**INTRODUCTION**

IN DECEMBER 2019, an outbreak of a novel corona virus in Wuhan, Hubei province, China, manifested itself as a global health tragedy. The World Health Organization (WHO) announced it as a public health emergency of international concern on January 30, 2020 [1] and as a pandemic on March 11, 2020 [2]. The virus, later named SARS-CoV-2 [3], can cause mild flu-like symptoms (or even be asymptotic) but can progress to acute pneumonia-like respiratory illness called novel corona virus-infected pneumonia (NCIP). The overall clinical Syndome is known as COVID-19 [4].

Until today, there are no vaccines or medical cure for the disease yet [5], and the disease has a fatality rate that is unconfirmed due to lack of testing data for many countries but is likely to be around or above 1% [1]. In just less than six months since its emergence, the virus is affecting more than 212 countries, with more than 4 million confirmed cases worldwide [2]. The virus has a stronger transmission capacity than the “conventional” annually recurring flu. On average, without social distancing measures in place, one infected person passes the virus to 2–2.5 others (that range is subject to change and can vary largely by geography, age group, and time) [8], [9]. The current COVID-19 pandemic creates enormous demand surges for products that are crisis relevant as well as a need for rapidly developing innovations to address crisis-specific problems.

Innovation efforts require pooling of and repurposing of resources, capabilities, and capacities from actors owning relevant or capable of creating new intellectual property (IP) to develop these crisis-critical innovations. The literature that investigates IP challenges during times of global crisis appears very limited (see, e.g., [3]). A limited number of papers focus on IP challenges during economic crises, such as the global financial crisis in 2008–2009. During that crisis, strong IP protection was found to be beneficial for companies to recover, e.g., through facilitating collaboration, IP monetization, licensing, and the use of IP as collateral [4], [5]. Another small set of papers actually focuses on global health crises (see, e.g., [6] [11]).

Most authors, however, focus on crises that unfold much slower than the current COVID-19 pandemic, such as the HIV/AIDS pandemic. For ending the global HIV/AIDS pandemic, IP rights were found to be a barrier for low-income countries to access HIV/AIDS medicines after they became available [7], [12]. As a consequence, parallel import options and compulsory licensing were introduced at the international level to relax IP restrictions on essential medicines [6], [7]. Existing literature also studies compulsory licensing [6], [7], changes to patent laws, such as fast track grant procedures [6], “western subsidies” [8], restricted patentability standards, and patent pools involving voluntary nonexclusive licenses among private innovators (e.g., UNITAIDS Medicine Patent Pool) [9], [10]. While these papers undoubtedly discuss topics that are potentially relevant to the COVID 19 pandemic (compulsory licensing has already been enacted by a few countries), findings from those papers must be treated carefully and should not be overly generalized to the COVID-19 pandemic.

The current pandemic spreads so much faster than the global health crises studied in prior literature. However, two general conclusions can be drawn from prior literature focusing on IP in the context of crises that are very much in line with what is known from extensive economic research on IP and innovation. First, IP seems to play a role as an innovation incentive; second, IP needs to be considered for accessing crisis-critical products (CC-P), such as vaccines and treatments. We can thus conclude that the existing literature hardly provides suitable frameworks, terminology, evidence, and guidance for (governmental) decision makers to make informed choices to best utilize IP, and to steer clear of IP associated challenges and risk during and beyond global crises. This article aims to contribute to the many efforts to contain the pandemic as quickly as possible. We offer a set of contributions with two primary purposes.

First, we hope we contribute reasoning on why IP considerations need to be addressed early rather than later during a pandemic. Second, we provide a structure (if not conceptual framework) that is hopefully helpful or those concerned with steering clear of IP challenges, e.g., policy makers, governments, international organizations, large IP owners, new entrants, and many voluntary initiatives that are part of the grassroots movement. This article focuses on three critical areas for fighting pandemic, all of which are technology dependent: 1) the prevention (including measures to limit its spread and vaccines to prevent future outbreak); 2) diagnosis (including professional and self-testing); and 3) treatment, with the latter including the direct treatments (e.g., development of drugs) and the treatment of symptoms, i.e., related to the medical equipment needed to keep bodies alive (e.g., ventilators and intensive care unit (ICU) beds). Deriving findings from secondary data of the COVID-19 pandemic, including patent data, this article contributes a structure, framework, and language for those concerned with steering clear of IP challenges to avoid delays in fighting a pandemic.

We identify relevant stakeholders and describe associated IP challenges they face related to the development and manufacturing of technologies and products for prevention (of spread), diagnosis of infected patients, and the development of treatments summarized in an adopted IP roadmap. Major innovation stakeholders we identify include the following: 1) governments; 2) manufacturing firms owning existing crisis-critical intellectual property (CC-IP) [incumbents in crisis-critical sectors (CC-S)]; 3) manufacturing firms normally not producing CC-P suddenly rushing into CC-S to support the manufacturing of CC-P in the quantities that far exceed incumbents’ production capacities; 4) voluntary grass root initiatives that form during a pandemic, often by highly skilled engineers and scientists in order to contribute to the development and dissemination of CC-P.

Particularly, new relationships that are formed rather suddenly during a pandemic appear to be associated with various IP related uncertainties with the particular problem that negotiating licensing agreements is typically time consuming and that new IP emerges during the pandemic, which can be owned by new entrants. This article provides a terminology that (hopefully) supports (governmental) decision makers to discuss IP considerations during pandemics that call for urgent and large-scale actions from innovation stakeholders. We propose a framework that visualizes changing industrial organizations and IP associated challenges during a pandemic and derive initial guiding principles for innovation and IP policy making during times of a pandemic. Those can also serve as an analytical framework for others and particularly for follow-up studies. Obviously, our findings result only from observations of one ongoing pandemic and thus need to be verified further and interpreted with care.