n.d.). [Speech transcript]. Helmet-Based Ventilation for Acute Respiratory Failure. <a href="https://www.helmetbasedventilation.com/online-course">https://www.helmetbasedventilation.com/online-course</a>
CI3	Anonymous (2020, March 31). College student makes masks for the deaf & hard of hearing. <i>LEX18 News</i> . <a href="https://www.lex18.com/news/coronavirus/college-student-makes-masks-for-the-deaf-hard-of-hearing">https://www.lex18.com/news/coronavirus/college-student-makes-masks-for-the-deaf-hard-of-hearing</a>
CI4	Cohen, A. (2020, February 4). COVID-19 case capacity maps predict when your area will run out of healthcare resources: The dashboard crunches socioeconomic data, hospital capacity, and COVID-19 case counts. <i>Fast Company</i> . <a href="https://www.fastcompany.com/90485430/covid-19-case-capacity-maps-predict-when-your-area-will-run-out-of-healthcare-resources">https://www.fastcompany.com/90485430/covid-19-case-capacity-maps-predict-when-your-area-will-run-out-of-healthcare-resources</a>
CI5	Etherington, D. (2020, April 2). Forward launches ‘forward at home’ primary care service to address covid-19 healthcare crunch. <i>TechCrunch</i> . <a href="https://techcrunch.com/2020/04/02/forward-launches-forward-at-home-primary-care-service-to-address-covid-19-healthcare-crunch/amp/">https://techcrunch.com/2020/04/02/forward-launches-forward-at-home-primary-care-service-to-address-covid-19-healthcare-crunch/amp/</a>
CI6	Grewal, K. (2020, March 28). Abbott laboratories launches 5-minute coronavirus test that is portable: the test employs molecular technology, which is highly valued by the scientific community for its accuracy. <i>ThePrint</i> . <a href="https://theprint.in/india/abbott-laboratories-launches-5-minute-coronavirus-test-that-is-portable/390299/">https://theprint.in/india/abbott-laboratories-launches-5-minute-coronavirus-test-that-is-portable/390299/</a>
CI7	Multiple pages from the same website: Arc Health. (n.d.). See beyond Jean’s convincing smile. <a href="https://www.archealth.io/">https://www.archealth.io/</a> Arc Health. (n.d.). Improve quality of care for your most vulnerable patients. <a href="https://www.archealth.io/care-homes">https://www.archealth.io/care-homes</a>

	<p>Arc Health. (n.d.). <i>Arc demo for care homes</i> [Demo transcript]. Arc Health. <a href="https://www.archealth.io/care-homes">https://www.archealth.io/care-homes</a></p> <p>Arc Health. (n.d.). Improve efficiency, increase capacity. <a href="https://www.archealth.io/urgent-care">https://www.archealth.io/urgent-care</a></p>
<b>CI8</b>	<p>Coronavirus: Defence firm Babcock to make 10,000 ventilators. (2020, April 6). <i>BBC News</i>. <a href="https://www.bbc.com/news/business-52059084">https://www.bbc.com/news/business-52059084</a></p>
<b>CI9</b>	<p>Sharpe, O. (n.d.). Coronavirus: EasyJet and Virgin staff to help at NHS Nightingales hospitals. <i>Aviation Business News</i>. <a href="https://www.aviationbusinessnews.com/low-cost/coronavirus-easyjet-and-virgin-staff-to-help-at-nhs-nightingale-hospitals/">https://www.aviationbusinessnews.com/low-cost/coronavirus-easyjet-and-virgin-staff-to-help-at-nhs-nightingale-hospitals/</a></p>
<b>CI10</b>	<p>Halstead business makes a creative shift to help fight against covid-19. (2020, April 2). <i>KWCH</i>. <a href="https://www.kwch.com/content/news/Halstead-business-makes-creative-shift-to-help-fight-against-COVID-19-569302321.html">https://www.kwch.com/content/news/Halstead-business-makes-creative-shift-to-help-fight-against-COVID-19-569302321.html</a></p>
<b>CI11</b>	<p>Hammock Financial Services Ltd. (n.d.). <i>We source PPE for key workers across the UK</i>. SOS-Supplies. <a href="https://sos-supplies.com/">https://sos-supplies.com/</a></p>
<b>CI12</b>	<p>NIPPY 3 + sleep apnoea device converted for Covid-19 frontline. (2020, April 8). <i>THE ENGINEER</i>. <a href="https://www.theengineer.co.uk/sleep-apnoea-nippy-3-leeds-ventilator-covid-19/">https://www.theengineer.co.uk/sleep-apnoea-nippy-3-leeds-ventilator-covid-19/</a></p>
<b>CI13</b>	<p>Chatmeter. (n.d.). <i>Crisis management program for healthcare</i>. <a href="https://www.chatmeter.com/healthcare/">https://www.chatmeter.com/healthcare/</a></p>
<b>CI14</b>	<p>Medley, A. (2020, April 2). UH professor develops innovative waterproofing for N95 masks to combat spread of COVID-19. <i>Houston Chronicle</i>. <a href="https://www.chron.com/local/article/UH-professor-develops-innovative-water-proofing-15174448.php">https://www.chron.com/local/article/UH-professor-develops-innovative-water-proofing-15174448.php</a></p>
<b>CI15</b>	<p>Maltha, J. (2020, April 15). <i>Philips launches national portal for digital exchange of COVID-19 patient data in the Netherlands</i>. Philips. <a href="https://www.philips.com/a-w/about/news/archive/standard/news/articles/2020/20200415-philips-launches-national-portal-for-digital-exchange-of-covid-19-patient-data-in-the-netherlands.html">https://www.philips.com/a-w/about/news/archive/standard/news/articles/2020/20200415-philips-launches-national-portal-for-digital-exchange-of-covid-19-patient-data-in-the-netherlands.html</a></p>
<b>CI16</b>	<p>Argos, G. (2020, March 31). Coronavirus Philadelphia: Health department offering free access to app that connects new moms with lactation experts amid stay-at-home orders. <i>CBS NEWS PHILLY</i>. <a href="https://philadelphia.cbslocal.com/2020/03/31/coronavirus-philadelphia-health-department-offering-free-access-to-app-that-connects-new-moms-with-lactation-experts-amid-stay-at-home-orders/">https://philadelphia.cbslocal.com/2020/03/31/coronavirus-philadelphia-health-department-offering-free-access-to-app-that-connects-new-moms-with-lactation-experts-amid-stay-at-home-orders/</a></p>
<b>CI17</b>	<p>Devlin, H. (2020, March 31). NHS developing app to trace close contacts</p>

	of coronavirus carriers. <i>The Guardian</i> . <a href="https://www.theguardian.com/uk-news/2020/mar/31/nhs-developing-app-to-trace-close-contacts-of-coronavirus-carriers">https://www.theguardian.com/uk-news/2020/mar/31/nhs-developing-app-to-trace-close-contacts-of-coronavirus-carriers</a>
<b>CI18</b>	Lang, F. (2020, March 31). MIT Teams Shares New \$500 Emergency Ventilator Design with the Public. <i>Interesting Engineering</i> . <a href="https://interestingengineering.com/mit-team-shares-new-500-emergency-ventilator-design-with-the-public">https://interestingengineering.com/mit-team-shares-new-500-emergency-ventilator-design-with-the-public</a>
<b>CI19</b>	Hitti, N. (2020, April 3). MIT develops one-piece plastic face shields for coronavirus medics. <i>Dezeen</i> . <a href="https://www.dezeen.com/2020/04/03/mit-covid-19-face-shields-design/">https://www.dezeen.com/2020/04/03/mit-covid-19-face-shields-design/</a> MIT Project Manus. (n.d.). <i>MIT COVID-19 FACE SHIELD</i> . [Assembly Instructions transcript]. <i>Dezeen</i> . <a href="https://www.dezeen.com/2020/04/03/mit-covid-19-face-shields-design/">https://www.dezeen.com/2020/04/03/mit-covid-19-face-shields-design/</a>
<b>CI20</b>	Mental health app available for free during coronavirus outbreak. (2020, March 30). <i>Med-Tech Innovation News</i> . <a href="https://www.med-technews.com/news/mental-health-app-available-for-free-during-coronavirus-outb/">https://www.med-technews.com/news/mental-health-app-available-for-free-during-coronavirus-outb/</a>
<b>CI21</b>	Mask Match. (n.d.). <i>Send your masks to healthcare workers without leaving your house</i> . <a href="https://www.mask-match.com/">https://www.mask-match.com/</a>
<b>CI22</b>	Energy Voice. (2020, March 23). <i>Iqarus develops potentially life-saving service during pandemic</i> . <a href="https://www.energyvoice.com/coronavirus/230050/iqarus-develops-potentially-life-saving-service-during-pandemic/">https://www.energyvoice.com/coronavirus/230050/iqarus-develops-potentially-life-saving-service-during-pandemic/</a>
<b>CI23</b>	Kossoff, J. (2020, April 19). Medical detection dogs able to sniff 750 people an hour could help identify coronavirus cases, researchers say. <i>Business Insider</i> . <a href="https://www.businessinsider.com/sniffer-dogs-answer-to-the-covid-19-testing-crisis-mirror-2020-4">https://www.businessinsider.com/sniffer-dogs-answer-to-the-covid-19-testing-crisis-mirror-2020-4</a>
<b>CI24</b>	Schmitt, C. & Jenkins, R. (2020, April 14). <i>Refugees offer medical experience to help tackle coronavirus crisis in France</i> . UNHCR. <a href="https://www.unhcr.org/news/stories/2020/4/5e9460f74/refugees-offer-medical-experience-help-tackle-coronavirus-crisis-france.html">https://www.unhcr.org/news/stories/2020/4/5e9460f74/refugees-offer-medical-experience-help-tackle-coronavirus-crisis-france.html</a>
<b>CI25</b>	Lovett, L. (2020, March 30). GoodRx launches telemedicine price comparison service, amid growing demand during covid-19 pandemic. <i>Mobihealth News</i> . <a href="https://www.mobihealthnews.com/news/goodrx-launches-telemedicine-price-comparison-service-amid-growing-demand-during-covid-19">https://www.mobihealthnews.com/news/goodrx-launches-telemedicine-price-comparison-service-amid-growing-demand-during-covid-19</a>
<b>CI26</b>	Innen-leben. (n.d.). <i>Strength-giving sentences for unprecedented times. A do-it-yourself card set</i> . <a href="https://www.innen-leben.org/inside-life/">https://www.innen-leben.org/inside-life/</a>

<p><b>CI27</b></p>	<p>Fix The Mask (n.d.). <i>Get the most out of your surgical mask.</i>  <a href="https://www.fixthemask.com/">https://www.fixthemask.com/</a></p> <p>Fix The Mask. (n.d.). <i>The Importance of Mask Fit.</i> [Video Transcript]. Fit The Mask. <a href="https://www.fixthemask.com/">https://www.fixthemask.com/</a></p>
<p><b>CI28</b></p>	<p>Etherington, D. (2020, April 16). FDA debuts new online portal to encourage donation of plasma from recovered COVID-19 patients. <i>TechCrunch.</i>  <a href="https://techcrunch.com/2020/04/16/fda-debuts-new-online-portal-to-encourage-donation-of-plasma-from-recovered-covid-19-patients/">https://techcrunch.com/2020/04/16/fda-debuts-new-online-portal-to-encourage-donation-of-plasma-from-recovered-covid-19-patients/</a></p>
<p><b>CI29</b></p>	<p>Miliard, M. (2020, March 31). Epic, OCHIN launch COVID-19 app for front-line care coordination. <i>Healthcare IT News.</i>  <a href="https://www.healthcareitnews.com/news/epic-ochin-launch-covid-19-app-frontline-care-coordination">https://www.healthcareitnews.com/news/epic-ochin-launch-covid-19-app-frontline-care-coordination</a></p>
<p><b>CI30</b></p>	<p>Dunning, H. (2020, April 8). New COVID-19 project will use the power of smartphones to search for treatments. Imperial College London News.  <a href="https://www.imperial.ac.uk/news/196733/new-covid-19-project-will-power-smartphones/">https://www.imperial.ac.uk/news/196733/new-covid-19-project-will-power-smartphones/</a></p>
<p><b>CI31</b></p>	<p>ClearMask. (n.d.). <i>ClearMask introduces world's first CE-marked, fully transparent surgical mask.</i>  <a href="https://www.theclearmask.com/updates/2021/9/13/clearmask-introduces-worlds-first-ce-marked-fully-transparent-surgical-mask">https://www.theclearmask.com/updates/2021/9/13/clearmask-introduces-worlds-first-ce-marked-fully-transparent-surgical-mask</a></p>
<p><b>CI32</b></p>	<p>TVP Health. (n.d.). <i>The Evolution of AIRA.</i>  <a href="https://theventilatorproject.org/2020/07/09/the-evolution-of-aira-ventilator/">https://theventilatorproject.org/2020/07/09/the-evolution-of-aira-ventilator/</a></p>
<p><b>CI33</b></p>	<p>Myers, I. (2020, April 7). Foster + partners shares template for a reusable face visor to aid fight against COVID-19. <i>Designboom.</i>  <a href="https://www.designboom.com/design/foster-and-partners-shares-template-reusable-face-visor-covid-19-04-07-2020/">https://www.designboom.com/design/foster-and-partners-shares-template-reusable-face-visor-covid-19-04-07-2020/</a></p>

**Table B2:** Coded Segments exported from MAXQDA 2020

Code	Coded segments
AI	<p>The app works by creating a network of smartphones to power a virtual supercomputer, capable of processing billions of calculations, without collecting or disclosing users' Country/Nation data. No personal data is downloaded to or processed from the user's device.</p> <p>CI30: 6 - 6 (0)</p> <p>"However, we have to do difficult and complicated analyses using artificial intelligence to find out which molecule or combinations of molecules might be able to disrupt the virus when it's inside the body.</p> <p>CI30: 9 - 9 (0)</p>
Experimental	<p>experimental project</p> <p>CI23: 6 - 6 (0)</p>
Triggered privacy concerns	<p>triggered privacy concerns</p> <p>CI17: 7 - 7 (0)</p>
not especially browser friendly	<p>is not especially browser friendly</p> <p><a href="#">inhibit the correct access to information</a></p> <p>CI4: 10 - 10 (0)</p>
Costly solution	<p>Overnight the department of Defence said it was commissioning 60 of these machines, worth \$415 dollars million on top of already pledging the pay for operational costs with the machines in other hospitals for an additional 400\$.</p> <p>CI1: 25 - 25 (0)</p>
Tech solution	<p>a hydrogen peroxide vapor decontaminates the N95 masks</p> <p>CI1: 18 - 18 (0)</p> <hr/> <p>Do you want to know more? Click the button below to begin.</p> <p><a href="#">remote course, there is some level of technology here as well...</a></p> <p>CI2: 55 - 55 (0)</p> <hr/> <p>A new dashboard by healthcare analytics company Definitive Healthcare pinpoints how many days until hospitals in your region reach "capacity failure," which is code for "people will die because care is unavailable." Here are a few examples:</p> <p>CI4: 3 - 3 (0)</p> <hr/> <p>tech-focused primary care medical practice</p> <p>CI5: 3 - 3 (0)</p> <p>we collect some biometrics</p> <p><a href="#">biometrics in AFIs (read memo)</a></p>

CI5: 5 - 5 (0)

This approach provides a whole new level of remote care, over and above what's typically defined as "telemedicine,"

CI5: 6 - 6 (0)

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It employs molecular technology,

CI6: 4 - 4 (0)

Its unique isothermal nucleic acid amplification technology

CI6: 8 - 8 (0)

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Arc incorporates the latest advancements in telehealth

CI7: 32 - 32 (0)

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3D-printer

CI8: 18 - 18 (0)

---

3-D printing machine

CI10: 4 - 4 (0)

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SOS-Supplies

[online platform](#)

CI11: 1 - 1 (0)

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A sleep apnoea machine being phased out of service can be modified into a ventilator to treat people with Covid-19, claim engineers and scientists in Leeds.

[we are still talking about a "machine"](#)

CI12: 3 - 3 (0)

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software

CI13: 10 - 10 (0)

---

nanotech coatings

CI14: 8 - 8 (0)

---

portal for digital exchange of COVID-19 patient data

CI15: 1 - 1 (0)

---

It's a new app called Pacify.

CI16: 9 - 9 (0)

tele-lactation app

CI16: 10 - 10 (0)

---

developing app

CI17: 1 - 1 (0)

developed an algorithm for the app.

CI17: 9 - 9 (0)

---

The device's main part already exists in most hospitals' inventory: Ambu resuscitation bags.

CI18: 10 - 10 (0)

---

die-cutting process. Machines cut the design

CI19: 10 - 10 (0)

---

The mental health app

CI20: 4 - 4 (0)

---

*mask donation site*

CI21: 14 - 14 (0)

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telehealth marketplace

CI25: 5 - 5 (0)

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Download the PDF document, print it out, cut the cards.

CI26: 5 - 5 (0)

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online portal

[online portal for exchanging plasma](#)

CI28: 1 - 1 (0)

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a new mobile app

CI29: 4 - 4 (0)

The COVID-19 Preparedness App

CI29: 7 - 7 (0)

self-screen and healthcare volunteers to triage using smartphones

CI29: 7 - 7 (0)

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artificial intelligence

CI30: 9 - 9 (0)

A desktop computer with an eight-core processor running 24 hours a day would take decades to process the data, but a network of 100,000 smartphones running six hours a night could do the job in just a couple of months.

CI30: 12 - 12 (0)

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	<p>In the United States, the ClearMask™ brand received FDA clearance as a Class II medical device on April 6, 2020, and meets applicable ASTM Level 3 requirements in the United States for fluid resistance and flammability. The ClearMask™ transparent surgical mask also passed additional tests in accordance with the transparent mask guidelines released by the United Kingdom, including tests for resistance to penetration of microorganisms (ASTM F1671) and visibility (EN 166).</p> <p>CI31: 6 - 6 (0)</p> <hr/> <p>hardware store parts</p> <p>CI32: 6 - 6 (0)</p> <hr/> <p>digital and laser cutters</p> <p>CI33: 5 - 5 (0)</p>
No-Tech solution	<p>Both airlines are reaching out to those staff who have not been working due to planes having been grounded following the coronavirus outbreak to consider helping at the new hospitals being built across the country.</p> <p><a href="#">Humans</a></p> <p>CI9: 4 - 4 (0)</p> <hr/> <p>Medical detection dogs</p> <p><a href="#">trained dogs</a></p> <p>CI23: 1 - 1 (0)</p> <hr/> <p>Refugees offer medical experience</p> <p><a href="#">humans</a></p> <p>CI24: 1 - 1 (0)</p>
Unclear Tech level	<p>After a conversation with her mom, they put their craft skills to work.</p> <p>"We started out making them with bed sheets that we had, and luckily bed sheets are big," Lawrence said. "So we have two or three sets so we're making them out of that. Then, a couple months ago we needed plastic fabric for something. And so we have a whole roll of that and the window is only this big so having a whole roll is very helpful so luckily we haven't needed any supplies yet."</p> <p><a href="#">Not clear whether they used some machines to assemble (there is a plastic component) or if they merely relied on "manual" craft skills...</a></p> <p>CI3: 7 - 8 (0)</p> <hr/> <p>includes assessments to determine if a worker is fit to travel, and the provision of tailored advice from the Iqarus clinical team, in line with current Health Protection Scotland guidance.</p> <p>CI22: 4 - 4 (0)</p>
Aesthetic	<p><i>elegant</i></p> <p>CI27: 23 - 23 (0)</p>

With its fully transparent, anti-fog plastic barrier, the ClearMask™ brand increases visual communication, which may help avoid costly errors and adverse outcomes. As demonstrated in a first-of-its-kind study in the Journal of the American Medical Association, the ClearMask™ is also critical in establishing rapport and earning trust.

[the exterior design generates trust](#)

CI31: 7 - 7 (0)

needed an exterior that was both practical but could also be visually appealing

CI32: 25 - 25 (0)

pleasing in both functionality and visual appeal.

CI32: 30 - 30 (0)

## Scalable

*Each one can handle about 80,000 masks a day*

[Increasing capacity](#)

CI1: 19 - 19 (0)

The production has already been ramped up to deliver 50,000 ID NOW coronavirus test kits

CI6: 6 - 6 (0)

50k+ consultations with Arc: Arc is trusted by world-class healthcare providers and is used by hundreds of pharmacies and GP surgeries.

CI7: 29 - 29 (0)

10,000 ventilators to help deal with the coronavirus crisis.

CI8: 3 - 3 (0)

Apple chief executive Tim Cook tweeted on Sunday that it has designed and is now making the protective gear.

The tech giant plans to make more than one million shields a week, which will be shipped first to US medical workers and then distributed globally.

CI8: 7 - 8 (0)

20 million face masks which it is donating worldwide to help prevent the spread of the virus.

CI8: 9 - 9 (0)

Requests for her work with face shields come from across the U.S.

CI10: 5 - 5 (0)

donated 50,000 pieces of PPE so far.

CI11: 14 - 14 (0)

sharing their design online on their website so that manufacturers and companies can recreate the lifesaving device for hospitals around the world.

CI18: 9 - 9 (0)

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mass-producing disposable face shields

CI19: 3 - 3 (0)

According to MIT, the die-cutter machines used in mass production would be able to make 50,000 of the flat face shields per day.

CI19: 12 - 12 (0)

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My Possible Self has grown a base of more than 60,000 registered users

CI20: 5 - 5 (0)

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Over the past 3 months, our community has sent 821,000 masks from 6,200 donors to 7,300 recipients. This includes deliveries to every state, as well as Puerto Rico and Washington DC.

CI21: 4 - 4 (0)

Over a period of three months, Mask Match delivered 820,000+ masks to healthcare workers around the United States.

CI21: 12 - 12 (0)

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our product is being manufactured at scale today. We have distributed tens of thousands of braces in two months, and production can be easily ramped up to meet the demand nationally and even globally.

CI27: 14 - 14 (0)

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the scalable smartphone app

CI29: 3 - 3 (0)

the scalable app

CI29: 6 - 6 (0)

broadening the capacity

CI29: 7 - 7 (0)

building capacity in the face of this growing public health emergency

CI29: 14 - 14 (0)

---

over 18 million masks in the United States and globally.

CI31: 10 - 10 (0)

---

designing a ventilator that could potentially reach the national and global market.

[aiming to large scale production](#)

CI32: 13 - 13 (0)

---

as been designed with the aim of facilitating quick mass production of the visors

CI33: 4 - 4 (0)

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Concentration on core functionality\Essential functions/informations

*necessary component of any education.*

*providing essential info*

CI2: 28 - 28 (0)

*The materials are based on their unique first-hand knowledge of the equipment on the market and are designed to provide the most critical information which respects the learner's background and limited time.*

CI2: 38 - 38 (0)

learn more about this interface and use it in different settings

CI2: 53 - 53 (0)

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COVID-19 case capacity maps predict when your area will run out of healthcare resources

CI4: 1 - 1 (0)

You can also see each county's ICU bed count, ventilator use, number of COVID-19 cases, severe case count, and remaining percent capacity.

CI4: 9 - 9 (0)

pivotal information

CI4: 10 - 10 (0)

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so we put together a kit that has a bunch of sensors in it that we actually mail to you. This includes an EKG, a connected thermometer, connected blood pressure cuff and a pulse oximeter."

CI5: 5 - 5 (0)

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Let me show you. This is the clinician interface: it is easy to use and gives clinicians the ability to remotely measure patient observations using built-in examination tools like the pulse oximeter. Now, like you, if a patient is suffering from ear pain, I want to be able to examine their ears. But when you are seeing a patient over a video it is not always possible to do this and that's where the medical comes in. You can remotely examine the patient's ear with a light and disposable covers. In fact, with the medicam I can explore the patient's auditory canal and image their tympanic membrane. And watch, I can even play helpful videos to guide the carer and patient throughout the examination. If you want to examine the patient's throat it's simple with the medicam, just ask the patient to give you a big "AH". Let's take a look. Cristal clear views of the oropharynx. You can also use the medicam to examine the skin up close in three dimensions. And all of these images can be recorded using the built-in capture feature just like that.

Next, I would like to show you the stethoscope. Arc comes with an integrated stethoscope that has been refined to filter different sounds. Clicking on stethoscope heart will load the instructions for the patient so they know where to place the stethoscope for heart sound like this. You can also listen to the tricuspid and mitral valves and that's not all.

Arc also includes a blood pressure monitor and thermometer so you can perform a full clinical examination. It's that simple? Remotely examine care home patients so you can reduce travel time and complete 94% of consultations without the need for a face-to-face appointment. Schedule a call with our NHS partnership team.

*Able to perform key functions which usually are done when going in presence to a prac-*

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titioner

CI7: 33 - 35 (0)

- Auscultate heart, lung and abdominal sounds
- Examine ears, throat and skin
- Measure patient observations

CI7: 50 - 52 (0)

*blood pressure cuff, stethoscope, thermometer, pulse oximeter and a small camera for the throat and ears provided at the hospital*

*All the essential equipment we find when going in-presence too*

CI7: 63 - 63 (0)

*examine vitals such as patients' oxygen levels as well as perform heart and lung checks.*

*The word "vitals" is significant here...*

CI7: 64 - 64 (0)

---

In a challenging time like this it is crucial that patients have access to care information and it can connect with their local hospitals, nurse practitioners, doctors, pharmacies and other healthcare services.

CI13: 14 - 14 (0)

---

AIRA now possessed an interface tablet which displayed important information and making it easier to interact with from the viewpoint of medical professionals and engineers alike.

CI32: 27 - 27 (0)

Concentration on  
core functionality\Accessible\Comfortable

"We're trying different things to for people with cochlear implants and hearing aids if they can't wrap around the ears," Lawrence said. "We're making some that have around the head and around the neck."

CI3: 10 - 10 (0)

adjusting them to their face.

CI19: 11 - 11 (0)

apply light pressure across your cheeks instead of placing it all directly on your nose

CI27: 6 - 6 (0)

*You breathe easier wearing the braced mask. Something about the snug fit causes your mouth and nose to adjust to the mask material much sooner and you just flat out breathe easier."*

CI27: 24 - 24 (0)

*They fit much more comfortably*

CI27: 25 - 25 (0)

---

	<p><i>I didn't have any issues with it being too tight or falling off.</i></p> <p>CI27: 25 - 25 (0)</p> <p><i>I almost feel naked using this mask</i></p> <p>CI27: 26 - 26 (0)</p> <p><i>I feel way more comfortable</i></p> <p>CI27: 27 - 27 (0)</p> <p><i>able to remove the ear loops from a surgical mask, that bite into my ears over time</i></p> <p>CI27: 27 - 27 (0)</p> <p><i>I have worn the essential brace for 10-12 straight with no discomfort</i></p> <p>CI27: 27 - 27 (0)</p>
	<p>Fully transparent, anti-fog masks available</p> <p><a href="#">comfort in communication</a></p> <p>CI31: 3 - 3 (0)</p> <p>maximum clarity and comfort,</p> <p>CI31: 5 - 5 (0)</p>
	<p>pleasing in both functionality and visual appeal.</p> <p>CI32: 30 - 30 (0)</p>
Concentration on core functionality\Accessible\Small/Portable	<p>small, lightweight and portable.</p> <p>CI6: 4 - 4 (0)</p>
	<p>the size of AIRA was actually reduced by an impressive 30%, greatly reducing the space necessary to house the ventilator in medical environments where it would be used.</p> <p>CI32: 29 - 29 (0)</p> <p>dditionally, the unit size successfully decreased every iteration, considering the needs of transportation and storage for medical environments.</p> <p>CI32: 32 - 32 (0)</p>
Concentration on core functionality\Accessible\Non-hospital settings	<p>remotely</p> <p><a href="#">remote (care) access</a></p> <p>CI5: 5 - 5 (0)</p> <p>new level of remote care</p> <p>CI5: 6 - 6 (0)</p> <p>limit the number of people going in to medical facilities</p> <p><a href="#">remote (care) access</a></p>

CI5: 8 - 8 (0)

treat them outside of the ICU

CI5: 10 - 10 (0)

---

“With rapid testing on ID NOW, healthcare providers can perform molecular point-of-care testing outside the traditional four walls of a hospital in outbreak hotspots.”

CI6: 6 - 6 (0)

---

remote consultation with the ability to examine patients in real-time.

CI7: 1 - 1 (0)

Arc incorporates the latest advancements in telehealth to enable caring patients to be examined remotely with the doctor in their surgery and the patient using arc from a care home.

CI7: 32 - 32 (0)

Your all-in-one triage, remote examination and consultation solution that reduces the need for face-to-face appointments.

CI7: 37 - 37 (0)

Give patients access to urgent care from pharmacies in your local community

CI7: 46 - 46 (0)

---

Thus the INSIDE-LIFE Card Set serves both as tool for crisis prevention and crisis intervention – practical, simple and at home.

[self-care at home](#)

CI26: 3 - 3 (0)

---

is aimed at care delivery in non-traditional settings without EHRs.

CI29: 3 - 3 (0)

"non-traditional healthcare settings such as tents, community centres and schools," according to Epic.

CI29: 6 - 6 (0)

The COVID-19 Preparedness App enables patients to self-screen and healthcare volunteers to triage using smartphones, broadening the capacity for emergency response

[remotely triage](#)

CI29: 7 - 7 (0)

It's meant to enable more care to be provided away from crowded hospitals and clinics – and to expand capacity in rural areas where access may be limited.

CI29: 11 - 11 (0)

---

Concentration on core functionality\Accessible\User-friendly

*Module 2 was well placed and instructive (especially to a neophyte like me)*

[Easy to understand](#)

---

CI2: 27 - 27 (0)

.com are the most accessible, comprehensive, and accurate source of information for practitioners.

CI2: 37 - 37 (0)

which respects the learner's background and limited time.

CI2: 38 - 38 (0)

The flow of information was smooth, and the graphics were very helpful in understanding the material.

CI2: 45 - 45 (0)

A new dashboard by healthcare analytics company Definitive Healthcare pinpoints how many days until hospitals in your region reach "capacity failure,"

[intuitive dashboard](#)

CI4: 3 - 3 (0)

smart display

CI5: 6 - 6 (0)

the clinician interface: it is easy to use and gives clinicians the ability to remotely measure patient observations using built-in examination tools like the pulse oximeter.

[for both patients and practitioners](#)

CI7: 33 - 33 (0)

will load the instructions for the patient so they know where to place the stethoscope for heart sound like this

[they have instructions and guidance available](#)

CI7: 34 - 34 (0)

Request supplies: Let us know what supplies you need, quantities and when you're running out.

Find suppliers: You'll receive an email with a list of approved suppliers with UK stock of the items you've requested, quantities and prices. We'll include contact details so you can order directly.

CI11: 5 - 6 (0)

easy-to-use dashboard

CI13: 4 - 4 (0)

"It was extremely easy to use.

CI16: 8 - 8 (0)

These will then be sent in their flat form to hospitals, where doctors, nurses and other frontline health care workers can quickly fold them into their three-dimensional form

before adjusting them to their face.

CI19: 11 - 11 (0)

Steep #1 – Peel protective film from both sides of face shield.

Steep #2 – Fold top strip over and make hard creases.

Steep #3 – Fold down visor pieces to make cover.

Steep #4 – Fold and crease side and bottom flaps.

Steep #5 – Clip in tabs to the slot on side.

Steep #6 – Attach doubled hair ties, elastic or rubber bands to complete.

CI19: 14 - 19 (0)

---

Dubbed GoodRx telehealth marketplace, users are able to select the type of condition they are looking to address. Patients can select one of 100 conditions, which run the gamut from cold and flu symptoms to erectile dysfunction, and even include COVID-19.

After the medical issue is selected, the site redirects patients to a list of telehealth services that treat that condition, along with the estimated price and pharmacy information. For example, a patient can search to see if a specific telehealth service has pharmacy pickup or medication delivery.

[intuitive procedure](#)

CI25: 5 - 6 (0)

ive people all their options, services and prices, so they can easily get the treatment they need.”

CI25: 8 - 8 (0)

---

- Download the PDF document, print it out, cut the cards.
- Formulate your own strength-giving sentences.
- Activate your psychological resilience against uncertainty and fear, as you would internalize a mantra.
- Further instructions can be found in the accompanying text on the PDF.

CI26: 5 - 8 (0)

---

interface flexibility

CI32: 25 - 25 (0)

needed an exterior that was both practical

CI32: 25 - 25 (0)

AIRA now possessed an interface tablet which displayed important information and making it easier to interact with from the viewpoint of medical professionals and engineers alike.

CI32: 27 - 27 (0)

The Ventilator Project also addressed interface concerns by introducing a Human Machine Interface (HMI) system, making control manipulation by medical professionals more straightforward with the help of simple control software.

---

CI32: 33 - 33 (0)

sharing the templates and material specifications

CI33: 4 - 4 (0)

the file for digital flatbed cutters and the assembly instructions can be found on the foster + partners' website here.

CI33: 4 - 4 (0)

Concentration on  
core functional-  
ity\Simple

Kevin works for Battelle, a non-profit research institute that routinely tests for dangerous pathogens and remembered the study they did 5 years ago showing medical masks could actually be cleaned and reused in an emergency.

*Laurie: "We were drawing schematics of what it could look like."*

*Reporter: "So, you sat down with a paper and start drawing?"*

*Laurie: "Exactly, I was describing what I see, what it looks like, where the air flows... we got into it right away."*

*The innovation has been simply figured out (design process)*

CI1: 9 - 12 (0)

*Laurie: "Yeah, I still do not think it is fully sunk in yet. It is overwhelming to think it started with an after-dinner conversation, drawing it out on a piece of paper and seeing if it was feasible."*

CI1: 24 - 24 (0)

Do you want to know more? Click the button below to begin.

CI2: 55 - 55 (0)

After a conversation with her mom, they put their craft skills to work.

"We started out making them with bed sheets that we had, and luckily bed sheets are big," Lawrence said. "So we have two or three sets so we're making them out of that. Then, a couple months ago we needed plastic fabric for something. And so we have a whole roll of that and the window is only this big so having a whole roll is very helpful so luckily we haven't needed any supplies yet."

With her mission centered around the deaf and hard of hearing community, she is going the extra mile.

"We're trying different things to for people with cochlear implants and hearing aids if they can't wrap around the ears," Lawrence said. "We're making some that have around the head and around the neck."

She explained the necessity for the plastic window on the masks is why she started this project in the first place.

[masks made of bed sheets and plastic](#)

CI3: 7 - 11 (0)

she retooled the 3-D printing machine she uses for cookie cutters to make headbands for protective face shields worn by doctors and nurses.

CI10: 4 - 4 (0)

---

The modification to is claimed to be straightforward and involves changes to the device's settings and reconfiguring the supply of oxygen so it flows directly to the face mask worn by the patient

CI12: 7 - 7 (0)

modifications easier.

CI12: 15 - 15 (0)

"Instead, the solution we eventually arrived at is much simpler. You have to change some of the settings, filters and the way oxygen reaches the patient. It is now a fix that hospital teams can undertake themselves using equipment which is readily available."

CI12: 17 - 17 (0)

---

we have cut all red tape that typically goes with implementing a software like Chat-mater.

[Simple to download the software \(reduced bureaucracy, hence complexity\)](#)

CI13: 18 - 18 (0)

---

seamlessly

CI15: 3 - 3 (0)

---

easily made using regular hospital devices

CI18: 6 - 6 (0)

easily replicated.

CI18: 8 - 8 (0)

---

face shields for medical workers fighting Covid-19, which come flat-packed and can be folded into shape.

CI19: 3 - 3 (0)

Made from a single piece of plastic, each shield comes in a flat design that can be swiftly folded into a three-dimensional structure when needed for use.

The face shields also offer additional protection with flaps that fold under the neck and over the forehead.

CI19: 5 - 6 (0)

Each single-piece shield will be made using the die-cutting process. Machines cut the design from thousands of flat sheets per hour.

[produced in a simple way \(process\)](#)

CI19: 10 - 10 (0)

---

It consists of 40 INSIDE cards and 40 LIFE cards which, when combined, can create 1,600 strength-giving and clarifying sentences.

CI26: 3 - 3 (0)

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	<p>simple CI26: 3 - 3 (0)</p> <hr/> <p>Made from a single compression modelled piece CI27: 14 - 14 (0)</p> <p>production can be easily ramped up CI27: 14 - 14 (0)</p> <p><i>A simple</i> CI27: 23 - 23 (0)</p> <hr/> <p>the simple yet productive design proved to the engineering team that positive pressure was possible through a bellow system, hence the utilization of minimalist pieces to move air with an outside air source. CI32: 12 - 12 (0)</p> <p>Eclare lifters, used in pneumatic food processing, were introduced to tackle the issue. <a href="#">design made of "simple components as well"</a> CI32: 15 - 15 (0)</p> <p>bellows from bee smokers. CI32: 17 - 17 (0)</p> <hr/> <p>Composed of just three pieces, the prototype has been designed with the aim of facilitating quick mass production of the visors CI33: 4 - 4 (0)</p>
Intrinsically sustainable value\Inclusive	<p>"I just saw that people were making masks on Facebook for everyone to have instead of the throwaway masks, and I was like, what about the deaf and hard of hearing population?" CI3: 4 - 4 (0)</p> <p>"I felt like there was a huge population that was being looked over," Lawrence said. "We're all panicking right now and so a lot of people are just not being thought of." CI3: 6 - 6 (0)</p> <p>if half of that is gone because you're wearing a mask then half of what you're saying is being missed, so even if it's not physically talking and just using ASL, then you need to have that kind of access." CI3: 12 - 12 (0)</p> <hr/> <p>purchase PPE for those who don't have the funds. CI11: 9 - 9 (0)</p> <hr/> <p>Silverman says she has also been able to hire lactation experts who have been laid off or furloughed because of the crisis.</p>

### hiring laid off people

CI16: 18 - 18 (0)

“You can protect the vulnerable people in society who may not have smartphones, and protect children. If enough adults across the population engage with the system and trust the system telling them they should isolate, you’re protecting all those individuals who don’t have a device.”

CI17: 10 - 10 (0)

Many refugees in Europe involved in medicine in their home countries are finding new ways to use their skills to help care for those in need. Below are two examples from France.

CI24: 4 - 4 (0)

The pandemic has given the charity an opportunity to contribute directly and has also made them extra busy.

Prior to the COVID-19 outbreak, volunteers translated around 10 documents per week, primarily helping asylum seekers with the asylum process in France. Now they are translating documents that provide information on the lockdown in France and advice on who to contact if a person is feeling unwell. In all, they have translated over 220 documents.

CI24: 15 - 16 (0)

Some asylum seekers don’t understand the lockdown, so we help to explain in their own language.”

“During difficult times, the language barrier can become frustrating. We want to help.”

### contributing to the relief of cultural barriers

CI24: 17 - 18 (0)

### innovating health equity in underserved areas

CI29: 6 - 6 (0)

broadening the capacity for emergency response in rural or underserved communities.

CI29: 7 - 7 (0)

It's meant to enable more care to be provided away from crowded hospitals and clinics – and to expand capacity in rural areas where access may be limited.

CI29: 11 - 11 (0)

When the pandemic began, our mission was to bring a human-centered mask to everyone who needed it, especially children, older adults, deaf and hard of hearing people, and those who heavily depend on visual communication

CI31: 9 - 9 (0)

Intrinsically sustainable value  
Resource-

clean and reuse n95 masks

[No disposable products: eco-friendly approach](#)

## efficient

CI1: 1 - 1 (0)

a young couple in Columbus, Ohio, who came up with a unique way to clean and reuse critically needed N95 masks.

CI1: 3 - 3 (0)

medical masks could actually be cleaned and reused in an emergency.

CI1: 9 - 9 (0)

the masks can be cleaned and then reused 20 times.

CI1: 18 - 18 (0)

---

Saves money and resources

CI2: 10 - 10 (0)

---

instead of the throwaway masks

[not disposable](#)

CI3: 4 - 4 (0)

"We started out making them with bed sheets that we had, and luckily bed sheets are big," Lawrence said. "So we have two or three sets so we're making them out of that. Then, a couple months ago we needed plastic fabric for something. And so we have a whole roll of that and the window is only this big so having a whole roll is very helpful so luckily we haven't needed any supplies yet."

[readily available resources](#)

CI3: 8 - 8 (0)

---

them outside of the ICU

CI5: 10 - 10 (0)

---

- Remotely assess deteriorating patients to avoid unnecessary hospitalisation
- Manage your care homes efficiently with fewer clinical resources

[careful management of resources that are lacking \(like ICU beds\)](#)

CI7: 21 - 22 (0)

- All-in-one triage, examination and consultation to avoid duplicate clinician sessions

CI7: 45 - 45 (0)

---

she retooled the 3-D printing machine she uses for cookie cutters to make headbands for protective face shields

CI10: 4 - 4 (0)

---

items currently in stock & ready to ship.

[system based on readily available items \(in stock\)](#)

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CI11: 3 - 3 (0)

---

A sleep apnoea machine being phased out of service can be modified into a ventilator  
[use of existing machine out of service](#)

CI12: 3 - 3 (0)

many more similar devices across the NHS that could be modified to provide respiratory support to very ill patients.

CI12: 5 - 5 (0)

It is now a fix that hospital teams can undertake themselves using equipment which is readily available.”

CI12: 17 - 17 (0)

---

Curran has also worked with nanotech coatings for fabrics. He's now implementing this technology to provide more protection against SARS and COVID-19.

[use of existing technology applied in former works](#)

CI14: 8 - 8 (0)

---

optimizing the use of healthcare resources.

CI15: 3 - 3 (0)

---

easily made using regular hospital devices

CI18: 6 - 6 (0)

The device's main part already exists in most hospitals' inventory:

[use of existing resources](#)

CI18: 10 - 10 (0)

This method would alleviate the use of a person standing day and night by a patient's bedside — something that's not currently possible in hospitals that are reaching over-capacity because of the rapidly spreading coronavirus — and keep them breathing long enough to then be strapped to a proper ICU ventilator.

CI18: 11 - 11 (0)

---

Made from a single piece of plastic

CI19: 5 - 5 (0)

"When you're thinking of materials, you have to keep supply chains in mind," said Martin Culpepper, professor of mechanical engineering and project leader.

"You can't choose a material that could evaporate from the supply chain," he added. "That is a challenging problem in this crisis."

---

CI19: 8 - 9 (0)

---

Our donors include people who had a single box of masks under their workbench or wildfire masks in their closet

CI21: 5 - 5 (0)

and very dedicated volunteers sewing handmade masks.

[no disposable \(eco-friendly\)](#)

CI21: 5 - 5 (0)

---

Get the most out of your surgical mask

[make the most out of existing resources](#)

CI27: 1 - 1 (0)

over a disposable mask or a cloth mask

CI27: 4 - 4 (0)

Made from a single compression modelled piece

CI27: 14 - 14 (0)

Fix the max believes we do not need to change our supply chain to get people the PPE we need, with the essential mask brace we are able to protect people now with the resources we have today.

CI27: 20 - 20 (0)

---

a concept was drawn up while considering available materials.

CI32: 6 - 6 (0)

they built their first prototype from hardware store parts

CI32: 6 - 6 (0)

utilization of minimalist pieces

CI32: 12 - 12 (0)

Eclare lifters, used in pneumatic food processing, were introduced to tackle the issue.

CI32: 15 - 15 (0)

bellows from bee smokers.

CI32: 17 - 17 (0)

---

reusable face visor

[eco-friendly nature](#)

CI33: 1 - 1 (0)

with a number of studios utilizing their 3D printers and laser cutters

[use of existing equipment](#)

CI33: 3 - 3 (0)

---

	<p>visor that can be cleaned and reused.</p> <p>CI33: 3 - 3 (0)</p>
<p>Optimized performance\Robustness</p>	<p>impervious to water</p> <p>CI14: 12 - 12 (0)</p> <hr/> <p>After testing a few materials that cracked and broke when bent, the team landed on the polycarbonate and polyethylene terephthalate glycol (PETG) materials.</p> <p>CI19: 7 - 7 (0)</p> <hr/> <p>fluid resistance, microbial cleanliness</p> <p>CI31: 5 - 5 (0)</p> <p>fluid resistance and flammability</p> <p>CI31: 6 - 6 (0)</p> <p>tests for resistance to penetration of microorganisms</p> <p>CI31: 6 - 6 (0)</p>
<p>Optimized performance\Quality care</p>	<p>life-saving idea</p> <p>CI1: 5 - 5 (0)</p> <p>testing on masks began.</p> <p><a href="#">Testing improves the quality</a></p> <p>CI1: 14 - 14 (0)</p> <hr/> <ul style="list-style-type: none"> <li>• Reduces rates of intubation, in-hospital mortality, and ICU length of stay</li> <li>• Improves patient experience and their tolerance of the treatment</li> <li>• Improves non-invasive ventilation success rates</li> <li>• Ensures better results sooner with improved patient outcomes</li> </ul> <p><a href="#">The service indirectly leads to quality care (if properly applied) for patients</a></p> <p>CI2: 6 - 9 (0)</p> <ul style="list-style-type: none"> <li>• Lowers rates of intubation, in-hospital mortality, and ICU length of stay</li> <li>• Provides painless respiratory support, thereby improves patient experience and tolerance of the NIV therapy</li> <li>• Ensures timely application and perfect fit, increasing the chances of positive patient outcomes.</li> </ul> <p><a href="#">From customer perspective</a></p> <p>CI2: 21 - 23 (0)</p>

higher chance of survival when applied promptly and correctly.

CI2: 54 - 54 (0)

---

its focus on what it terms a patient's "baseline," which is established by an in-person visit they make when they join

CI5: 4 - 4 (0)

---

highly valued by the scientific community for its accuracy.

[accuracy](#)

CI6: 4 - 4 (0)

qualitative detection of infectious diseases

CI6: 8 - 8 (0)

---

### **Improve the quality**

**CI7: 3 - 3 (0)**

avoid misdiagnosis and inappropriate prescribing.

CI7: 4 - 4 (0)

Accurately diagnose

CI7: 7 - 7 (0)

- Maintain your normal levels of clinical safety
- Use observations to aid diagnosis
- Manage cardiovascular and respiratory disease
- Undertake effective virtual ward rounds

CI7: 12 - 15 (0)

- Improve care
- Undertake virtual ward rounds in multiple care settings from your surgery.
- Deliver safe and high-quality care with comprehensive remote examination.
- Give your patients timely access to care without sacrificing quality.

CI7: 24 - 27 (0)

*"A doctor can watch a patient take their own temperature, blood pressure, use a stethoscope to check their heart and lungs and use a close-up camera to examine their ears and throat ... it's the closest thing to conducting a real appointment with patients."*

CI7: 56 - 56 (0)

*the NHS-approved video conference hubs enable GPs to take clinical measurements of residents without them needing to visit the home.*

CI7: 58 - 58 (0)

*a remote diagnosis hub that allows at-risk residents to be accurately assessed by a GP*

---

*without the need for a face-to-face visit*

CI7: 61 - 61 (0)

*guide patients on performing an examination on themselves while the doctor ensures they are doing it correctly.*

CI7: 65 - 65 (0)

---

legitimate suppliers, who have high quality and fully certified stock

CI11: 11 - 11 (0)

---

ensure air supply is maintained during an episode.

CI12: 6 - 6 (0)

mode, ensuring that the pressure inside the mask is slightly raised, keeping the patient's airway open and making it easier for them to breathe.

CI12: 8 - 8 (0)

enriched oxygen of between 40 to 60 per cent.

CI12: 8 - 8 (0)

the medical physics team wanted to reconfigure it further, to achieve more efficient use of hospital oxygen supplies. The clinical team, with the engineers, decided that the patient's mask would receive air from the device and oxygen directly from the hospital's supply system.

CI12: 13 - 13 (0)

many seriously ill patients did not need full ventilation, which requires sedation, but an intermediate level of support which could be provided by a CPAP device.

CI12: 14 - 14 (0)

---

avoid local overload in critical care units

[indirect benefit](#)

CI15: 3 - 3 (0)

---

and keep them breathing long enough to then be strapped to a proper ICU ventilator.

[life-saving](#)

CI18: 11 - 11 (0)

the MIT E-Vent is anticipated to have utility in helping free up existing supply or in life-or-death situations when there is no other option."

[good for its intended purpose](#)

CI18: 13 - 13 (0)

---

with the best quality of care at the heart of it."

CI22: 14 - 14 (0)

---

is key to making a high-quality mask solution

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	<p>CI27: 17 - 17 (0)</p> <hr/> <p>supporting up to 800mL of oxygen delivered in less than 0.5 seconds</p> <p>CI32: 7 - 7 (0)</p> <p>proper amount of air to regulate the inhale and exhale of a patient's breath.</p> <p>CI32: 7 - 7 (0)</p> <p>testing</p> <p>CI32: 8 - 8 (0)</p> <p>While not only doubling the volume of air made available, this also met the 3 modes of control necessary for a COVID-19 ventilator to be successful: pressure control, volume control and pressure support.</p> <p>CI32: 19 - 19 (0)</p> <p>optimized long-term airflow of the ventilator</p> <p>CI32: 26 - 26 (0)</p>
Optimized performance\Safe	<p>"If people aren't leaving their homes, and frankly, you don't really want them to leave their homes unless you need them to, you have to figure out how to do all that remotely</p> <p><a href="#">need to guarantee safety (contributing in flattening the epidemic curve)</a></p> <p>CI5: 5 - 5 (0)</p> <p>At launch, the service also includes home visits to collect urine and blood samples, as an added measure designed specifically to help patients adhere to CDC and health agency guidelines around self-isolation</p> <p>CI5: 7 - 7 (0)</p> <p>need to limit the number of people going in to medical facilities and hospital all across the country unless they absolutely need to</p> <p>CI5: 8 - 8 (0)</p> <p>getting people out of the hospitals, as much as possible for a second reason, which is not that the hospitals are overloaded, but that the hospitals are one of the fastest ways to spread COVID-19.</p> <p>CI5: 10 - 10 (0)</p> <hr/> <p>Minimise your visits to care homes to reduce transmission of Covid-19</p> <p>CI7: 20 - 20 (0)</p> <p><i>while minimising risk</i></p> <p>CI7: 61 - 61 (0)</p> <p><i>"Allows doctors who are self-isolating to continue working while retired doctors returning to medicine to fight the virus can conduct consultations from the safety of their own home."</i></p> <p><a href="#">safety also for practitioners...</a></p> <p>CI7: 62 - 62 (0)</p>

The solution can improve protection.

CI14: 12 - 12 (0)

---

The safety of medical data exchange remains of the utmost importance, even in times of crisis. As a result, the portal fully complies with the ISO27001 information security standard and the Dutch NEN7510 standard, which is specifically designed for information handling in the healthcare sector.

#### Data protection

CI15: 4 - 4 (0)

sharing patient data between hospitals quickly and securely

CI15: 6 - 6 (0)

data to be sent digitally in a secure manner.

#### Data protection

CI15: 7 - 7 (0)

---

The NHS is in talks to roll out a smartphone app that instantly traces close contacts of people carrying the coronavirus and advises them to self-isolate.

#### slow down infections

CI17: 4 - 4 (0)

Around 60% of the adult population would need to sign up and engage with the app by registering their symptoms or positive test results for it to be effective. Their proximity to other users would be logged, and they would follow advice given in alerts to self-isolate – even in cases where they were not aware of having been in contact with someone infected.

CI17: 6 - 6 (0)

There would need to be oversight of the app's deployment, clear "stop rules" about what happens to data after the pandemic is brought under control and careful attention paid to ensure those without smartphones would not be disadvantaged.

#### safety from a data perspective

CI17: 19 - 19 (0)

rotocols which ensure that these technologies are democratically governed

CI17: 21 - 21 (0)

---

a new service to safely manage suspected cases of coronavirus following their disembarkation from an offshore Country/Nation.

CI22: 3 - 3 (0)

Iqarus has been working round the clock with its client base to support them in mitigating their risk, encouraging clients to closely monitor the situation and advise them on how best to safely continue operations.

CI22: 6 - 6 (0)

can now offer clinically appropriate transport from either of the Aberdeen heliports to its dedicated reception centre in Aberdeen.

---

Following initial offshore assessment from the asset medic, the patient will then be transported via bespoke helicopters – aptly dubbed ‘the corona copter’ – that meet full hygiene standards for each trip.

CI22: 10 - 11 (0)

securing the mask

[increased protection](#)

CI27: 13 - 13 (0)

*more protective mask.*

CI27: 23 - 23 (0)

*I feel as though the seal is more effective than with a K/N9*

*Here the terminology "effective" should not be confused with being helpful but rather providing more protection!*

CI27: 27 - 27 (0)

Meanwhile, by collecting patient demographic information the app can help epidemiologists and government health officials track the spread and containment of coronavirus.

CI29: 8 - 8 (0)

provide clear communication and safety for healthcare providers and essential workers

CI31: 3 - 3 (0)

biocompatibility, which offers a high level of protection for medical use in environments such as operating rooms.

CI31: 5 - 5 (0)

tests for resistance to penetration of microorganisms

CI31: 6 - 6 (0)

has helped provide protection against the transfer of aerosols, fluids, and sprays

CI31: 7 - 7 (0)

Optimized performance\Higher-performance

*The benefit of having Aurika for a presentation far exceeded our expectations. Our team felt more confident to suggest and use this type of interface.*

CI2: 35 - 35 (0)

a whole new level of remote care, over and above what’s typically defined as “telemedicine,” which generally amounts to little more than video calls with doctors, Aoun points out.

[above the traditional telemedicine](#)

CI5: 6 - 6 (0)

At launch, the service also includes home visits to collect urine and blood samples, as an added measure designed specifically to help patients adhere to CDC and health agency

guidelines around self-isolation, while also getting a detailed and thorough level of care.  
A

[it moves further to the traditional telemedicine \(safety + quality\)](#)

CI5: 7 - 7 (0)

Arc incorporates the latest advancements in telehealth

[compare it with the traditional telemedicine](#)

CI7: 32 - 32 (0)

Unlike with some previous pandemics, including Sars and flu, a high proportion of transmission of Covid-19 occurs before a person is showing symptoms. So isolating people once they become ill and tracing contacts manually has limited effectiveness because the spread of the virus will be one step ahead, according to the team's analysis in the journal Science.

CI17: 11 - 11 (0)

"Traditional contact tracing is too slow for this virus and it won't work,

CI17: 12 - 12 (0)

creating the fit factor the passes the n95 standard

CI27: 13 - 13 (0)

With the essential mask brace adding fit to a high performing filter, the air inside is 100 times cleaner than the air outside the mask, passing the n95 standard.

CI27: 16 - 16 (0)

no other transparent masks meet both certifications.

CI31: 4 - 4 (0)

more air pressure than required

CI32: 23 - 23 (0)

Optimized performance\Helpful

- Reduces workload for clinicians while increasing non-invasive ventilation (NIV) success rates.
- Unique course material, not offered by any other learning provider.
- Includes updates and new development in helmet-based ventilation.

[Enable \(valuable information\) healthcare workers to work better](#)

CI2: 17 - 19 (0)

*informative*

CI2: 26 - 26 (0)

*Module 3 was beneficial because it addressed many of the incidental questions providers might have in a classroom.*

*beneficial*

CI2: 28 - 28 (0)

*The details would have been extremely useful to me if I worked with these helmets!*

CI2: 28 - 28 (0)

*instructive*

CI2: 31 - 31 (0)

*essential takeaways*

CI2: 32 - 32 (0)

*“When we first received Helmets at our hospital, we did not know where to turn for help to get them started. There was very limited information at that time on how to use them and what settings to use.*

*Thankfully, one of the Respiratory Therapists suggested checking [HelmetBasedVentilation.com](#). We found so much valuable information*

CI2: 33 - 34 (0)

*Our team felt more confident to suggest and use this type of interface.*

*learnability*

CI2: 35 - 35 (0)

*I felt the training course was very effective*

CI2: 46 - 46 (0)

---

*It is helpful*

*keep people up to date*

CI4: 9 - 9 (0)

---

*the training and skills our cabin crew have, working closely with the medical professionals, could help make a real difference.”*

*Crew with competences in care provides assistance*

CI9: 9 - 9 (0)

---

*provide accurate and up-to-date information online and ultimately improve customer and patients experiences for everyone.*

CI13: 19 - 19 (0)

---

*She says the goal is to ease any questions or concerns new parents may be experiencing.*

*providing information*

CI16: 13 - 13 (0)

*“When a mother or a father has a question about breastfeeding, it’s an emergency. If they don’t get that help they need immediately, they may lose their milk supply. Literally, in the last couple of weeks, clinics are closing. People can’t come in to see their doctors,” Silverman said. “We’re really able to help them the minute they need it and make sure breastfeeding continues.”*

---

CI16: 16 - 16 (0)

great way to get that support and help.

CI16: 17 - 17 (0)

Once a user reports symptoms or a positive test result, the app would trace back through close contacts over the past seven days and alert those calculated to be at risk

[help in contact tracing](#)

CI17: 14 - 14 (0)

content that is clinically proven to help people reduce stress, anxiety and mild to moderate depression.

[clinically proven](#)

CI20: 4 - 4 (0)

*A handy tool*

CI21: 18 - 18 (0)

“In addition to providing accurate information, especially during the initial uncertain period when a new virus emerges, advice on how to mitigate further risks and ensure business continuity should be shared.”

CI22: 18 - 18 (0)

“Stay home. Stay strong.” “Hospitals, charities and accommodation centres have been sending us documents, certificates and flyers, and we have been translating them for free,” Yasin said. “Some asylum seekers don’t understand the lockdown, so we help to explain in their own language.”

CI24: 17 - 17 (0)

ive people all their options, services and prices, so they can easily get the treatment they need.”

CI25: 8 - 8 (0)

These cards are amazing! I sent your link to many people I know who are really struggling with the quarantine. I’m sure they will be helpful.

CI26: 26 - 26 (0)

This is simple, but real help!

[providing help=effective](#)

CI26: 30 - 30 (0)

Optimized performance\Fast

it takes about 2 and a half hours

CI1: 18 - 18 (0)

faster adaptation of this life-saving therapy.

[Professionals learn fast how to adapt the helmet](#)

CI2: 15 - 15 (0)

Ensures timely application and perfect fit, increasing the chances of positive patient outcomes.

CI2: 23 - 23 (0)

---

has launched a test to detect coronavirus in just five minutes.

CI6: 3 - 3 (0)

The test can detect positive results in five minutes, while negative results take about 13 minutes

CI6: 4 - 4 (0)

---

Remotely assess deteriorating patients to avoid unnecessary hospitalisation

[rapid intervention/assess of clinical condition](#)

CI7: 21 - 21 (0)

10 mins for a consultation:

CI7: 30 - 30 (0)

Ensure the right patient sees the right clinician at the right time

CI7: 47 - 47 (0)

improve efficiencies in clinician time.

CI7: 49 - 49 (0)

*time-saving remote diagnostic solution*

[Fast diagnosis](#)

CI7: 60 - 60 (0)

---

face shields, which can be assembled in less than two minute

CI8: 22 - 22 (0)

---

One shield takes about 45 minutes to print

CI10: 6 - 6 (0)

---

Ensure patients can find hospitals, clinics, and other healthcare services in their time of need with Chatmeter's Crisis Management Program for Healthcare.

[give a prompt answer](#)

CI13: 3 - 3 (0)

rovide accurate and up-to-date information online

CI13: 19 - 19 (0)

---

sharing patient data between hospitals quickly

CI15: 6 - 6 (0)

---

The goal is to connect moms with a lactation expert within 30 seconds.

CI16: 15 - 15 (0)

"We're really able to help them the minute they need it and make sure breastfeeding continues."

CI16: 16 - 16 (0)

---

instantly traces close contacts

CI17: 4 - 4 (0)

---

health care workers can quickly fold them into their three-dimensional form

CI19: 11 - 11 (0)

---

*running in 48 hours to distribute masks and protective gear directly from donors to doctors, nurses and clinics.*

CI21: 16 - 16 (0)

---

we can assess those patients

CI22: 14 - 14 (0)

---

dogs can screen up to 750 people really quickly

CI23: 14 - 14 (0)

---

"A retired nurse, or any other volunteer or staff, with her own smartphone can be up and running in minutes," said Epic CEO Judy Faulkner in a statement. "This allows states, counties, and health systems to increase capacity quickly

CI29: 13 - 13 (0)

for rapidly building capacity

CI29: 14 - 14 (0)

---

an alternate route could be the best way to really make a rapid impact.

CI32: 4 - 4 (0)

supporting up to 800mL of oxygen delivered in less than 0.5 seconds.

CI32: 7 - 7 (0)

---

217 visors can be cut every hour

CI33: 4 - 4 (0)

The templates, which are for digital and laser cutters, offer a quicker turnover than masks produced by 3D printing. each visor can be cut in under 30 seconds and assembled in under a minute. alternatively, the face shields be flat-packed and distributed quickly in large quantities. using their digital flatbed cutter foster + partners has been

---

	<p>able to cut and assemble components for 1,000 masks in a single day</p> <p>CI33: 5 - 5 (0)</p>
<p>Optimized performance\Meeting regulatory requirements</p>	<p><i>FDA approval</i></p> <p>CI1: 15 - 15 (0)</p> <hr/> <p>the U.S. Food and Drug Administration (FDA) has issued the Emergency Use Authorisation (EUA) for the fastest available “molecular point-of-care” test to check for Covid-19.</p> <p>CI6: 3 - 3 (0)</p> <p>has not been FDA approved so far, but has only been authorised by the FDA to be used during an emergency.</p> <p>CI6: 9 - 9 (0)</p> <hr/> <p>legitimate suppliers, who have high quality and fully certified stock</p> <p>CI11: 11 - 11 (0)</p> <hr/> <p>As a result, the portal fully complies with the ISO27001 information security standard and the Dutch NEN7510 standard</p> <p>CI15: 4 - 4 (0)</p> <hr/> <p>The FDA has created a dedicated new website seeking recovered COVID-19 donations, and explaining its potential uses.</p> <p><a href="#">It is created by FDA itself (it went through all process of authorisation, reliability is guaranteed)</a></p> <p>CI28: 3 - 3 (0)</p> <hr/> <p>first CE-marked</p> <p>CI31: 1 - 1 (0)</p> <p>ClearMask™ is the world’s first and only fully transparent surgical mask that is both CE-marked and FDA-cleared</p> <p>CI31: 4 - 4 (0)</p> <hr/> <p>accommodate the full range of FDA requirements</p> <p>CI32: 7 - 7 (0)</p>
<p>Substantial cost reduction\Low-cost innovation</p>	<p>Saves money</p> <p>CI2: 10 - 10 (0)</p> <hr/> <p>And so we have a whole roll of that and the window is only this big so having a whole roll is very helpful so luckily we haven't needed any supplies yet."</p> <p>CI3: 8 - 8 (0)</p> <p>"So we are sending them out for free whenever we have people asking for them and if they're foreign, then maybe we'll charge shipping, but other than that they're complete-</p>

ly free."

only shipping costs

CI3: 14 - 14 (0)

---

so we put together a kit that has a bunch of sensors in it that we actually mail to you

CI5: 5 - 5 (0)

---

small, lightweight and portable.

CI6: 4 - 4 (0)

---

Minimise your travel to care homes

CI7: 10 - 10 (0)

*saves time spent travelling to and from care homes, as well as offering a cost-effective way to enhance support for patients*

CI7: 59 - 59 (0)

---

We do not accept suppliers who are profiteering and have over inflated prices.

CI11: 11 - 11 (0)

---

donating over 5 million dollars in free services to healthcare related businesses for the next 90 days

limited discount (free for 90 days)

CI13: 18 - 18 (0)

limited time offer

CI13: 21 - 21 (0)

---

affordable

CI18: 6 - 6 (0)

that's affordable

CI18: 8 - 8 (0)

The total cost of the device for the different parts is between \$400 to \$500

CI18: 9 - 9 (0)

---

Made from a single piece of plastic, each shield comes in a flat design that can be swiftly folded into a three-dimensional structure when needed for use.

The face shields also offer additional protection with flaps that fold under the neck and over the forehead.

CI19: 5 - 6 (0)

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pharmaceutical-cost-transparency tool, is rolling out a new feature that lets patients compare telemedicine prices and service options.

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	<p>CI25: 4 - 4 (0)</p> <hr/> <p>These devices are cost-effective,</p> <p>CI32: 22 - 22 (0)</p> <p>The Ventilator Project's fight to bring a low-cost, rapidly producible ventilator out into the world is over yet.</p> <p>CI32: 36 - 36 (0)</p> <hr/> <p>studios utilizing their 3D printers and laser cutters to produce vital face shields, foster + partners has now shared a template for a general-purpose visor that can be cleaned and reused.</p> <p>Composed of just three pieces, the prototype has been designed with the aim of facilitating quick mass production of the visors. using a zund G3 M 2500 cutting machine, or its equivalent, an incredible 217 visors can be cut every hour</p> <p>CI33: 3 - 4 (0)</p>
Substantial cost reduction\Low-cost innovation\No-cost solution	<p>donating worldwide</p> <p>CI8: 9 - 9 (0)</p> <hr/> <p>many already donated</p> <p>CI10: 5 - 5 (0)</p> <hr/> <p>donated 50,000 pieces of PPE so far.</p> <p>CI11: 14 - 14 (0)</p> <hr/> <p>Another positive is that the app is completely free.</p> <p>CI16: 11 - 11 (0)</p> <hr/> <p>app free</p> <p>CI20: 7 - 7 (0)</p> <hr/> <p>Refugees offer medical experience to help tackle coronavirus crisis in France.</p> <p><a href="#">volunteering</a></p> <p>CI24: 1 - 1 (0)</p> <p>The COVID-19 crisis has sparked an outpouring of solidarity from people around the world and that includes refugees, keen to help in the countries where they now live.</p> <p>CI24: 4 - 4 (0)</p> <hr/> <p>NonCommercial - You may not use the material for commercial purposes.</p> <p>CI26: 18 - 18 (0)</p> <hr/> <p>donation of plasma from recovered COVID-19 patients</p>

	CI28: 1 - 1 (0)
Substantial cost reduction\Low-cost innovation\External funds/resources	Those who would like to help Lawrence with the cost of materials and shipping, she is accepting donations on her GoFundMe page.
	<p><a href="#">Donations</a></p> <p>CI3: 15 - 15 (0)</p>
	<p>Our fundraising campaign helps us to purchase PPE for those who don't have the funds. We also receive donations from a select number of suppliers.</p>
	<p>CI11: 9 - 9 (0)</p> <p>After successfully raising £5,000 in two weeks, we're now raising more funds to donate PPE to the charities and organisations that most need it.</p> <p>You can contribute by clicking on our GoFundMe campaign here: your contribution will be used to source protective equipment for those on the frontline against COVID-19.</p> <p>If you're a supplier of PPE, we're also accepting donations.</p> <p>CI11: 15 - 17 (0)</p>
	<p>821,000 masks from 6,200 donors</p> <p>CI21: 4 - 4 (0)</p> <p>depth of generosity we saw from our donors.</p> <p>CI21: 8 - 8 (0)</p>
<p>There is still much work to be done, and a large part of that comes down to our donors. Quite literally every dollar moves us forward, whether it be to propel TVP through FDA authorization, or to simply buy snacks to keep our hardworking team of engineers well-fueled.</p> <p>CI32: 36 - 36 (0)</p>	



..Resource-efficient		1	<b>Covid Innovation 1:</b> Young couple creates new system to clean and reuse n95 masks
		2	<i>Article from Online Newspaper (Today)</i>
		3	Our series “Search for Solutions” continues with a look at a breakthrough system rolling out across the country that provides some relief for health care workers struggling with a lack of personal protective equipment, thanks to a young couple in Columbus, Ohio, who came up with a unique way to clean and reuse critically needed N95 masks. NBC’s Stephanie Gosk reports for TODAY.
..Resource-efficient		4	<b>Report Transcript (audio-visual content):</b>
		5	One of the biggest challenges in this crisis, a shortage of critical protective gear for frontline health care workers. But a month ago at the dining room table, Laurie and Kevin Hommema got an idea, a potentially gain-changing, life-saving idea. Lory – a family doctor in Ohio – was worried: the N95 masks in her hospital were in short supply.
..Quality care		6	<i>Laurie: “We had a meeting that day and just mentioned, I am afraid we were going to run out of N95s I think I said, I do not know if we are going to have a mask.”</i>
		7	That’s when her husband, Kevin, an engineer, asked a simple question.
		8	<i>Kevin: I said, “Why don’t you clean them up?”, and Lory said: “What do you mean?”</i>
..Resource-efficient		9	Kevin works for Battelle, a non-profit research institute that routinely tests for dangerous pathogens and remembered the study they did 5 years ago showing medical masks could actually be cleaned and reused in an emergency.
..Simple		10	<i>Laurie: “We were drawing schematics of what it could look like.”</i>
		11	<i>Reporter: “So, you sat down with a paper and start drawing?”</i>
		12	<i>Laurie: “Exactly, I was describing what I see, what it looks like, where the air flows... we got into it right away.”</i>
..Quality care		13	<i>Reporter: “By the way, you are obviously the perfect couple for each other”.</i>
..Meeting regulatory requirer		14	The following week testing on masks began.
		15	<i>Reporter: “How long did it take to get this FDA approval?”</i>
		16	<i>Lory: “I think it was a total of 14 days.”</i>
		17	<i>Reporter: “I do not know how often you work with the federal government but that’s blazing fast.”</i>
Tech solution		18	Here is how the technology works: a hydrogen peroxide vapor decontaminates the N95 masks; it takes about 2 and a half hours, and the masks can be cleaned and then reused 20 times.
..Fast		19	<i>Kevin: “Each one can handle about 80,000 masks a day.”</i>
..Resource-efficient		20	<i>Reporter: “That’s a game-changer for hospitals, isn’t it?”</i>
Scalable		21	<i>Laurie: “That’s an entire hospital’s worth over a few days.”</i>
		22	The decontamination systems are already being used in Ohio, Washington, and New York, and launched in Boston over the weekend. With more scheduled to be delivered around the country.
		23	<i>Reporter: “Do you guys sit there and just think, wow, we were so lucky, I had you, you had me, we had that moment?”</i>
..Simple		24	<i>Laurie: “Yeah, I still do not think it is fully sunk in yet. It is overwhelming to think it started with an after-dinner conversation, drawing it out on a piece of paper and seeing if it was feasible.”</i>
		25	A nurse in Ohio wrote Lory to thank her and said she walked into her break

Costly solution



room at the ICU and saw boxes of clean masks, and it felt like Christmas day. And it is about to be Christmas day in a lot of places in this Country. Overnight the department of Defence said it was commissioning 60 of these machines, worth \$415 dollars million on top of already pledging the pay for operational costs with the machines in other hospitals for an additional 400\$. They are going to be all around the Country by earlier May.

..Quality care

..Low-cost innovation

..Resource-efficient

..Fast

..Helpful

..Quality care

..Fast

..Helpful

..User-friendly

1 **Covid Innovation 2: Helmet-Based Ventilation for Acute Respiratory Failure**

2 *Website page (Helmet Based Ventilation)*

3 A Step-by-Step Course on Helmet Based Non-Invasive Positive Pressure Ventilation for COVID and non-COVID patients

- 4 • Reduces the learning curve for healthcare professionals
- 5 • Reduces work for clinicians
- 6 • Reduces rates of intubation, in-hospital mortality, and ICU length of stay
- 7 • Improves patient experience and their tolerance of the treatment
- 8 • Improves non-invasive ventilation success rates
- 9 • Ensures better results sooner with improved patient outcomes
- 10 • Saves money and resources

11 **A More Effective Solution for COVID-19 Treatment**

12 Helmet-based positive pressure ventilation saves lives, shortens ICU stay for patients who need ventilatory support and can be used in step-down units. It is beneficial for all respiratory distress patients, regardless of its cause.

13 **Benefits offered by this Course**

14 For healthcare professionals:

- 15 • Reduces the learning curve for healthcare professionals implementing helmet-based ventilation treatment for faster adaptation of this life-saving therapy.
- 16 • Accessible to professionals from different departments: RNs, RTs, and MDs.
- 17 • Reduces workload for clinicians while increasing non-invasive ventilation (NIV) success rates.
- 18 • Unique course material, not offered by any other learning provider.
- 19 • Includes updates and new development in helmet-based ventilation.

20 For patients:

- 21 • Lowers rates of intubation, in-hospital mortality, and ICU length of stay
- 22 • Provides painless respiratory support, thereby improves patient experience and tolerance of the NIV therapy
- 23 • Ensures timely application and perfect fit, increasing the chances of positive patient outcomes.

24 **What experts are saying:**

25 *“The course is impressive, thorough, detailed, and a must-see for all inter-professional teams working with COVID-19 patients (at a minimum).”*

26 *I was engaged immediately in Module 1 by the history of helmet-based ventilation. I found it fascinating and informative (and plan to share it with others).*

27 *Module 2 was well placed and instructive (especially to a neophyte like me) about basic pathophysiology, physiological explanations, and their interface with different helmet applications (i.e., CPAP & PAV). The clinical descriptions*

			28	were informative & detailed.
..Helpful				
..Helpful				
..Essential functions/informat				
			29	In Module 4, the issues and solutions sections were also comprehensive and thought-provoking. I especially loved the nursing interventions and nursing checklist.
			30	Module 5 is very timely to the future of nursing 2030 report in that it detailed the importance and pathways for creating inter-professional helmet teams. Detailing patient education and costs s separate considerations again demonstrates the thoroughness of the education, especially from a nurse's and administrator's viewpoint.
..Helpful			31	In Module 6, I found the design discussions between helmets fascinating and instructive. I particularly like that it emphasizes the discussion is focused on the United States' availability of helmets. The accessories discussion offered a thorough approach to what otherwise might be overlooked in a presentation of equipment.
..Helpful			32	One of the essential takeaways I discovered is that helmets and helmet-based ventilation are patient-friendly, provider-friendly, and resource-friendly." - Park Balevre, Associate Professor, Doctor of Nursing Practice DNP Program at Chamberlain University College of Nursing
..Helpful			33	"When we first received Helmets at our hospital, we did not know where to turn for help to get them started. There was very limited information at that time on how to use them and what settings to use.
			34	Thankfully, one of the Respiratory Therapists suggested checking <a href="https://www.helmetbasedventilation.com">HelmetBasedVentilation.com</a> . We found so much valuable information there and even invited Aurika Savickaite to give in-service for our Respiratory Therapists, Registered Nurses, and Physicians at our VA hospital in Chicago.
..Higher-performance			35	The benefit of having Aurika for a presentation far exceeded our expectations. Our team felt more confident to suggest and use this type of interface. Our patients liked the helmet interface over the traditional mask and even High flow oxygen therapy." - Edita Vines, Chief Registered Respiratory Therapist at Hines VA Medical Centre
..Helpful				
			36	"For the past 18 months, I have led a team advancing helmet NIV for COVID patients. Our team worked with the FDA to gain emergency use approval and developed the PEEP-Alert system to increase the safety of helmet use.
..User-friendly			37	From my perspective, the training materials developed by Aurika and her organization <a href="https://www.helmetbasedventilation.com">HelmetBasedVentilation.com</a> are the most accessible, comprehensive, and accurate source of information for practitioners.
..Essential functions/inf			38	The materials are based on their unique first-hand knowledge of the equipment on the market and are designed to provide the most critical information which respects the learner's background and limited time.
..User-friendly				
			39	This course is a must for people planning to implement HNIV in their facility and is highly recommended for current practitioners in order to get up-to-date with current literature and methods." - John Selker, Lead Investigator for the Oregon State Univeristy Fast Response Respiration team (OFRR), Univeristy Distinguished Professor Department of Biological & Ecological Engineering

40 *“Aurika Savickaite leads the initiative [HelmetBasedVentilation.com](http://HelmetBasedVentilation.com) which has the (badly needed, IMHO) goal of education on the helmet use in the USA.*

41 *As I said, she knows and understands about helmets A LOT and I have spoken about helmets with MANY people.” - Dr. Giacomo Bellani, Associate Professor of Anesthesia and Critical Care Medicine of the University of Milan-Bicocca, in Monza, Italy, and staff physician in the general Intensive Care Unit of San Gerardo Hospital. In 2003-2004 he was a research fellow at Massachusetts General Hospital, in Boston, MA. His research is largely focused on ARDS and mechanical ventilation monitoring.*

42 *“Seminal work showed efficacy of positive pressure respiration support from helmet therapy.*

43 *I got interested at the onset of Covid19 pandemic and began supporting efforts to test and make helmets and accessories for this therapy. [Helmetbasedventilation.com](http://Helmetbasedventilation.com) was set up almost as soon as Covid19 became known in the USA by Aurika Savickaite, I was impressed. Ms Savickaite based her site on her work as a nurse working on seminal research she had been involved with around using such a therapy for ARDS. With her tireless work the site has become the one place that most therapeutic tools in this area can be seen. Companies send her products which she tests. She has worked carefully to be independent of any company or position. The site continues to improve.*

44 *Recently I worked to get Ms. Savickaite to mentor doctors in Kenya; while they had equipment available, the first uses of it to save patients started the week she held a webinar. I am grateful for her work.” - Dr. Ted Selker, Technical Innovation for the Oregon State Univeristy Fast Response Respiration team (OFRR), Chief Technical Officer Alphyco.com & Chief Executive Officer at Ultrascanguide.com*

..User-friendly



45 I found the training course to be very good. I thought the pacing was good. The flow of information was smooth, and the graphics were very helpful in understanding the material. I thought it was very good to have both male and female presenters. The length of each lesson seemed appropriate for the subject and none of them seemed too long.

..Helpful



46 Most importantly, I felt the training course was very effective in presenting a very positive case, detailing the advantages of helmet-based ventilation, while also describing disadvantages and contraindications.

47 Of course, in addition to the video training course, there would have to be hands-on training to develop confidence and competence in using the equipment.

48 I especially liked the story Aurika told about her first impressions of helmet-based ventilation while then proceeding to describe her experience with the system, leading her to embrace the treatment. I felt that her transparency could validate other clinicians’ initial reservations.” - Kathy Prewitt BSN, RN, Licensed, State of Washington University of Washington Nursing School, degree awarded 1979, Specialty: Neonatal Nursing, NICU

49 **Speech Transcript (audio-visual content):**

50 Before the pandemic and before helmets in the United States were approved to be used in ICUs, patients here received oxygen via nasal cannula, face masks, and mechanical ventilation. Even though European hospitals have used helmets for more than 20 years which proved to be better than face masks, the USA have not yet approved the helmets for

patients in respiratory distress.

51 It was until covid started that the FDA allowed physicians to use this technology. This is what prompted me to create the helmet-based ventilation course.

52 My name is Aurika Savickaite, I am a registered nurse with a master's in science degree in nursing. I was part of a successful three-year study at the University of Chicago ICU, testing helmet-based ventilation. I also wrote the paper based on my experience while studying at the Russian university college of nursing back in 2014.

..Essential functions/informat



53 My goal is that you learn more about this interface and use it in different settings.

54 This course is designed for healthcare professionals, especially emergency medicine and ICU physicians, nurses, and respiratory therapist. With it, you will learn about an interface that is simple to fit and works with all features. Something that is easy for the patient to wear for a long period of time, and the tool that offers patients a higher chance of survival when applied promptly and correctly.

..Quality care

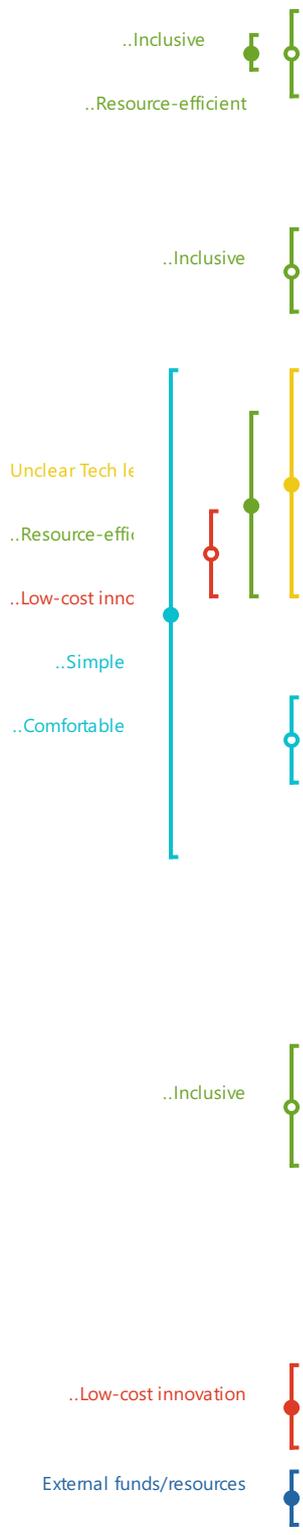


Tech solution



55 Do you want to know more? Click the button below to begin.

..Simple



1 **Covid Innovation 3:** College student makes masks for the deaf & hard of hearing

2 *Article from Online Newspaper (LEX18 News)*

3 WOODFORD COUNTY, Ky. (LEX 18) — A college senior from Versailles put her stir-craziness to good use with a project that will help the deaf and hard of hearing community.

4 "I just saw that people were making masks on Facebook for everyone to have instead of the throwaway masks, and I was like, what about the deaf and hard of hearing population?" explained 21-year-old Ashley Lawrence.

5 Lawrence is a senior studying education for the deaf and hard of hearing at Eastern Kentucky University. Due to the virus, she is living back at home and doing her student teaching from home.

6 "I felt like there was a huge population that was being looked over," Lawrence said. "We're all panicking right now and so a lot of people are just not being thought of. So, I felt like it was very important that, even at a time like this, people need to have that communication."

7 After a conversation with her mom, they put their craft skills to work.

8 "We started out making them with bed sheets that we had, and luckily bed sheets are big," Lawrence said. "So we have two or three sets so we're making them out of that. Then, a couple months ago we needed plastic fabric for something. And so we have a whole roll of that and the window is only this big so having a whole roll is very helpful so luckily we haven't needed any supplies yet."

9 With her mission centered around the deaf and hard of hearing community, she is going the extra mile.

10 "We're trying different things to for people with cochlear implants and hearing aids if they can't wrap around the ears," Lawrence said. "We're making some that have around the head and around the neck."

11 She explained the necessity for the plastic window on the masks is why she started this project in the first place.

12 "For anyone who uses speech reading, lip reading, anybody like that," Lawrence said about the purpose of the masks. "And people who are profoundly deaf who use ASL as their primary mode of communication. ASL is very big on facial expressions, and it is part of the grammar. So, I don't know if you have seen Virginia Moore on Andy Beshear's things at five o'clock, but she's very emotive, and if half of that is gone because you're wearing a mask then half of what you're saying is being missed, so even if it's not physically talking and just using ASL, then you need to have that kind of access."

13 In less than two days, Lawrence already had dozens of orders from six states. To order one of Lawrence's masks, reach out to her at [dhhmaskproject@gmail.com](mailto:dhhmaskproject@gmail.com).

14 "I'm not charging anything for them because I think that if you need them, then you need them and I don't think that you should have to pay for them," Lawrence said. "So we are sending them out for free whenever we have people asking for them and if they're foreign, then maybe we'll charge shipping, but other than that they're completely free."

15 Those who would like to help Lawrence with the cost of materials and shipping, she is accepting donations on her GoFundMe page.

..Essential functions/informat



1

## Covid Innovation 4: COVID-19 case capacity maps predict when your area will run out of healthcare resources

2

*Magazine Article (Fast Company)*

..User-friendly



3

Want to know precisely how threatened your region’s healthcare system is by COVID-19? A new dashboard by healthcare analytics company Definitive Healthcare pinpoints how many days until hospitals in your region reach “capacity failure,” which is code for “people will die because care is unavailable.” Here are a few examples:

Tech solution

4

- Portland, Oregon: 18 days

5

- Los Angeles: 14 days

6

- Seattle, Chicago, and Boston: 9 days

7

- Philadelphia: 4 days

8

- New York: 0 days. (Severe case capacity: 513. Severe cases: 1,294. Remaining percent capacity: 0%.)

..Essential functions/infc



9

Click here to find your own region. You can also see each county’s ICU bed count, ventilator use, number of COVID-19 cases, severe case count, and remaining percent capacity. It is helpful—and by helpful we mean terrifying.

..Helpful



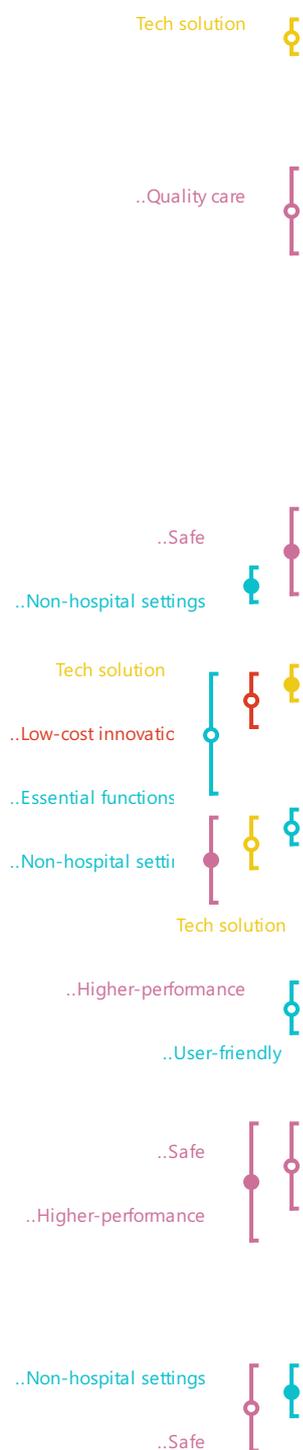
10

All this pivotal information is yours if you’re patient because the chart holding the goods you want to see is not especially browser friendly. We had to expand our browsers rightward to view the whole chart, and it is a little hard to use. But it’s well worth it if you can get past the bugs.

..Essential functions/informat



not especially browser friendly



- 1 **Covid Innovation 5:** Forward launches “forward at home” primary care service to address covid-19 healthcare crunch.
- 2 *Blog Post (TechCrunch)*
- 3 The global coronavirus pandemic has already caused a tremendous strain on healthcare resources around the world, and it’s leading to a shift in how healthcare is offered. Startup Forward, which debuted in 2016 and has since expanded its tech-focused primary care medical practice to Country/ Nations in major cities across the U.S., is launching a new initiative called “Forward At Home” that reflects those changes and adapts its care model accordingly.
- 4 Forward’s primary differentiator is its focus on what it terms a patient’s “baseline,” which is established by an in-person visit they make when they join; it employs a body scanner at a doctor’s office to take a number of readings and produces an interactive chart displayed on-screen in the doctor’s exam room. Forward founder and CEO Adrian Aoun, who previously led special projects at Google before building the health tech company, said that as the company has ramped its efforts to support patients during the COVID-19 pandemic, including through in-clinic and drive-through testing, it also wanted to address the ongoing need for care for non-COVID patients.
- 5 “If people aren’t leaving their homes, and frankly, you don’t really want them to leave their homes unless you need them to, you have to figure out how to do all that remotely,” Aoun said in an interview, referring to Forward’s comprehensive biometric data gathering process. “So we’ve implemented a bunch of different things as rapidly as possible. The first is, how do we collect some biometrics — so we put together a kit that has a bunch of sensors in it that we actually mail to you. This includes an EKG, a connected thermometer, connected blood pressure cuff and a pulse oximeter.”
- 6 This approach provides a whole new level of remote care, over and above what’s typically defined as “telemedicine,” which generally amounts to little more than video calls with doctors, Aoun points out. Forward’s approach includes automated vitals monitoring for alerting a doctor if a patient needs intervention, and a patient has access to all their own data in the app as well. The Forward At Home product also takes their exam room smart display and brings it to their mobile devices, presenting it for shared consultation between doctor and patient during viral visits, which are available 24/7 to Forward members.
- 7 At launch, the service also includes home visits to collect urine and blood samples, as an added measure designed specifically to help patients adhere to CDC and health agency guidelines around self-isolation, while also getting a detailed and thorough level of care. Aoun says that this part of the offering doesn’t make sense at scale, and will likely revert to in-clinic visits once the COVID-19 crisis passes.
- 8 The rest of the model, though spurred into deployment because of the coronavirus conditions, and the need to limit the number of people going in to medical facilities and hospital all across the country unless they absolutely need to, is here to stay, however. Aoun says that Forward’s goal has always been to address the need for tech-friendly, advanced and comprehensive primary care for everyone, but that it took an approach similar to Tesla’s by addressing the top end of the market first in order to be able to fund development of more broadly available services later on.
- 9 Meanwhile, the need to shift as much care as possible to in-home is pressing, and evidence from countries around the world is increasingly pointing to how important that is to stopping the spread.

..Non-hospital settings

..Resource-efficient

..Safe



10

“The big thing to flatten the curve, the whole point of it, is that the hospitals are going to be overrun,” Aoun said. “So you want to take as many cases as you can, where they don’t actually have to be in the ICU, and treat them outside of the ICU — that’s your first principle. Then your second principle is, and China kind of discovered this early [...] they started moving to getting people out of the hospitals, as much as possible for a second reason, which is not that the hospitals are overloaded, but that the hospitals are one of the fastest ways to spread COVID-19.”

11

That’s a perspective also supported by lessons shared from Italian medical professionals in their effort to deal with the COVID-19 situation there, which has essentially decimated large parts of their medical facility infrastructure.

12

Forward is also still continuing the other work it’s doing to address COVID-19 needs, including providing its risk assessment screening tool to all, as well as offering testing via clinics and drive-throughs to members, as well as mental health support. It’s also looking to expand its drive-through testing to new sites across the U.S. The Forward At Home initiative, meanwhile, will help ensure that clients who have other pressing health needs aren’t left behind while the effort to combat COVID-19 continues.



1 **Covid Innovation 6: Abbott Laboratories launches 5-minute coronavirus test that is portable**

2 *Article from Online Newspaper (ThePrint)*

3 A well-known American medical devices company has launched a test to detect coronavirus in just five minutes. Abbott Laboratories on Friday announced that the U.S. Food and Drug Administration (FDA) has issued the Emergency Use Authorisation (EUA) for the fastest available “molecular point-of-care” test to check for Covid-19.

4 The test can detect positive results in five minutes, while negative results take about 13 minutes. It will run on Abbott’s ID Now platform, which is small, lightweight and portable. It employs molecular technology, which is highly valued by the scientific community for its accuracy. Apart from quick test results, a selling point of the ID NOW platform is that it can be used in urgent care clinics, not just traditional hospitals.

5 Speaking to ThePrint, an official working at Abbott Laboratories India said, “We also plan to hold a video conference on Monday and see if this kit can be used in India.” Although, the company is not sure whether these kits can be used in the current crisis in India.

6 Abbott will make this test available next week to healthcare workers in urgent care settings in the United States. The production has already been ramped up to deliver 50,000 ID NOW coronavirus test kits each day from the next week. Robert B. Ford, president and chief operating officer, Abbott Laboratories said, “With rapid testing on ID NOW, healthcare providers can perform molecular point-of-care testing outside the traditional four walls of a hospital in outbreak hotspots.”

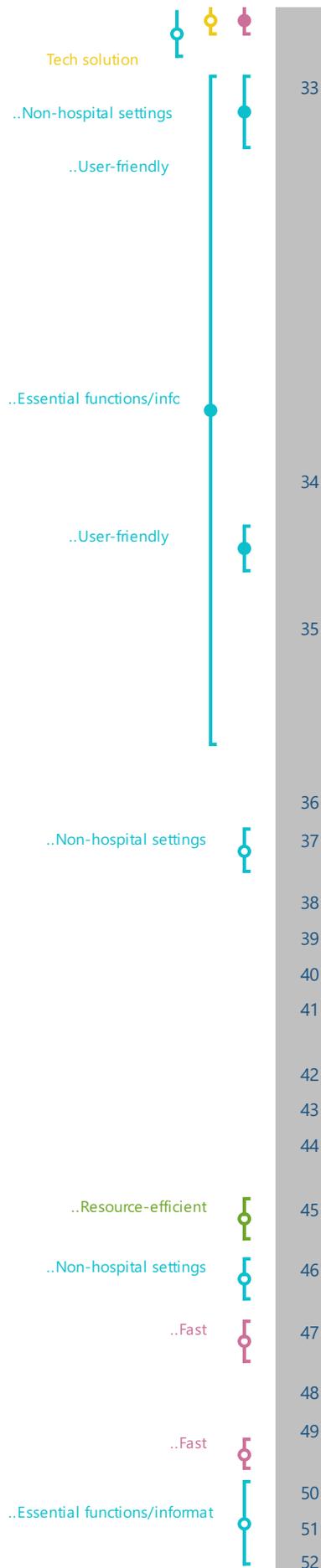
7 This molecular point-of-care testing helps detect the virus by identifying a small section of the virus’ genome. This portion is later amplified until there’s enough for detection.

8 In a press release, Abbott Laboratories describes IDNOW as a “rapid, instrument-based, isothermal system for the qualitative detection of infectious diseases. Its unique isothermal nucleic acid amplification technology provides molecular results in just minutes, allowing clinicians to make evidence-based clinical decisions during a patient visit”.

9 The press release also notes that the ID NOW test has not been FDA approved so far, but has only been authorised by the FDA to be used during an emergency.

10 According to a John Hopkins University tally, the total number of reported coronavirus cases in the United States has reached 1,04,000. The death toll in the country has surpassed 1,700.

..Non-hospital settings		1	<b>Covid Innovation 7:</b> Now healthcare professionals can see beneath the surface, by enhancing remote consultation with the ability to examine patients in real-time.
..Quality care		2	<i>Website page (Arc Health)</i>
..Quality care		3	<b>Arc for care homes: Improve the quality of care for your most vulnerable patients</b>
..Quality care		4	Perform physical examinations on care home patients so you can avoid misdiagnosis and inappropriate prescribing.
..Quality care		5	<i>Why Arc?</i>
..Quality care		6	<b>Better clinical care</b>
		7	Accurately diagnose your care home patients.
		8	Remotely listen to heart and lung sounds, perform ENT examinations and record observations.
..Low-cost innovation		9	The importance of examination:
		10	• Minimise your travel to care homes
		11	• Reduce the spread of Covid-19
		12	• Maintain your normal levels of clinical safety
..Quality care		13	• Use observations to aid diagnosis
		14	• Manage cardiovascular and respiratory disease
		15	• Undertake effective virtual ward rounds
		16	• Prescribe with confidence
		17	• Improve scheduling appointments with carers
		18	<b>Optimise</b>
..Safe		19	• Save valuable time
		20	• Minimise your visits to care homes to reduce transmission of Covid-19
..Fast		21	• Remotely assess deteriorating patients to avoid unnecessary hospitalisation
..Resource-efficient		22	• Manage your care homes efficiently with fewer clinical resources
		23	<b>Progress</b>
		24	• Improve care
		25	• Undertake virtual ward rounds in multiple care settings from your surgery.
..Quality care		26	• Deliver safe and high-quality care with comprehensive remote examination.
		27	• Give your patients timely access to care without sacrificing quality.
		28	94% of consultations completed: Complete 94% of your consultations without the need for care home visits or referrals.
Scalable		29	50k+ consultations with Arc: Arc is trusted by world-class healthcare providers and is used by hundreds of pharmacies and GP surgeries.
..Fast		30	10 mins for a consultation: Save time that would have otherwise been spent on travel and admin, so you can focus on what matters most – patient care.
		31	<b>Demo Transcript (audio-visual content):</b>
..Higher-performan		32	Welcome to Arc Health. Arc incorporates the latest advancements in



telehealth to enable caring patients to be examined remotely with the doctor in their surgery and the patient using arc from a care home.

33

Let me show you. This is the clinician interface: it is easy to use and gives clinicians the ability to remotely measure patient observations using built-in examination tools like the pulse oximeter. Now, like you, if a patient is suffering from ear pain, I want to be able to examine their ears. But when you are seeing a patient over a video it is not always possible to do this and that's where the medical comes in. You can remotely examine the patient's ear with a light and disposable covers. In fact, with the medicam I can explore the patient's auditory canal and image their tympanic membrane. And watch, I can even play helpful videos to guide the carer and patient throughout the examination. If you want to examine the patient's throat it's simple with the medicam, just ask the patient to give you a big "AH". Let's take a look. Cristal clear views of the oropharynx. You can also use the medicam to examine the skin up close in three dimensions. And all of these images can be recorded using the built-in capture feature just like that.

34

Next, I would like to show you the stethoscope. Arc comes with an integrated stethoscope that has been refined to filter different sounds. Clicking on stethoscope heart will load the instructions for the patient so they know where to place the stethoscope for heart sound like this. You can also listen to the tricuspid and mitral valves and that's not all.

35

Arc also includes a blood pressure monitor and thermometer so you can perform a full clinical examination. It's that simple? Remotely examine care home patients so you can reduce travel time and complete 94% of consultations without the need for a face-to-face appointment. Schedule a call with our NHS partnership team.

36

### Arc for Urgent care: Improve efficiency and increase capacity

37

Your all-in-one triage, remote examination and consultation solution that reduces the need for face-to-face appointments.

38

Remotely triage, examine and consult with patients in a single session.

39

*Why Arc?*

40

Fully integrated urgent care

41

Safely resolve 94% of consultations by remotely listening to heart and lung sounds, performing ENT assessments and recording observations.

42

### Efficient Optimise urgent care

43

Telephone triage has a completion rate of only 46%.

44

With Arc, clinicians complete 94% of unscheduled consultations in a single session.

45

- All-in-one triage, examination and consultation to avoid duplicate clinician sessions

46

- Give patients access to urgent care from pharmacies in your local community

47

- Ensure the right patient sees the right clinician at the right time

48

### Increase Clinician capacity

49

Remotely triage, examine and consult with patients from your urgent care centre to improve efficiencies in clinician time.

50

- Auscultate heart, lung and abdominal sounds

51

- Examine ears, throat and skin

52

- Measure patient observations

	53	94% of consultations completed remotely: Arc extends the capabilities of video consultations, enabling 94% of consultations to be completed remotely.
	54	50k+consultations with Arc: Arc is trusted by healthcare providers including the NHS and has safely managed over 50,000 consultations.
	55	51% of unscheduled urgent care: Arc generates cost-savings on the 51% of unscheduled urgent care with its all-in-one triage, examine and consult solution.
..Quality care	56	<i>"A doctor can watch a patient take their own temperature, blood pressure, use a stethoscope to check their heart and lungs and use a close-up camera to examine their ears and throat ... it's the closest thing to conducting a real appointment with patients."</i> - WIRED
	57	<i>"It moves beyond a simple video call with the doctor by giving the patient access to a blood pressure monitor, pulse oximeter, stethoscope, contactless thermometer and even a light to check the ear, nose and throat."</i> - BBC News
..Quality care	58	<i>"Remote diagnosis hub offers care homes a GP lifeline during pandemic ... the NHS-approved video conference hubs enable GPs to take clinical measurements of residents without them needing to visit the home."</i> - CAREHOME Professionals
..Low-cost innovation	59	<i>"The NHS-approved technology saves time spent travelling to and from care homes, as well as offering a cost-effective way to enhance support for patients and meet obligations for regular monitoring."</i> - HealthinvestorUK
..Fast	60	<i>"Game-changing med-tech gives care homes a GP lifeline ... revolutionises care for the most vulnerable with time-saving remote diagnostic solution."</i> - BBH (Building better healthcare)
..Safe	61	<i>"Care home residents are set to benefit from new technology that offers easier access to a GP while minimising risk ... a remote diagnosis hub that allows at-risk residents to be accurately assessed by a GP without the need for a face-to-face visit."</i> - The Care Home Environment
..Quality care	62	<i>"Allows doctors who are self-isolating to continue working while retired doctors returning to medicine to fight the virus can conduct consultations from the safety of their own home."</i> - THE SCOTSMAN
..Safe	63	<i>"Doctors are able to remotely examine the patient through an attached blood pressure cuff, stethoscope, thermometer, pulse oximeter and a small camera for the throat and ears provided at the hospital."</i> - PULSE
..Essential functions/informat	64	<i>"Genius system lets doctors help patients test themselves over video ... transforming safety in GP surgeries with its unique hubs that allow doctors to remotely examine vitals such as patients' oxygen levels as well as perform heart and lung checks."</i> - THE SUN
..Essential functions/informat	65	<i>"A British tech firm is transforming GP surgeries ... the hubs, which are manufactured in Hastings, East Sussex, guide patients on performing an examination on themselves while the doctor ensures they are doing it</i>
..Quality care		

  *correctly.* - DAILY EXPRESS

	1	<b>Covid Innovation 8: Defence firm Babcock to make 10,000 ventilators</b>
	2	<i>Article from Online Newspaper (BBC NEWS)</i>
Scalable	3	Defence firm Babcock has said it will be manufacturing 10,000 ventilators to help deal with the coronavirus crisis.
	4	The plan comes nearly two weeks after Dyson said it had received a government order for 10,000 ventilators.
	5	Both devices still have to pass stringent medical tests before they can be accepted.
	6	The move came as tech giant Apple, best-known for phones and computers, said it would start making face shields for medical workers.
Scalable	7	Apple chief executive Tim Cook tweeted on Sunday that it has designed and is now making the protective gear.
	8	The tech giant plans to make more than one million shields a week, which will be shipped first to US medical workers and then distributed globally.
No-cost solution	9	It has also sourced 20 million face masks which it is donating worldwide to help prevent the spread of the virus.
Scalable	10	Meanwhile, Babcock said in a statement that it had "responded quickly to the UK Prime Minister's UK Ventilator Challenge".
	11	"We are proud to have been awarded a contract by the Cabinet Office to manufacture 10,000 Zephyr Plus ventilators, subject to regulatory approvals; a product being developed in collaboration with an established major international supplier of critical care ventilators," the firm added.
	12	The supplier, believed to be based outside the UK, has asked not to be named.
	13	A ventilator is a machine that helps a person breathe by getting oxygen into the lungs and removing carbon dioxide.
	14	A shortage of ventilators to treat coronavirus patients with acute symptoms is seen as one of the major problems facing the NHS as it battles the pandemic.
	15	Babcock's statement did not say where the ventilators would be manufactured, but it has factories in Scotland and south-west England.
	16	Companies, from electronics firms to carmakers, have been shifting production to help make vital medical equipment and supplies for hospitals around the world.
Tech solution	17	• Self-isolating design student makes PPE masks
	18	• 3D-printer owners rally to create NHS face masks
	19	• Councils appeal for protective gear for carers
	20	In a video posted on Twitter, Apple's Mr Cook said: "This is a truly global effort, and we're working continuously and closely with governments at all levels to ensure these are donated to places of greatest need."
	21	Apple has pulled in designers, engineers and suppliers to shape, produce and ship the face shields.
..Fast	22	Mr Cook said the first shipment of the plastic face shields, which can be assembled in less than two minutes, was delivered last week to some hospitals in Silicon Valley. The materials are sourced from both the US and China.
	23	"In both these efforts, our focus is on unique ways Apple can help, meeting essential needs of caregivers urgently and at a scale the circumstances require," Mr Cook added. "For Apple, this is a labour of love and gratitude, and we will share more of our efforts over time."

24 With a worldwide shortage of hospital equipment such as ventilators and protective gear for medical workers, organisations, educational institutions and individuals have been joining the effort to meet the demand.

25 In the UK, around 1,400 3D-printer owners have pledged to use their machines to help make face masks for the NHS.

No-Tech solution



..Helpful

1 **Covid Innovation 9: Coronavirus: EasyJet and Virgin staff to help at NHS Nightingale hospitals**

2 *Article from Online Newspaper (Aviation Business News)*

3 EasyJet and Virgin Atlantic have reached out to thousands of staff to help out at the new Nightingale hospitals as part of the fight against coronavirus.

4 Both airlines are reaching out to those staff who have not been working due to planes having been grounded following the coronavirus outbreak to consider helping at the new hospitals being built across the country.

5 EasyJet has already written to all 9,000 of its UK-based staff, which includes 4,000 cabin crew who are trained in CPR, while Virgin Atlantic will write to approximately 4,000 of their employees from today (30 March), prioritising those with the required skills and training.

6 Those who volunteer will perform clinical support roles, including changing beds, tending to patients and assisting doctors and nurses working on the wards.

7 The NHS has confirmed that they are being built in London, Birmingham and Manchester and other sites are being considered.

8 Director of cabin services for EasyJet, Tina Milton, said: "We have all needed the NHS at some point in our lives and so we are so proud that our crew can now help to support the NHS at this crucial time.

9 "The NHS is at the forefront of dealing with this health emergency but the training and skills our cabin crew have, working closely with the medical professionals, could help make a real difference."

10 Chief customer officer at Virgin Atlantic, Corneel Koster, said: "We are very grateful to the NHS for everything they are doing in extremely challenging circumstances and we're committed to doing all we can to support the national effort against the rapid acceleration of Covid-19."

11 "We are very proud of our highly skilled people at Virgin Atlantic and since the Government's Coronavirus Job Retention Scheme was announced, we have been inundated with our employees looking to help other organisations at this time of crisis.

12 "The NHS approached us with this unique opportunity as they recognise the value and experience our medically trained cabin crew and trainers will bring to the incredible Nightingale Hospital initiative."

13 "In addition, our cargo business is very busy with extra flights, keeping global supply chains running and transporting essential medical supplies into the UK at this time."

14 Staff and volunteers working at the new hospitals will be offered free accommodation. Those staying in the hotels will have breakfast provided and lunch or dinner depending on the shifts that they are working.



- 1 **Covid Innovation 10:** Halstead business makes a creative shift to help fight against covid-19.
- 2 *Article from Online Newspaper (KWCH)*
- 3 A Halstead business owner is taking a creative turn with her company to help those on the front line of the fight against COVID-19.
- 4 With her business, Bobbi's Cutters, Bobbi Barton specializes in printing custom cookie cutters. Seeing an opportunity to help medical professionals, she retooled the 3-D printing machine she uses for cookie cutters to make headbands for protective face shields worn by doctors and nurses.
- 5 Barton has made hundreds of masks, many already donated and shipped to Newton Medical Center. Requests for her work with face shields come from across the U.S.
- 6 "One shield takes about 45 minutes to print," Barton explains. "They can print two, four or eight at once, depending on printer size".
- 7 Of 400 made so far, 250 shields have been delivered, 225 to Newton Medical Center.

	1	<b>Covid Innovation 11: SOS-Supplies sources PPE for key workers across the UK</b>
	2	<i>Website page (SOS-Supplies)</i>
..Resource-efficient	3	We are a team of volunteers supporting the NHS, charities, schools, and other key workers in need of urgent PPE. We do this by matching organisations in need with UK PPE suppliers who have items currently in stock & ready to ship.
..User-friendly	4	<b>How it works</b>
	5	Request supplies: Let us know what supplies you need, quantities and when you're running out.
	6	Find suppliers: You'll receive an email with a list of sos approved suppliers with UK stock of the items you've requested, quantities and prices. We'll include contact details so you can order directly.
	7	Get regular stock updates: Every day we'll update you with PPE stock levels and any new suppliers.
..Inclusive	8	<b>Relying on donations?</b>
External funds/resources	9	Our fundraising campaign helps us to purchase PPE for those who don't have the funds. We also receive donations from a select number of suppliers. Request supplies here and let us know what you need.
..Quality care	10	<b>Our approved suppliers</b>
..Meeting regulatory	11	We do everything we can to only recommend legitimate suppliers, who have high quality and fully certified stock. We do not accept suppliers who are profiteering and have over inflated prices.
..Low-cost innovation	12	We're a small team of volunteers, so while we do light due-diligence on our suppliers and their certifications, we ask you to do your own due-diligence, ask for pictures and check certificates before ordering.
Scalable	13	<b>Help us to support those who don't have the funds to purchase the PPE they need</b>
No-cost solution	14	We've already donated 50,000 pieces of PPE so far.
External funds/resources	15	After successfully raising £5,000 in two weeks, we're now raising more funds to donate PPE to the charities and organisations that most need it.
	16	You can contribute by clicking on our GoFundMe campaign here: your contribution will be used to source protective equipment for those on the frontline against COVID-19.
	17	If you're a supplier of PPE, we're also accepting donations.

..Resource-efficient

Tech solution

..Resource-efficient

..Quality care

..Simple

..Quality care

..Quality care

..Quality care

..Quality care

..Simple

# 1 Covid Innovation 12: Nippy 3+ sleep apnoea device converted for Covid-19 frontline

2 Magazine Article (*The Engineer*)

3 A sleep apnoea machine being phased out of service can be modified into a ventilator to treat people with Covid-19, claim engineers and scientists in Leeds.

4 The modification to the NIPPY 3+ has come about following a collaboration between clinical staff, engineers, and physicists at Leeds Teaching Hospitals Trust (LTHT) and academics and technologists at Leeds University.

5 There are an estimated 100 of the devices in Leeds hospitals and there could be many more similar devices across the NHS that could be modified to provide respiratory support to very ill patients.

6 Sleep apnoea stops a person breathing in their sleep and devices like NIPPY 3+ step in to ensure air supply is maintained during an episode.

7 The modification to is claimed to be straightforward and involves changes to the device’s settings and reconfiguring the supply of oxygen so it flows directly to the face mask worn by the patient.

8 The machine operates in a CPAP (constant positive airway pressure) mode, ensuring that the pressure inside the mask is slightly raised, keeping the patient’s airway open and making it easier for them to breathe. According to Leeds University, it provides enriched oxygen of between 40 to 60 per cent.

9 It is further claimed that because it is a modification to a device, it does not have to go through a full regulatory approval process.

10 In a statement, Dr David Brettle, head of the Medical Physics team at LTHT, said: “We knew there could be pressure on the NHS for more ventilators during the current coronavirus outbreak and this was a way of coming up with a potential solution. Scientists and clinicians working with academics and technicians have made it happen.”

11 Professor Nikil Kapur, from the School of Mechanical Engineering at Leeds University, said: “The collaboration showed how the University was able to support colleagues at LTHT who had brilliant ideas but insufficient time to investigate them because they were having to prepare their hospitals to deal with the unfolding pandemic.”

12 Working on a suggestion from the medical physics department at LTHT, the University team came up with a ventilator based on a conversion of a NIPPY 3+ device in four days. That working model had air and oxygen being fed into the device and then on to the patient.

13 It was evaluated at LTHT last week, but the medical physics team wanted to reconfigure it further, to achieve more efficient use of hospital oxygen supplies. The clinical team, with the engineers, decided that the patient’s mask would receive air from the device and oxygen directly from the hospital’s supply system.

14 Also, there was evidence from China that many seriously ill patients did not need full ventilation, which requires sedation, but an intermediate level of support which could be provided by a CPAP device.

15 Professor Kapur, said: “The decision was then to move onto the next iteration of the re-modelled device, and the changing requirements actually made those modifications easier.

16 Dr Pete Culmer, Associate Professor in the School of Mechanical Engineering at Leeds, added: “Previously we had been looking at having to fit each machine with seven new components – and that would have required a

..Simple  
..Resource-efficient



17

system to manufacture those new components.

“Instead, the solution we eventually arrived at is much simpler. You have to change some of the settings, filters and the way oxygen reaches the patient. It is now a fix that hospital teams can undertake themselves using equipment which is readily available.”

# 1 Covid Innovation 13: Crisis Management Program for Healthcare

2 Website page (Chatmeter)

3 ..Fast

3 Ensure patients can find hospitals, clinics, and other healthcare services in their time of need with Chatmeter's Crisis Management Program for Healthcare.

4 ..User-friendly

4 Get free access to the listings management, review management, and social media tools you need to manage your online presence during the COVID-19 pandemic, all in one easy-to-use dashboard

- 5 • Expert Listing Management
- 6 • Free Services for 90-Days
- 7 • Country/NationHQ Dashboard
- 8 • No Strings Attached

9 Tech solution

## 9 Introduction Transcript (audio-visual content):

10 Hi, my name is Collin Holmes, I am the founder and CEO of Chatmater, a local search software company I started about 10 years ago.

11 I am coming to you live today from my home office to talk a little bit about how Chatmater would like to help both healthcare providers and consumers during this unprecedented crisis.

12 I would like to take a moment to thank all of the healthcare providers out there for putting your lives at risk in order to save American lives. Every day is becoming even more difficult and challenging for both them and patients as we face enormous confusion around what locations, services and facilities are open and available.

13 Here at Chatmater we are seeing first-hand how quickly things are changing, we are currently helping tens of thousands of locations managing and update their information on key sites like Google Maps, Yelp... in a timely fashion just as quickly as States are updating their information and policies across the country. We have been instrumental in working with brands across retail, restaurants, automotive and healthcare providers to manage this chaos. But we are just not doing enough.

14 ..Essential functions/informat

14 In a challenging time like this it is crucial that patients have access to care information and it can connect with their local hospitals, nurse practitioners, doctors, pharmacies and other healthcare services.

15 Keeping your information updated in Google Maps and other major sites is critical at this time because this is the way that patients will be made aware of changes in your operations.

16 Unfortunately, we are seeing it becomes increasingly more difficult for healthcare providers to update their information online and keep in constant contact with patients as operations are changing on a daily basis.

17 The truth of matter is we are all in this together and I simply felt like we could do more.

18 ..Low-cost innovation

19 ..Simple

18 I could not be happier to announce today the Chatmater will be donating over 5 million dollars in free services to healthcare related businesses for the next 90 days, and to make this happen we have cut all red tape that typically goes with implementing a software like Chatmater. This is completely free for 90 days, there are no strings attached.

20 ..Fast

19 So, you may be asking yourself why we are doing this. Because we had to do. This is only the right thing to do. I found a Chatmater based on the principle of helping businesses connect with consumers provide accurate and up-to-date information online and ultimately improve customer and

..Low-cost innovation



patients experiences for everyone.

20

I am excited to provide these services and I know I can speak for the whole company that they are ready willing and able to help in this difficult time.



21

To take advantage of this limited time offer please fill out the form on this page and remember the Chatmeter team will contact you to get started.

22

As the pandemic continues it is important than ever to make sure your patients can find you. Please do not wait, contact us today.

23

Thank you for your time and we are anxious to get started.

1 **Covid Innovation 14:** UH professor develops innovative water-proofing for N95 masks to combat spread of COVID-19

2 *Article from Online Newspaper (Houston Chronicle)*

3 In the wake of the growing coronavirus pandemic, UH professor Dr. Seamus Curran developed a viable solution to a pressing problem. When Curran first heard about the critical shortage of N95 masks, he wanted to help.

4 "To be absolutely frank with you, I was horrified when I first heard these calls about doctors and nurses in very unsafe situations," he said.

5 Curran is now waiting for FDA approval of an innovative waterproofing solution he created for the N95 masks.

6 "Standard masks are somewhat porous, and especially if they get wet, they can allow the virus to penetrate," Curran said. "The virus requires the medium of water. Water is the conduit, the roadway. So, if doesn't have a road, it has nowhere to go."

7 Curran is well-renowned for his work in nanotechnology using a hydrophobic coating to improve the protection of surgical masks to prevent the transmission of the virus. He first launched a nanotechnology business in 2013.

8 His company, Integricote, based at the UH Technology Bridge, has created manufacturing sealers for masonry, wood and concrete. Since 2011, Curran has also worked with nanotech coatings for fabrics. He's now implementing this technology to provide more protection against SARS and COVID-19.

9 "N95 masks are the gold standard, able to filter very small particles and offering better protection than standard surgical masks," Curran said. "But they are hard to manufacture, and global demand is for tens of millions of masks."

10 Curran has strived to undertake research that specifically provides solutions for societal problems.

11 "We were seeing the virus spread around the world, and thinking about what we could do," he said. "I hate playing defense. I wanted to do something."

12 He purchased masks approximately six weeks ago and started experimenting with the technology. "We can make them impervious to water," he said. "The solution can improve protection."

13 Curran's strongest motivator is to simply help those healthcare workers on the frontlines.

14 "I'm just trying to help those care workers, because they're the ones fighting the fight," Curran said, and added he has begun talking with investors and manufacturers to potentially ramp up manufacturing capacity.

15 "We're waiting for mask producers to come to us, and we'll try this out," he said. Curran said he's confident that if the mask producers come forward, FDA approval will come quickly.

..Resource-efficient

Tech solution



..Robustness

..Safe



Tech solution		1	<b>Covid Innovation 15:</b> Philips launches national portal for digital exchange of COVID-19 patient data in the Netherlands
		2	<i>Website page (Philips)</i>
		3	In cooperation with Erasmus Medical Center (Rotterdam, The Netherlands), Jeroen Bosch Hospital ('s-Hertogenbosch, the Netherlands) and the Netherlands Ministry of Health, Welfare and Sport (VWS), Philips has created an online portal that allows Dutch hospitals to seamlessly share COVID-19 patient information with one another. In the fight against an escalating pandemic like COVID-19, being able to share patient data between hospitals at the 'touch of a button' is vitally important to optimizing the use of healthcare resources. It can, for example, assist in the seamless transfer of infected patients between hospitals to avoid local overload in critical care units. Since its launch on March 28, 95% of Dutch hospitals have already been connected to the portal for digital exchange of COVID-19 patient data.
..Simple			
..Resource-efficient			
..Quality care			
		4	The new COVID-19 portal, which is available to all Dutch hospitals, is not linked directly to an individual hospital's EPD (Electronic Patient Dossier), PACS (Picture Archiving and Communication System) or pathology department systems. Instead, specific information, such as a patient's radiology images, reports and patient summary is shared via the portal. The information is instantly available to a receiving hospital provided the originating hospital and the patient have given their explicit consent. The safety of medical data exchange remains of the utmost importance, even in times of crisis. As a result, the portal fully complies with the ISO27001 information security standard and the Dutch NEN7510 standard, which is specifically designed for information handling in the healthcare sector.
..Safe			
..Meeting regulatory req			
		5	<i>"I am extremely proud that we were able to implement this portal together with the government, Jeroen Bosch Hospital and Philips in this short term to support care for patients with COVID-19."</i> - Simon Vermeer, Chief Information Officer (CIO) at the Erasmus Medical Center
..Fast			
..Safe			
		6	"In this time of crisis, Philips is offering a solution for sharing patient data between hospitals quickly and securely," said Simon Vermeer, Chief Information Officer (CIO) at the Erasmus Medical Center. "Sharing patient data needs to be done in a secure way and the current solution is often to send a USB stick or DVD. I am extremely proud that we were able to implement this portal together with the government, Jeroen Bosch Hospital and Philips in this short term to support care for patients with COVID-19. I would also like to express my gratitude to the teams at all the organizations that have worked hard on this."
		7	Philips Interoperability Solutions built the new COVID-19 portal on top of its existing XDS Cloud document sharing service, which allows patient data to be sent digitally in a secure manner. For more information on Philips Interoperability Solutions, <a href="#">click here</a> .
..Safe			

	1	<b>Covid Innovation 16:</b> Health department offering free access to app that connects new moms with lactation experts aimed stay-at-home orders
	2	<i>Article from Online Newspaper (CBS News Philly)</i>
	3	The COVID-19 pandemic has led to a dramatic rise in the use of telemedicine. Now, new moms in this era of social distancing are getting much-needed help using technology.
	4	Being a new mom is daunting for many and perhaps even more so now in the era of sheltering at home.
	5	Christine Strickland says she feels very fortunate to have delivered her son — just six-and-a-half-weeks-old and born on Valentine’s Day — before the citywide lockdown went in place.
	6	“We got kind of lucky before things got kind of crazy,” she said.
	7	But with lactation clinics effectively closed throughout Philadelphia, Strickland turned to a new program offered by the Department of Health.
..User-friendly	8	“It was extremely easy to use. I was able to do it from yoga pants from my living room,” she said.
Tech solution	9	It’s a new app called Pacify.
Tech solution	10	The Philadelphia Department of Health secured a contract making the tele-lactation app accessible to all city residents immediately through at least July 1.
No-cost solution	11	Another positive is that the app is completely free.
..Helpful	12	“Pacify is available 24/7,” Pacify Chief Clinical Officer Melanie Silverman said.
	13	She says the goal is to ease any questions or concerns new parents may be experiencing.
	14	“They can stay on as long as they want and ask anything related to the kinds of questions they can answer,” Silverman added.
..Fast	15	The goal is to connect moms with a lactation expert within 30 seconds.
..Helpful	16	“When a mother or a father has a question about breastfeeding, it’s an emergency. If they don’t get that help they need immediately, they may lose their milk supply. Literally, in the last couple of weeks, clinics are closing. People can’t come in to see their doctors,” Silverman said. “We’re really able to help them the minute they need it and make sure breastfeeding continues.”
..Fast		
..Helpful	17	“I think this is our first lesson in parenting that things aren’t going to go the way we plan them to,” Strickland said. “I think this app that the city has made available is a great way to get that support and help.
..Inclusive	18	Silverman says she has also been able to hire lactation experts who have been laid off or furloughed because of the crisis.

		1	<b>Covid Innovation 17: NHS developing app to trace close contacts of coronavirus carriers</b>
		2	<i>Article from Online Newspaper (The Guardian)</i>
		3	Technology is nearly ready for use and would also tell people when they should self-isolate
..Fast		4	The NHS is in talks to roll out a smartphone app that instantly traces close contacts of people carrying the coronavirus and advises them to self-isolate.
..Safe		5	The app, developed by NHSX – the health service’s digital transformation arm – with academic and industry partners is in advanced stages of evaluation and is weeks away from being ready to be deployed, the Guardian understands.
		6	Around 60% of the adult population would need to sign up and engage with the app by registering their symptoms or positive test results for it to be effective. Their proximity to other users would be logged, and they would follow advice given in alerts to self-isolate – even in cases where they were not aware of having been in contact with someone infected.
..Safe		7	The prospect of an app that would give the government access to health and Country/Nation data has already triggered privacy concerns and would herald an unprecedented level of surveillance.
Triggered privacy concerns		8	However, digital contact tracing has been a central part of the containment strategy in China and, according to a new analysis by scientists at the University of Oxford, “digital herd protection” is likely to be crucial in order to lift current restrictions without seeing a huge resurgence of infections.
		9	“We see it as the only alternative to ... applying isolation to the whole population,” said Prof David Bonsall, senior researcher at Oxford University’s Nuffield Department of Medicine and a clinician, who co-led the project. “We think it’s going to be a very important part of that strategy.” The Oxford team developed an algorithm for the app.
Tech solution		10	“That’s where this concept of herd protection came from,” said Bonsall. “You can protect the vulnerable people in society who may not have smartphones, and protect children. If enough adults across the population engage with the system and trust the system telling them they should isolate, you’re protecting all those individuals who don’t have a device.”
..Inclusive		11	Unlike with some previous pandemics, including Sars and flu, a high proportion of transmission of Covid-19 occurs before a person is showing symptoms. So isolating people once they become ill and tracing contacts manually has limited effectiveness because the spread of the virus will be one step ahead, according to the team’s analysis in the journal Science.
..Higher-performance		12	“Traditional contact tracing is too slow for this virus and it won’t work,” said Bonsall. “By the time you’ve identified the contact, they’ve already transmitted. It doesn’t scale either.”
..Higher-performance		13	The team has been working on the algorithm since mid-January and has studied the Chinese app that gives people a red or green code determining whether they need to self-isolate.
		14	The app would not need to access Country/Nation data, but could log users’ proximity to each other through Bluetooth. Once a user reports symptoms or a positive test result, the app would trace back through close contacts over the past seven days and alert those calculated to be at risk. Once deployed, developers would use data on who is actually infected to optimise the app’s performance and gain further insights into how transmission occurs.
..Helpful		15	It is expected that the final phase of evaluation, which will include getting sign-off from ethics committees and also ironing out any technical glitches,

will be completed within weeks. However, it is possible the app would be rolled out later in the year before current restrictions are lifted.

16 In China, authorities have reportedly used mass surveillance of smartphone data to classify people's health status according to a traffic light system and restrict movements accordingly. The system is being used to control who is allowed to return to work and other activities as the city of Wuhan began to relax its lockdown in the past week.

17 It is understood that the NHS app would be an opt-in system and that it would not be required to access NHS testing services, or to get permission to return to work, for instance. Instead, people would be encouraged to sign up as part of a collective effort to bring the pandemic under control.

18 Prof Michael Parker, director of the Wellcome Centre for Ethics and Humanities at the University of Oxford and co-author of the paper, said that it ought to be possible to roll out the contact-tracing app without breaching data protection laws. "In emergency situations, there are all sorts of things that are allowable that wouldn't be otherwise and that seems appropriate," he said. "The most important thing is there's public trust and confidence and clarity of what's happening."

..Safe

19 There would need to be oversight of the app's deployment, clear "stop rules" about what happens to data after the pandemic is brought under control and careful attention paid to ensure those without smartphones would not be disadvantaged.

20 David Leslie, an ethicist at the Alan Turing Institute who studies the governance of data-driven technologies, said that public trust in data collection, sharing and use have been eroded by the monetisation of personal data by big tech companies and the intrusive use of data by some governments. Despite this, the circumstances of the pandemic could allow people to set aside these reservations.

..Safe

21 "I believe that if we put the proper protocols of responsible innovation in place – protocols which ensure that these technologies are democratically governed, based on individual and community consent, proportional, and constrained with sunset provisions – a higher level of intrusiveness would be more widely acceptable," he said.

22 An NHSX spokesperson said: "NHSX is looking at whether app-based solutions might be helpful in tracking and managing coronavirus, and we have assembled expertise from inside and outside the organisation to do this as rapidly as possible."

23 A UK start-up company is preparing to launch a free app that will help people observe physical distancing more effectively by informing them when Country/Nations are busy. The Keep Your Distance app, developed by Lanterne, will provide real-time live data on the businesses and essential places that people need to visit, such as supermarkets and pharmacies. The app uses GPS satellite data and data available from Google and crowdsourced information to help people decide whether or not it is a good time to visit. If a Country/Nation is particularly crowded, users are presented with less crowded alternatives nearby.



1 **Covid Innovation 18: MIT Team Shares New \$500 Emergency Ventilator Design with the Public.**

2 *Article from Online Newspaper (Interesting Engineering)*

3 Their design could help alleviate the shortage of ventilators amid the coronavirus outbreak.

4 Currently, most countries have a shortage of ventilators in hospitals, which is a considerable worry amid the coronavirus outbreak. Considered to be life-saving devices, these are needed to help pump oxygen into coronavirus patients' lungs, which are badly affected by the virus.

5 Companies such as Dyson, Tesla, Ford, and General Motors are working hard at designing and building ICU ventilators, however, these can take time to first be designed then deemed safe to use.

6 In the meantime, a group of MIT scientists has created an emergency ventilator, which is affordable, and easily made using regular hospital devices.

7 The MIT design is available online

8 A team of volunteers, scientists, physicians, and computer scientists at MIT known as E-Vent put their heads together three weeks ago to revive a 10-year-old ventilator project. The end result is a ventilator design that's affordable and easily replicated.

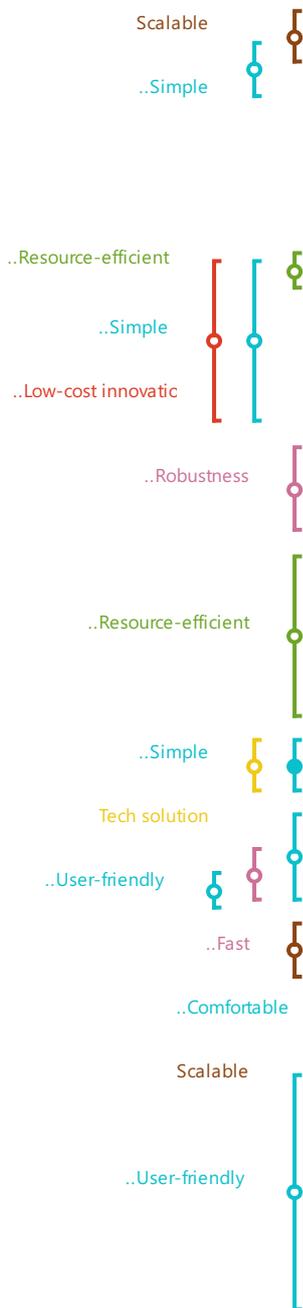
9 The total cost of the device for the different parts is between \$400 to \$500, and the team plans on sharing their design online on their website so that manufacturers and companies can recreate the lifesaving device for hospitals around the world.

10 The device's main part already exists in most hospitals' inventory: Ambu resuscitation bags. Usually, these are manually operated by emergency technicians or medical professionals to keep the patient breathing until they are hooked up to a ventilator.

11 The team at MIT has adapted the Ambu bags by attaching them to an automated mechanism that automatically pumps the bag with air in the same manner if a human were handling it. This method would alleviate the use of a person standing day and night by a patient's bedside — something that's not currently possible in hospitals that are reaching over-capacity because of the rapidly spreading coronavirus — and keep them breathing long enough to then be strapped to a proper ICU ventilator.

12 There's no exact date as to when the prototype information will be shared for all to use. However, the team members, who prefer to remain anonymous at this stage so as not to be inundated with requests or questions, have stated that they eventually want to secure the U.S. Food and Drug Administration (FDA) approvals.

13 The researchers warn on their website "While it cannot replace an FDA-approved ICU ventilator, in terms of functionality, flexibility, and clinical efficacy, the MIT E-Vent is anticipated to have utility in helping free up existing supply or in life-or-death situations when there is no other option."



1 **Covid Innovation 19: MIT develops one-piece plastic face shields for coronavirus medics**

2 *Magazine Article (Dezeen)*

3 Massachusetts Institute of Technology researchers have begun mass-producing disposable face shields for medical workers fighting Covid-19, which come flat-packed and can be folded into shape.

4 In a bid to meet the increasing demand for personal protective equipment (PPE) amid the coronavirus pandemic, a team of researchers at the Massachusetts Institute of Technology (MIT) have designed disposable face shields that can be mass-produced rapidly.

5 Made from a single piece of plastic, each shield comes in a flat design that can be swiftly folded into a three-dimensional structure when needed for use.

6 The face shields also offer additional protection with flaps that fold under the neck and over the forehead.

7 After testing a few materials that cracked and broke when bent, the team landed on the polycarbonate and polyethylene terephthalate glycol (PETG) materials.

8 "When you're thinking of materials, you have to keep supply chains in mind," said Martin Culpepper, professor of mechanical engineering and project leader.

9 "You can't choose a material that could evaporate from the supply chain," he added. "That is a challenging problem in this crisis."

10 Each single-piece shield will be made using the die-cutting process. Machines cut the design from thousands of flat sheets per hour.

11 These will then be sent in their flat form to hospitals, where doctors, nurses and other frontline health care workers can quickly fold them into their three-dimensional form before adjusting them to their face.

12 According to MIT, the die-cutter machines used in mass production would be able to make 50,000 of the flat face shields per day.

13 **Assembly Instructions transcript:**

14 Steep #1 – Peel protective film from both sides of face shield.

15 Steep #2 – Fold top strip over and make hard creases.

16 Steep #3 – Fold down visor pieces to make cover.

17 Steep #4 – Fold and crease side and bottom flaps.

18 Steep #5 – Clip in tabs to the slot on side.

19 Steep #6 – Attach doubled hair ties, elastic or rubber bands to complete.



- 1 **Covid Innovation 20:** Mental health app available for free during coronavirus outbreak
- 2 *Magazine Article (MedTech)*
- 3 My Possible Self is making itself available free of charge to support the nation's wellbeing during the coronavirus outbreak.
- 4 The mental health app contains content that is clinically proven to help people reduce stress, anxiety and mild to moderate depression.
- 5 My Possible Self has grown a base of more than 60,000 registered users and last summer was commissioned by the NHS to combat poor mental health in London.
- 6 Joanne Wilkinson, founder, said: "With all of us facing uncertainty about our health, loved ones and work, and increasing social isolation, it is no wonder we are seeing a rise in stress and anxiety.
- 7 "At My Possible Self we want to help and are making our app free for anyone who signs up.
- 8 "Based on face-to-face therapy, we will teach you psychological strategies and coping skills to tackle stress and anxiety and boost your mood.
- 9 "You can also use our mood tracker to see how activities, places and people influence your mood - so you can focus more on the things that help and less on the things that don't.
- 10 "We will continue to offer our app for free until we have come through this crisis. We will do whatever we can to help."
- 11 My Possible Self has been adopted by a number of small, medium and large employers across the public and private sector to support employee wellbeing.
- 12 The app offers users a set of tools and techniques to better understand mood, notice patterns in behaviour, become more self-aware and improve mental wellbeing.
- 13 Employers and NHS organisations can use MPS Connect and MPS Analytics to monitor wellbeing at a group level and provide focused support to individuals when needed.

Scalable  
 ..External funds/resources  
 ..Resource-efficient  
 ..Resource-efficient

1 **Covid Innovation 21:** Send your masks to healthcare workers without leaving your house.

2 *Website page (Mask-match)*

3 Dear Mask Match Community,

4 We at Mask Match have been overwhelmed by the response to the needs of our healthcare workers. Over the past 3 months, our community has sent 821,000 masks from 6,200 donors to 7,300 recipients. This includes deliveries to every state, as well as Puerto Rico and Washington DC.

5 Our donors include people who had a single box of masks under their workbench or wildfire masks in their closet, many small business owners eager to help, and very dedicated volunteers sewing handmade masks.

6 Our recipients include ER doctors in NY and NJ, local hospital and EMS providers in Mississippi caring for patients in the aftermath of a tornado, and Navajo Nation EMS providers amongst many others.

7 Over the past few weeks, we've seen fewer requests for masks. This is a great sign that supply chains are catching up to demand, and a very welcome one, as there are simply not as many boxes of masks out there waiting to be discovered. We've decided to join forces with GetUsPPE, an organization well-prepared to support PPE needs and advocate for healthcare workers throughout future waves of COVID-19.

..External funds/resources

8 As the start of the crisis loomed, we were inspired to act and we expected a challenge. What we did not expect was the level of dedication from our volunteers and the depth of generosity we saw from our donors. We would like to thank our donors for that generosity, our health care provider recipients for their patience as we worked out the kinks, and our volunteers for their tireless work.

9 Our last request to our community: please wear masks. It's been conclusively shown that this is the most effective tool we have to protect ourselves and our country from this terrible disease. Let's continue showing that we care for each other by taking this simple step.

10 The Mask Match Co-Founders (Liz, Chloe, Emma, & Colin)

Scalable

11 **Impact**

12 Over a period of three months, Mask Match delivered 820,000+ masks to healthcare workers around the United States. We delivered masks to every state, plus Puerto Rico and Washington D.C., and even some to Canada.

Tech solution

13 **Mask Match in the press**

14 *'It's what we have to do': Bay Area women launch mask donation site for healthcare workers.* - SF Gate

15 *"The group Mask Match has been helping small- and mid-size hospitals and clinics get the critical, protective masks they need."* - ABC News Person of the Week

..Fast

16 *"The pair got Mask Match up and running in 48 hours to distribute masks and protective gear directly from donors to doctors, nurses and clinics."* - Fox News

17 *"So far, Mask Match has helped thousands of needed supplies reach health care workers"* - The New York Times



18

*“A handy tool for determining where to direct your N95 respirators and surgical mask” - The Cut*

19

*“The newfound service Mask Match ... is connecting residents throughout the country who have extra masks with health care workers who need them.” - NY Daily News*

1 **Covid Innovation 22: Iqarus develops potentially life-savings service during pandemic**

2 *Webpage on a website news (Energy News)*

3 Global healthcare provider Iqarus, an International SOS company, has developed and launched a new service to safely manage suspected cases of coronavirus following their disembarkation from an offshore Country/ Nation.

..Safe

Unclear Tech level

4 The new service, Covid 19 Medevac (CMED), includes assessments to determine if a worker is fit to travel, and the provision of tailored advice from the Iqarus clinical team, in line with current Health Protection Scotland guidance.

5 Since the first reports of a confirmed case of coronavirus (COVID-19) on an offshore installation in the Norwegian section of the North Sea, there has been a steady increase of suspected and confirmed cases.

..Safe

6 Iqarus has been working round the clock with its client base to support them in mitigating their risk, encouraging clients to closely monitor the situation and advise them on how best to safely continue operations.

7 The global healthcare provider has now developed a service to support clients with the receipt, transfer and assessment of suspected cases of COVID-19 from Aberdeen heliports which allows duty holders to meet their obligation to assess patients and determine if they are fit for onward travel.

8 Dr Stuart Scott, clinical director, offshore, topside and diving at Iqarus explained: “Offshore assets are confined spaces, with plenty of movement by multinational staff on and off the rig, usually by helicopter between onshore bases in Norway and the UK

9 “With cases increasing across both countries, it was only ever a matter of time before the virus spread to offshore platforms.”

..Safe

10 In order to offer a solution to the growing concern of operators and offshore workers, Iqarus can now offer clinically appropriate transport from either of the Aberdeen heliports to its dedicated reception centre in Aberdeen.

11 Following initial offshore assessment from the asset medic, the patient will then be transported via bespoke helicopters – aptly dubbed ‘the corona copter’ – that meet full hygiene standards for each trip.

12 Upon arrival onshore the patient is assessed following which the healthcare provider’s team of specialist clinicians will advise suitability for onward travel or alternatively, refer them to the next point of assessment.

13 Dr Scott continued: “Until now, returning suspected or confirmed cases back to shore for treatment was a predicament. The wellbeing of others, and mitigation of infection spread is paramount to operations. Flying patients back brought with it concerns for pilots’ safety, whilst teams onshore have not been properly set up to deal with potentially high-risk cases.

..Fast

..Quality care

14 “This new service, further backed by the recently confirmed helicopter operators, means that we can assess those patients quickly with the best quality of care at the heart of it.”

15 The new opt- in service, CMED, is available to all duty holders in line with HSE L123. Fully risk assessed, it is the exclusive means by which Iqarus will use a medevac for suspected COVID-19 cases.

16 Dr Scott also reminds clients and the wider business community that following government guidelines and best practice for good hygiene is still key to restricting the spread of the virus.

17 “For offices, we recommend following the standard guidance for any



18

business in terms of good hygiene and travel screening. It's all about educating employees and keeping them informed. We all have a responsibility to protect the people who work for us and with us", he said.

"In addition to providing accurate information, especially during the initial uncertain period when a new virus emerges, advice on how to mitigate further risks and ensure business continuity should be shared."

19

Iqarus' key recommendations include:

20

- Government advice remains that those who develop symptoms of a new continuous/ persistent cough, or a high temperature (above 38oC) should self-isolate for 7 days.

21

- Those who share a household with someone who develops these symptoms should self-isolate for 14 days to ensure they do not develop symptoms themselves.

22

- People who are asymptomatic are advised to follow social distancing measures to minimise the spread of Covid-19.

23

- This advice also applies to those mobilising to offshore installations. Individual installation operators will risk assess individuals who have travelled internationally within the last 14 days.

24

- Health Protection Scotland have advised that testing of symptomatic individuals is currently not being carried out offshore.

25

If there are any concerns as to whether a particular individual should mobilise offshore, these should be discussed with your Medical Advisor and recommendations will be made on a case by case basis.

26

Iqarus, which has been providing healthcare solutions for the oil and gas industry for more than 40 years, delivers effective medical and occupational health services in complex and demanding operating environments.

27

As the largest provider of healthcare to the industry, its medical and security experts have extensive experience supporting clients in previous outbreaks including Ebola, Zika virus, plague, SARS, bird flu and the H1N1 2009 influenza pandemic.



1 **Covid Innovation 23:** Medical detection dogs able to sniff 750 people an hour could help identify coronavirus cases

2 *Article from Online Newspaper (Business Insider)*

3 Specially trained medical detection dogs could be the solution to the crisis in the lack of testing that many countries are facing during the coronavirus pandemic.

4 The dogs are capable of sniff testing 750 people an hour, according to the head of a non-profit which trains medical dogs.

5 The potential for the dogs to respond to the coronavirus pandemic is being explored by the London School of Hygiene and Tropical Medicine (LSHTM), Durham University, and the Medical Detection Dogs organization.



6 LSHTM published a press release in late March describing the experimental project, which is seeking to establish whether the dogs can reliably detect COVID-19 in the way they can other disease.

7 They plan to train six dogs if the initial trials are successful, according to an April 17 report by Britain's Daily Mirror tabloid.

8 The training involves the dogs being given coronavirus patients' face masks to sniff to discover if COVID-19 has a unique odor that can be identified by a dog's enhanced senses of smell, the Mirror said.

9 It will take several weeks of experimentation before it will be known if dogs are able to identify the coronavirus.

10 James Logan, the head of the department of disease control at LSHTM, said: "It's early days for COVID-19 odor detection. We do not know if COVID-19 has a specific odor yet, but we know that other respiratory diseases change our body odor so there is a chance that it does.

11 "And if it does, dogs will be able to detect it. This new diagnostic tool could revolutionise our response to COVID-19."

12 Medical detection dogs are already used to help screen for a range of conditions including cancer, malaria and Parkinson's.

13 Claire Guest, CEO of the Medical Detection Dogs charity, told the Mirror: "There have already been so many fantastic achievements in the dogs' work to detect human disease, and I believe they can be trained to sniff out COVID-19."

..Fast



14 "When resources and testing kits are low, hundreds of people can't be tested in one go. But the dogs can screen up to 750 people really quickly. By identifying those who need to be tested and self-isolate, they can stop the spread."

..No-cost solution

..No-cost solution

..Inclusive

..Inclusive

1 **Covid Innovation 24:** Refugees offer medical experience to help tackle coronavirus crisis in France.

2 *Website Page (UNHCR)*

3 Doctors from Libya and Somalia are among refugee medics joining the battle to fight COVID-19 and save lives.

4 The COVID-19 crisis has sparked an outpouring of solidarity from people around the world and that includes refugees, keen to help in the countries where they now live. Many refugees in Europe involved in medicine in their home countries are finding new ways to use their skills to help care for those in need. Below are two examples from France.

#### 5 **Mohamed's Story**

6 Mohamed, 39, worked as a doctor in his home country of Libya and was training to become a surgeon until violence forced him to flee to France in 2016. The hardship of the sea crossing did not diminish his desire to serve and pursue his career.

7 He passed the French language exams required to start the process of registering as a doctor and completed internships where he shadowed senior doctors at hospitals in the northern city of Rouen and Limoges in the centre west of the country. He also volunteered for French charities including "Les Restos du Cœur," and is prepared to go wherever he is needed.

8 "My dream is to work as a doctor. It's my life. It's my oxygen," Mohamed says.

9 When the COVID-19 crisis began in France, he immediately registered on the emergency roster set up by the Ministry of Health to support medical staff in hospitals.

10 "I am ready to do anything to help." "Refugee doctors can contribute to support and fight the virus. I have seen that in other European countries, refugee doctors are also called to work and help with the emergency situation", Mohamed says. "I am ready to do anything to help. I can work in the emergency room in a hospital at any position. I can be an assistant nurse; I can help in giving information. For all these positions, it's very important to have staff in hospitals who know how to deal with such a situation. You have to be very careful, even in carrying the garbage," he said.

11 Mohamed says his experience of war in Libya has taught him to remain calm and focused in difficult situations. "An epidemic can be stressful, but it's nothing compared to war. I am not scared. I am ready to go anywhere in France to help," he said.

#### 12 **Yasin's Story**

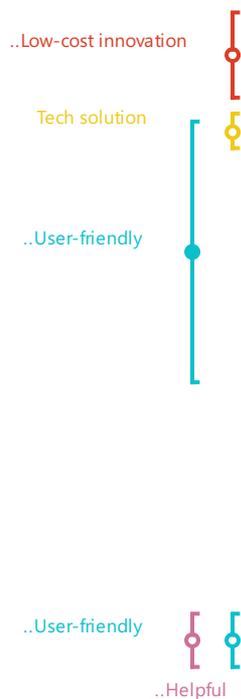
13 Before Yasin fled Somalia three years ago, he studied medicine and qualified as a doctor. When he arrived in France he was eager to continue his work as a medic. In the event, he was unable to find work and eventually spent time living on the streets of Paris.

14 Undeterred, he founded an NGO, Network of Exiles in France, to make a difference in his new home country. Refugees and asylum seekers are heavily involved in the organization, participating in language exchanges and volunteering to translate documents.

15 The pandemic has given the charity an opportunity to contribute directly and has also made them extra busy.

16 Prior to the COVID-19 outbreak, volunteers translated around 10

<p>..Inclusive</p> 		<p>documents per week, primarily helping asylum seekers with the asylum process in France. Now they are translating documents that provide information on the lockdown in France and advice on who to contact if a person is feeling unwell. In all, they have translated over 220 documents.</p>
<p>..Helpful</p> 	<p>17</p>	<p>“Stay home. Stay strong.” “Hospitals, charities and accommodation centres have been sending us documents, certificates and flyers, and we have been translating them for free,” Yasin said. “Some asylum seekers don’t understand the lockdown, so we help to explain in their own language.”</p>
<p>..Inclusive</p> 	<p>18</p>	<p>“During difficult times, the language barrier can become frustrating. We want to help.”</p>
	<p>19</p>	<p>Once the lockdown is over, Yasin and the other volunteers plans to chart a new way forward but for now they have a simple message:</p>
	<p>20</p>	<p>“Stay home. Stay strong,” Yasin said.</p>



1 **Covid Innovation 25:** GoodRx launches telemedicine price comparison service, amid growing demand during Covid.19 pandemic

2 *Article from Online Newspaper (Mobihealth News)*

3 Users can choose from 100 conditions and get information about telemedicine pricing and medication services.

4 GoodRx, the Californian startup best known for its pharmaceutical-cost-transparency tool, is rolling out a new feature that lets patients compare telemedicine prices and service options.

5 Dubbed GoodRx telehealth marketplace, users are able to select the type of condition they are looking to address. Patients can select one of 100 conditions, which run the gamut from cold and flu symptoms to erectile dysfunction, and even include COVID-19.

6 After the medical issue is selected, the site redirects patients to a list of telehealth services that treat that condition, along with the estimated price and pharmacy information. For example, a patient can search to see if a specific telehealth service has pharmacy pickup or medication delivery.

7 The startup is pitching this as a way to get care during the coronavirus pandemic.

8 “As Americans stay home, and with our front-line hospitals and clinics experiencing tremendous demand, we want to help people get access to services for a range of medical issues,” Doug Hirsch, co-CEO and cofounder of GoodRx, said in a statement. “Our goal with the telehealth marketplace is to give people all their options, services and prices, so they can easily get the treatment they need.”

9 **Why it matters**

10 Telemedicine has seen a sharp increase in usage in the last few months as the cases of the coronavirus have spiked. Providers are pitching telemedicine as a way to provide individuals with care, while protecting themselves and the patients from new germs.

11 "If there are any silver linings it's that the [American Medical Association] along with many other organizations have been working for telehealth adoption for some time. Obviously it is really having its moment right now and [has been] able to step up to keep providers and patients safe on the front lines," Meg Barron, vice president of Digital Health Strategy at the American Medical Association (AMA), said during the MassChallenge coronavirus innovation summit, last week.

12 **The larger trend**

13 As telemedicine takes center stage, consumers and providers alike are learning more about the technology. Last week the AMA launched the Telemedicine Quick Reference Guide, aimed at helping clinicians figure out best practices for implementing the tech. The guidelines cover everything from policy and coding to implementation.

14 The association also kicked off a virtual panel discussion on telemedicine and COVID-19, where clinicians can give their input and share experiences.

1 **Covid Innovation 26:** Strength-giving sentences for unprecedented times. A do-it-yourself card set

2 *Website Page (Innen-Leben)*

3 To give us all a little help, meaning, and a ray of hope in this current crisis we have developed a small Do-it-yourself Card Set. It consists of 40 INSIDE cards and 40 LIFE cards which, when combined, can create 1,600 strength-giving and clarifying sentences. Using these sentences you can support your own coping strategies. These sentences are oriented towards the basic human needs of security, autonomy, relationships, and the strengthening of self esteem. Thus the INSIDE-LIFE Card Set serves both as tool for crisis prevention and crisis intervention – practical, simple and at home.

4 **Here's how it works:**

- 5 • Download the PDF document, print it out, cut the cards.
- 6 • Formulate your own strength-giving sentences.
- 7 • Activate your psychological resilience against uncertainty and fear, as you would internalize a mantra.
- 8 • Further instructions can be found in the accompanying text on the PDF.
- 9 • Feel free to share this link with family, friends and colleagues so that the strength-giving sentences reach as many people as possible.
- 10 • We look forward to receiving photos of your own personal card set, and your experiences with the INSIDE-LIFE Card Set.

11 **Dissemination**

12 INNEN-LEBEN (INSIDE-LIFE, 2020) by Dr. Sabine Ebersberger and Dr. med. Michael Bohne is licensed under a Creative Commons 4.0 License.

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- 14 • Share - copy and redistribute the material in any medium or format
- 15 • Adapt - remix, transform, and build upon the material

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- 19 • ShareAlike - If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.
- 20 • No additional restrictions - You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.

21 Juliette:

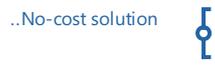
22 2. April 2020 um 10:22

23 A huuuuge thank you from Vietnam!

24 Sharon:

25 8. Mai 2020 um 10:43

26 These cards are amazing! I sent your link to many people I know who are really struggling with the quarantine. I'm sure they will helpful.



..Helpful



27 Thank you from France!

28 Irina Kurilenko:

29 31. Januar 2021 um 19:59

30 Thank you very much from Sain-Patersburg!!! You are great!!! This is simple, butt real help!



# 1 Covid Innovation 27: Get the most out of your surgical mask

2 Website Page (Fix The Mask)

..Resource-efficient



## 3 CDC recommends use of mask braces:

4 Use a Mask Fitter or Brace over a disposable mask or a cloth mask to prevent air from leaking around the edges of the mask.

..Comfortable



## 5 How does it create a good fit?

6 Our patented Nose Cushions apply light pressure across your cheeks instead of placing it all directly on your nose. It's the key difference between our flat rubber sheet template and the Essential Mask Brace, and truly changes the game.

## 7 Video Transcript (audio-visual content):

8 Covid-19 is a respiratory disease that spreads when infected individuals do things like talk, cough or sneeze, and produce droplets containing virus particles.

9 Airborne diseases do not just spread through large droplets. As these droplets evaporate, they break down into even smaller virus-carrying particles called aerosols. These airborne droplets can form clouds that can stay in the air for several hours and travel further than six feet.

10 Unfortunately, when people use standard precautions like cloth or surgical masks, wearers are vulnerable to these dangerous particles entering through gaps on the tops sides or bottom of the face covering. This is why the n96 respirator is the gold standard in airborne protection, they create a good fit by making a seal between the wearer and the respirator.

11 To better understand the surgical mask, fix the max did a layer-by-layer comparison of an n95 respirator and a surgical mask to compare the differences.

12 We found that they use the same soft inner liner. The n95 respirator has a rigid structure that creates that good fit. Then, they both use the same melt-blown material which ensures 95% filtration of small particles. And finally, they use the same fluid resistant exterior, this means that the key difference between an n95 respirator and a surgical mask is that a surgical mask lacks the fit structured required. That's how we decided to fix the mask with the essential mask brace.

..Safe



..Higher-performan



..Resource-efficient



..Simple

Scalable

13 When paired with the lose fitting surgical mask, the essential mask brace goes over the outside securing the mask and creating the fit factor the passes the n95 standard.

14 Made from a single compression modelled piece our product is being manufactured at scale today. We have distributed tens of thousands of braces in two months, and production can be easily ramped up to meet the demand nationally and even globally.

15 So, that's great to know. But the real question is: "Does it work"?

..Simple

..Higher-performance



..Quality care



16 The key here is something called "fit factor". Fit factor tells you how much cleaner the air inside your mask is compared to the air outside your mask. With no face covering, the air is the same level of cleanliness. With a loose-fitting cloth or surgical mask, the air is two times cleaner. With the essential mask brace adding fit to a high performing filter, the hair inside is 100 times cleaner than the air outside the mask, passing the n95 standard.

17 While most mask solutions feature either fit or filtration, the essential mask brace shows that having both is key to making a high-quality mask solution.

18 The genius behind this design is in its scalability, there are at least 100 times

..Resource-efficient



19 more surgical masks made per day than n95 respirators.  
In March the WHO asked the industry to increase [PPE] manufacturing by 40% to meet rising global demand.

20 Fix the max believes we do not need to change our supply chain to get people the PPE we need, with the essential mask brace we are able to protect people now with the resources we have today.

21 **What People are saying:**

22 *"This product is godsend. We went down the N95 road, but the fit test and fit check was very cumbersome and challenging, let alone getting enough respirators. Your Product is perfect."* – Peter Nazzal, director at Homeless Shelter at CCSWW

..Safe



..Simple

Aesthetic

23 *"I have been researching masks since the pandemic started. The Essential Barce is the answer to better fitting and therefore more protective mask. A simple, elegant, and effective solution. I feel a much greater level of protection when using it."* – Dr. Ira M. Wendroff, Dentist.

..Comfortable



24 *"As they advertised this keeps your glasses from fogging. One other surprise thing. You breathe easier wearing the braced mask. Something about the snug fit causes your mouth and nose to adjust to the mask material much sooner and you just flat out breathe easier."* – Teacher, Kickstarter Backer

..Comfortable



25 *"I am so happy with them! Thank you! They fit much more comfortably than the 2.0 braces that I made. I just wore them around the house for 8 hours today and I didn't have any issues with it being too tight or falling off."* - Teacher, Kickstarter Backer.

..Comfortable



..Comfortable



26 *"I love that I can speak through it. I go back and forth using a Montana mask which is very hard for people to hear me. After using restrictive mask for so long and then switching back to a level 3 with a face brace I almost feel naked using this mask."* - Daniel W., Registered Dental Hygienist.

..Comfortable



..Safe

..Comfortable



..Comfortable

27 *"While wearing the essential brace, I feel way more comfortable. For two reasons; 1 I feel as though the seal is more effective than with a K/N95, and also, I am able to remove the ear loops from a surgical mask, that bite into my ears over time. I have worn the essential brace for 10-12 straight with no discomfort. Its really the only thing out there that fits my face and provides the level of protection that I am looking for."* – David M., Fulfillment Center

..No-cost solution



..Meeting regulatory req

Tech solution



1

**Covid Innovation 28:** FDA debuts new online portal to encourage donation of plasma from recovered COVID-19 patients

2

*Blog Post (TechCrunch)*

3

One of the avenues currently being pursued in terms of developing an effective treatment for COVID-19 is through the use of convalescent plasma. Basically, that means using the liquid component of blood from people who have had, and already recovered fully from, COVID-19 to produce treatments that hopefully translate to others the antibodies they developed over the course of fighting off the virus. The FDA has created a dedicated new website seeking recovered COVID-19 donations, and explaining its potential uses.

4

Use of convalescent plasma is hardly a new concept: It's been in use since the late 1890s, in fact, and was employed during the 1918 Spanish flu pandemic, albeit with "mixed results." Modern methods could help improve the efficacy and potential of recovered plasma as a treatment method, and there are a number of drugs in development that use plasma (both animal and human) as the basic active ingredient of their approach.

5

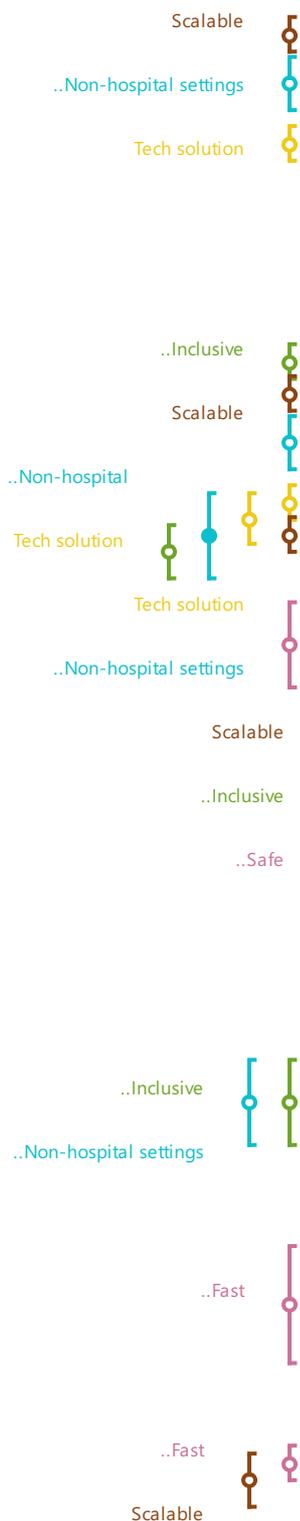
The new FDA website around COVID-19 plasma donation defines what it is, and why it's under investigation as a possible treatment. It also outlines what conditions need to be met in order for an individual to be qualified to donate (no symptoms for at least 28 days prior to donation, or at least 14 days when combined with a confirmed negative lab test for active COVID-19 viral presence), and it directs you to donate via an American Red Cross or local blood center nearby.

6

Why is so much COVID-19 patient plasma needed, if it's not yet even proven to be effective in treatment of the virus? Mainly because there are a lot of efforts underway to determine whether it actually can help with efforts to combat the virus, including clinical trials for a number of different treatments, as well as single-patient treatment authorizations through what are known as emergency investigational new drug (eIND) one-off usage approvals from the FDA.

7

As with every potential treatment and vaccine in development to address COVID-19 at this stage, recovered plasma remains unproven, and it's unlikely ongoing efforts to study its effectiveness will bear definitive proof one way or another in the near term. Still, there's a growing need for plasma supplies to help further that work, hence the FDA's decision to spur more donations with dedicated informational resources like this one.



1 **Covid Innovation 29:** Epic, OCHIN launch COVID-19 app for front-line care coordination

2 *Article from Online Newspaper (Healthcare IT News)*

3 First set to deploy in Washington State, the scalable smartphone app, which integrates with Epic's Care Everywhere platform, is aimed at care delivery in non-traditional settings without EHRs.

4 Epic has launched a new mobile app designed for those on the frontlines of the coronavirus pandemic who might not have immediate access to an electronic health record.

5 **Why it matters**

6 Designed in collaboration with OCHIN – the non-profit health technology organization focused on innovating health equity in underserved areas – and the Washington State Health Care Authority, the scalable app is meant to support emergency care in "non-traditional healthcare settings such as tents, community centres and schools," according to Epic.

7 The COVID-19 Preparedness App enables patients to self-screen and healthcare volunteers to triage using smartphones, broadening the capacity for emergency response in rural or underserved communities.

8 Meanwhile, by collecting patient demographic information the app can help epidemiologists and government health officials track the spread and containment of coronavirus.

9 Patients can also sign up for a MyChart account, enabling coordination of follow-up care, according to the company, and integration with Epic's Care Everywhere interoperability platform can send data to EHRs at other healthcare facilities.

10 **The larger trend**

11 The COVID-19 Preparedness App was first developed to help Washington, the first state to be hard hit by the pandemic, prepare for a big increase in patients. Now it's being shared with states nationwide, to enable more connected care at ad hoc emergency triage sites such as tent-based fever clinics. It's meant to enable more care to be provided away from crowded hospitals and clinics – and to expand capacity in rural areas where access may be limited.

12 **On the record**

13 "A retired nurse, or any other volunteer or staff, with her own smartphone can be up and running in minutes," said Epic CEO Judy Faulkner in a statement. "This allows states, counties, and health systems to increase capacity quickly, which will be helpful especially in hard hit and underserved communities. It has been meaningful to work with Washington state and OCHIN to help patients during this crisis."

14 "This is an unprecedented, innovative solution for rapidly building capacity in the face of this growing public health emergency," added Abby Sears, CEO at OCHIN. "We applaud the leadership of the state of Washington and the generosity and foresight of Epic as we stand together in this crisis."

1 **Covid Innovation 30:** New COVID-19 project will use the power of smartphones to search for treatments

2 *Webpage on a News website (Imperial College London News)*

3 Imperial researchers will look for potential new treatments for COVID-19 using the computing power of people's smartphones.

4 Working with Vodafone Foundation, the 'Corona-AI' project will use the free DreamLab app, which crunches calculations using a smartphone's computing power while its user sleeps. The app has already helped find potential new cancer drugs and is now aiming to help in the fight against the coronavirus pandemic.

5 Data generated from the calculations will help Imperial scientists identify existing drugs and food-based molecules with antiviral properties. Ultimately, they hope to enable tailored treatments to be developed for patients with COVID-19.



6 The app works by creating a network of smartphones to power a virtual supercomputer, capable of processing billions of calculations, without collecting or disclosing users' Country/Nation data. No personal data is downloaded to or processed from the user's device.

7 Researchers believe that in the long run this work could speed up access to effective drugs and enable tailored treatments against this infectious disease.

8 Dr Kirill Veselkov from the Department of Surgery and Cancer at Imperial College London, who is leading the research, said: "We urgently need new treatments to tackle Covid-19. There are existing drugs out there that might work to treat it, and the great thing about repurposing existing drugs is that we already know they are safe to use and so we could potentially get them to patients quickly.

Tech solution



9 "However, we have to do difficult and complicated analyses using artificial intelligence to find out which molecule or combinations of molecules might be able to disrupt the virus when it's inside the body. We want to target not just one protein but the whole network that the virus creates in order to survive. Then we can see which drugs containing these molecules might be possible candidates to fight the virus, and we can also look at which foods containing helpful molecules might boost the body's ability to fend it off.

10 "All of this takes a huge amount of computing power and DreamLab creates a supercomputer that enables us to do this important work in a relatively short timeframe."

### 11 **Speeding up the job**

12 While traditional experimental research and standard research methods could take years to develop, the mobile cloud-based processing approach of DreamLab can drastically reduce the time taken to analyse the huge amount of data that exists. A desktop computer with an eight-core processor running 24 hours a day would take decades to process the data, but a network of 100,000 smartphones running six hours a night could do the job in just a couple of months.

Tech solution



13 Instead of looking for brand new drug molecules, the project will search through a database of thousands of existing drugs that could be repurposed to fight COVID-19. As these drugs are already known to be safe, they could be used much sooner than new drugs.

14 In addition, the project will comb through a database of food molecules that could potentially boost the drugs' ability to fight COVID-19 in the body.

15 **Multiple lines of attack**

16 Coronaviruses need their hosts – us – to survive and replicate. They do this by ‘hijacking’ cellular processes, using our own proteins to help them survive. The complex interactions between the virus’ proteins and our own are called ‘virus-host interactome networks’.

17 Traditional antiviral drugs only target one of the proteins involved, but this leaves the possibility of the virus mutating to get around the roadblock created by the drug. Instead, any treatment needs to be able to tackle multiple parts of the virus-host interactome network.

18 This is where the supercomputing power of the nation’s smartphones comes in. DreamLab uses machine learning, on a mobile supercomputing network, to analyse billions of combinations of existing drug, food-based molecules and genetic interactions, fundamentally reducing the time needed to make discoveries.

19 The best treatment could include existing drugs and supportive molecules found in foods. However, mapping how combinations of molecules interact with the virus-host interactome network is very complicated, and combinations of three, four, or even more compounds would be impossible to test in the lab.

20 A member of the DreamLab collaboration, Professor Michael Bronstein from the Department of Computing Imperial College London, said: “We are using network-based AI methods to identify antiviral compounds amongst a dataset of thousands of molecules, by modelling the network effects of the interactions between these molecules and biomolecules in our body.

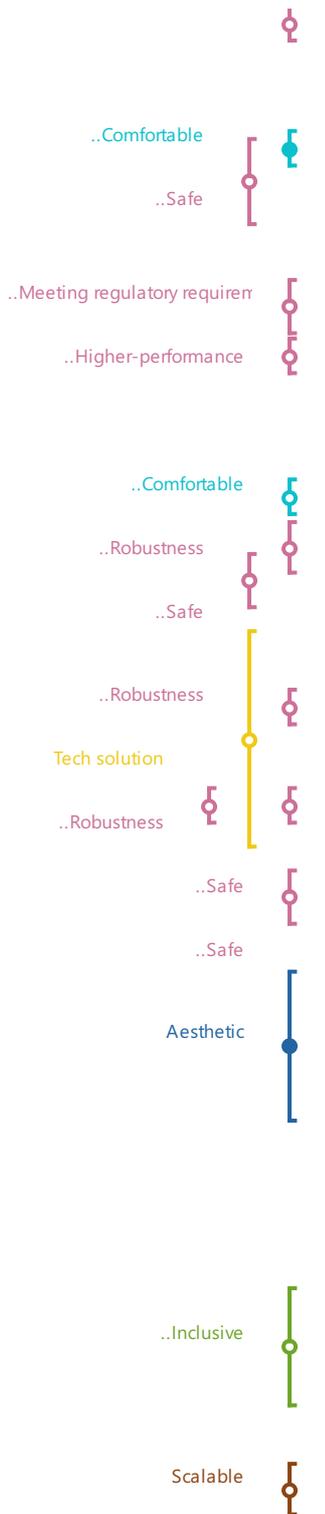
21 “We have previously successfully used these methods to find ‘hyperfoods’ containing anti-cancer drug-like compounds, are now retooling them for the new disease.”

22 Eventually, the team hopes that multi-drug therapies with supportive diets could be prescribed to help COVID-19 patients recover.

23 **Improving patient outcomes**

24 Head of the Department of Surgery and Cancer at Imperial, Professor George Hanna, said: “These are unprecedented times that demand radical and unprecedented scientific solutions. The DreamLab: Corona-AI project team have taken their knowledge and success in using AI technology to discover anti-cancer properties in existing drugs and foods and put that to use against this new global threat.”

25 Member of the project team, Dr Reza Mirnezami, Consultant Colorectal Surgeon, Royal Free Hospital, said: “The DreamLab team are working on harnessing the power of AI to identify how commonly used, approved drugs could be ‘redeployed’ in the war against COVID-19. Moreover, we are looking at how to improve outcomes in COVID-19 patients using diet, which will undoubtedly affect host immunity and gut microbial resilience.”



1 **Covid Innovation 31:** ClearMask introduces world’s first CE-marked, fully transparent surgical mask

2 *Website page (Clear Mask)*

3 Fully transparent, anti-fog masks available in the European Union to provide clear communication and safety for healthcare providers and essential workers.

4 ClearMask LLC, a privately held American medical supply company, announced today that its ClearMask™ is the world’s first and only fully transparent surgical mask that is both CE-marked and FDA-cleared. To date, no other transparent masks meet both certifications.

5 The ClearMask™ transparent surgical masks meet the CE Marking requirements as a Class I medical device under the European Union Medical Device Regulation (2017/745) and can be used in hospitals, clinics, schools, and other settings. The mask is optimized for maximum clarity and comfort, meeting applicable EN 14683 requirements for fluid resistance, microbial cleanliness, and biocompatibility, which offers a high level of protection for medical use in environments such as operating rooms.

6 In the United States, the ClearMask™ brand received FDA clearance as a Class II medical device on April 6, 2020, and meets applicable ASTM Level 3 requirements in the United States for fluid resistance and flammability. The ClearMask™ transparent surgical mask also passed additional tests in accordance with the transparent mask guidelines released by the United Kingdom, including tests for resistance to penetration of microorganisms (ASTM F1671) and visibility (EN 166).

7 During the pandemic, the ClearMask™ brand has helped provide protection against the transfer of aerosols, fluids, and sprays, and has been widely adopted as the new standard to help improve communication and trust where masks are required. With its fully transparent, anti-fog plastic barrier, the ClearMask™ brand increases visual communication, which may help avoid costly errors and adverse outcomes. As demonstrated in a first-of-its-kind study in the Journal of the American Medical Association, the ClearMask™ is also critical in establishing rapport and earning trust.

8 The company started developing the transparent mask in 2017 after their deaf co-founder suffered an adverse experience during her surgery. Traditional surgical masks blocked her providers’ faces, impeding effective communication and essential safety checks.

9 “When the pandemic began, our mission was to bring a human-centered mask to everyone who needed it, especially children, older adults, deaf and hard of hearing people, and those who heavily depend on visual communication. ClearMask continues to fight against the current pandemic and we are here to stay,” said Allysa Dittmar, President of ClearMask.

10 To date, ClearMask has provided over 18 million masks in the United States and globally. The company has partnered with several distributors, including Cardinal Health, Grainger, Henry Schein, McKesson, and Oaktree Products, and is currently onboarding distributors for the CE-marked masks. The masks can be purchased in the United States through ClearMask’s website at [www.buy.theclearmask.com](http://www.buy.theclearmask.com), and countries outside the United States may purchase the masks here.

11 **About ClearMask**

12 ClearMask, LLC is an American-based medical supply company that focuses on improving communication while making connections more human. Its products may help reduce errors and increase satisfaction by facilitating visual communication for all. For more information, please visit

 [www.theclearmask.com](http://www.theclearmask.com).

1 **Covid Innovation 32: The Evolution of Aira**

2 *Website page (TVP Health)*

3 Even before COVID-19, ventilators were in short supply and overwhelmingly expensive. Now that demand for these live-saving machines has been exacerbated by the pandemic, the situation is even more dire. The conclusion is straightforward: as the virus spreads, the problem must be addressed, and quickly.

4 In March of 2020, Tyler Mantel launched The Ventilator Project in order to pursue a solution. Founded as a non-profit, TVP sought to take a different approach than mainstream commercial ventilator companies, knowing that an alternate route could be the best way to really make a rapid impact.

..Fast 

5 As the pandemic continued to disrupt and encumber traditional medical supply chains, the engineering team began sourcing as many materials as possible from outside traditional economic channels. TVP was determined to address the ventilator shortage from the perspective of immediacy and efficiency.

..Resource-efficient 

6 During the initial design phase of the AIRA ventilator, a concept was drawn up while considering available materials. This was naturally one of the most difficult stages of the design process, but TVP persevered. On the very first day the engineering team assembled, they built their first prototype from hardware store parts—all to prove they could get positive air pressure.

..Resource-efficient   
Tech solution 

7 After a few early breakthroughs in the design, the engineering team was able to accommodate the full range of FDA requirements for the device, supporting up to 800mL of oxygen delivered in less than 0.5 seconds. By mid-April, the team had developed a full system and new exterior that was able to meter out the proper amount of air to regulate the inhale and exhale of a patient’s breath.

..Meeting regulatory req   


..Quality care 

8 As of May 1st, The Ventilator Project began testing the v6 prototype. By mid-May, development progressed to updates for the expiratory tract, alarm circuit and user interface system. The team introduced some design changes to improve both the device’s functionality and manufacturability, reducing the form factor by over 50% and optimizing the battery for the newer system. By May 22nd, TVP transitioned from internal to external testing with the help of Intertek, an international Quality Assurance facility.

..Fast 

..Quality care 

..Quality care 

9 External testing is the final stage before AIRA can be authorized by the FDA, an absolutely critical milestone that will allow the ventilator to be manufactured and distributed in the U.S.

10 The following images and descriptions paint a clearer picture of the steps involved in developing AIRA, as well as the details behind their conception.

11 **STAGE 1**

12 Stage 1 was the first iteration of The Ventilator Project’s design. Commonly known as ‘proof of concept’ in the engineering world, the simple yet productive design proved to the engineering team that positive pressure was possible through a bellows system, hence the utilization of minimalist pieces to move air with an outside air source.

..Simple 

..Resource-efficient 

13 More important than just a mechanical feat was the symbolic victory that came from Stage 1 succeeding – an acceptance letter of sorts into the program of designing a ventilator that could potentially reach the national and global market.

Scalable 

14 **STAGE 2**

15 After the success of Stage 1, Stage 2 presented an immediate need for the

..Resource-efficient  
..Simple

..Resource-efficient  
..Simple

..Quality care

..Low-cost innovation  
..Higher-performance

..User-friendly  
Aesthetic  
..User-friendly  
..Quality care  
..User-friendly

16 **STAGE 3**

17 With resources at their most expensive and innovation in high demand, the engineering team came upon the realization that an alternative to conventional respiratory technology could be found right under their noses, albeit in an unexpected form: bellows from bee smokers. This unique thought process advanced the project to Stage 3—the point of reaching a reduced force to push air. The introduction of bellows allowed the team to push a higher volume of air faster. However, even during this success there was a minor roadblock: though the bellows moved air at the right pressure, the team was only hitting the low limits of pressure necessary – not the high limits.

18 **STAGE 4**

19 Stage 4 proved pivotal in the development of a high-capacity ventilator as the engineering team took the initiative to double the number of bee bellows by stacking them. While not only doubling the volume of air made available, this also met the 3 modes of control necessary for a COVID-19 ventilator to be successful: pressure control, volume control and pressure support.

20 So, what do these different modes mean?

21 Pressure control refers to the ability of the ventilator to a constant airway pressure for a set period of time. Volume control refers to the ability of the ventilator to distribute a custom volume to the patient and pressure support means the ventilator is capable of assisting the patient’s breathing patterns without adverse effect.

22 Other modifications include a microcontroller which operated as the brain of the ventilator. Microcontrollers are very useful in that they are essentially miniature computers which execute commands given to the ventilator. These devices are cost-effective, small, and productive machinery.

23 This prototype model also was able to produce more air pressure than required by the Association for the Advancement of Medical Instrumentation, so the team modified the motor and drive system in response.

24 **STAGE 5**

25 With the internal hardware solidified, it truly became time for the engineering and design team to begin considering the functionality of the ventilator within hospitals, including its overall aesthetic and interface flexibility within those environments. AIRA needed an exterior that was both practical but could also be visually appealing, which led the team to work with industrial engineers who designed the model which excellently communicated the simplicity but practicality of the ventilator itself.

26 Stage 5 also presented the ability of this model to use computational techniques to model fluid dynamics, which optimized long-term airflow of the ventilator.

27 Perhaps one of the most important details of this stage was that the AIRA

..User-friendly  
..Essential functions/info

..Small/Portable

Aesthetic  
..Comfortable

..Small/Portable

..User-friendly

..Low-cost innovation  
..External funds/resource

now possessed an interface tablet which displayed important information and making it easier to interact with from the viewpoint of medical professionals and engineers alike.

## 28 STAGE 6 & Version 6.2

29 The Ventilator Project still had work to do: enter Stage 6. They soon realized that in addition to improvements to the ventilator's overall functionality, its size could also be dramatically reduced. After some rigorous work by the engineering team, the size of AIRA was actually reduced by an impressive 30%, greatly reducing the space necessary to house the ventilator in medical environments where it would be used. Of greater importance was the feat of the engineering team in developing our own mass flow sensor, a device used in machinery to detect the rate of airflow entering a system.

30 Version 6.2 incorporates these advancements with the industrial design specs produced as conceptual models and finalized into one final piece, pleasing in both functionality and visual appeal. Great strides were made with the inspiratory and expiratory valves, such as the integration of the expiratory system into one part. Flow regulators were also optimized in this stage, making it the most efficient seen by the engineering team at The Ventilator Project to date.

31 What about functionality? The Ventilator Project needed to fully understand the issues with modern ventilators from a full-circle perspective to create the best model thus far. TVP's product management team spent time seeking to understand the frustrations and goals of respiratory therapists working with patients so that technologies could be better customized to meet those needs.

32 The concerns therapists brought to the team's attention included confusing control systems and immovable machinery, in addition to storage challenges. Some of the more productive modifications made to this iteration as a result of this feedback was a stackable design to simplify storage in hospitals. Additionally, the unit size successfully decreased every iteration, considering the needs of transportation and storage for medical environments.

33 The Ventilator Project also addressed interface concerns by introducing a Human Machine Interface (HMI) system, making control manipulation by medical professionals more straightforward with the help of simple control software.

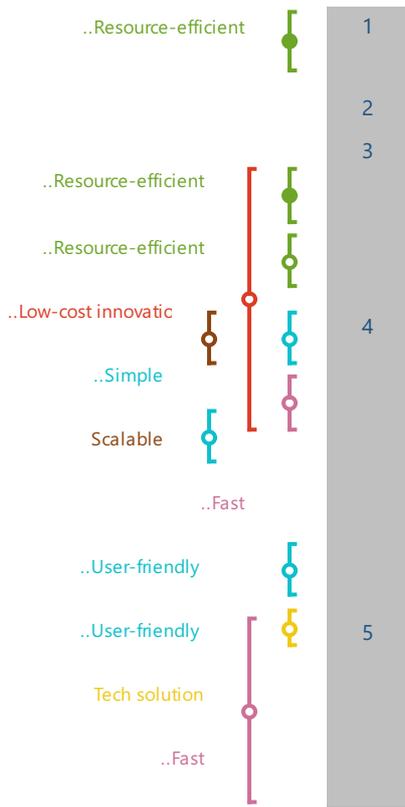
34 What made the design process for this iteration so truly fascinating is the fact that multiple members of the respiratory care team were considered in its development. Whether operated by ICU doctors to nurses and therapists themselves, the unit was constructed to be as versatile as possible.

35 Needless to say, the evolution of AIRA has been a tedious but continuously productive process. From engineering to product management, many hands contributed to the iterative development of AIRA from its meek beginnings to the streamlined, polished unit seen today.

36 However, just because the latest iteration of AIRA has been developed, this doesn't mean The Ventilator Project's fight to bring a low-cost, rapidly producible ventilator out into the world is over yet. There is still much work to be done, and a large part of that comes down to our donors. Quite literally every dollar moves us forward, whether it be to propel TVP through FDA authorization, or to simply buy snacks to keep our hardworking team of engineers well-fueled.

37 We need your help. If you're able to contribute there's no better time to do it than now. Your contribution greatly aids not just what we're doing here at

 The Ventilator Project, but also all those who we seek to impact.



1 **Covid Innovation 33: foster + partners shares template for a reusable face visor to aid the fight against COVID-19**

2 *Magazine Article (Designboom)*

3 Since the outbreak of COVID-19 many architects and designers have joined the effort to fight the pandemic. with a number of studios utilizing their 3D printers and laser cutters to produce vital face shields, foster + partners has now shared a template for a general-purpose visor that can be cleaned and reused.

4 Composed of just three pieces, the prototype has been designed with the aim of facilitating quick mass production of the visors. using a zund G3 M 2500 cutting machine, or its equivalent, an incredible 217 visors can be cut every hour. the british-based practice hopes that by sharing the templates and material specifications as an open-source resource other studios and manufacturers will be encouraged to use their laser cutting machines to produce the much-needed equipment for those on the frontline of COVID-19. the file for digital flatbed cutters and the assembly instructions can be found on the foster + partners' website here.

5 The templates, which are for digital and laser cutters, offer a quicker turnover than masks produced by 3D printing. each visor can be cut in under 30 seconds and assembled in under a minute. alternatively, the face shields be flat-packed and distributed quickly in large quantities. using their digital flatbed cutter foster + partners has been able to cut and assemble components for 1,000 masks in a single day.

## Erklärung\*

Hiermit erkläre ich,

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Dozent/in Prof. Dr. Bernd Ebersberger

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Semester

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Hohenheim, 15/02/2022 Mustaj Arjela

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