

Inter-Organizational Data Sharing during COVID-19 Health Emergency: Lesson Learnt from Veneto and Lombardy Regions

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Abstract

The importance of data driven decision making in evidence based public health has significantly risen with the aim of answering today's challenges and of providing new sustainable solutions. However, the advent of big data and data sciences techniques poses new challenges in terms of data sharing as multiple sources of data imply multiple stakeholders involved. Although the potential impact of data sharing among public organizations is widespread, several initiatives of cross-organizations information sharing fail. While revealing the necessity of cooperation between organizations to cope with the health emergency, the current pandemic COVID-19 has shed light on the complexity of inter-organizational data practices. In the last few years, several attempts have been made by the authors to identify factors affecting information sharing in the public sector. The framework developed by Yang and Maxwell (2011) summarizes the main insights from existing literature, providing a comprehensive overview of factors impacting data sharing initiatives and classifying them into technological, organizational and political factors. The aim of this research study is to investigate factors that hinder data sharing initiatives put in place to deal with the health emergency. To this end, we rely on multiple case studies. The Lombardy and Veneto regions were selected because the epidemic was initially concentrated in these two regions. The first hotspots of COVID-19 cases were identified in two geographical areas located in the Lombardy and Veneto regions, and stringent measures were introduced to contain the epidemic. The analysis of the case study is used to gain concrete, in-depth knowledge about inter-organizational data sharing in the context of epidemics. The findings of this research study confirm some of the relationships between technological and organizational factors and the success of the data sharing initiatives in the context of an emer-

gency, as well as extend the proposed framework exploring further sources of complexity.

Keywords

Data Sharing, COVID-19, Public Health, Inter-Organizational Data Sharing, Bio-Surveillance

1. Introduction

Revealing the necessity of cooperation and coordination to cope with a health emergency, the current COVID-19 pandemic shed light on the relevance of inter-organizational data sharing for the bio-medical research community and for policymakers. The former leveraged international data sharing for the rapid accumulation of valuable knowledge. By sharing information, from the initial genome sequencing of the corona virus to the incubation period and effectiveness of safety measures, the international data sharing practices put in place among researchers significantly contributed to scientific progress (Rios et al., 2020; Rodríguez-Flores et al., 2022). Although secondary data used for research purposes is recognized as a complex process attracting strong debate within the research community and beyond (Hutchings et al., 2020), the sharing of data and information between researchers in the context of the outbreak has been facilitated by digital platforms and already established guidelines supporting the standardization of data and metadata regardless of the area of study (Rios et al., 2020), i.e. The FAIR principles (Wilkinson et al., 2016). A concrete example of the impact of international data sharing is represented by the results achieved by the GISAID data sharing platform, which gathered more than 450,000 viral genomes in 1 month and was defined as a game changer in the pandemic by the World Health Organization (WHO)¹. With regard to intervention planning and policy-making, inter-organizational data sharing is a crucial activity for surveillance purposes. The usage of surveillance systems in collecting, analyzing and interpreting data for controlling outbreak spread (Thacker & Berkelman, 1988) is widely recognized by researchers and practitioners. Real-time monitoring of infectious disease spread and early warning detection are important objectives of public health surveillance systems aiming to minimize the morbidity and mortality caused by an infectious disease (Yan et al., 2017). In the last few years, the target of surveillance systems has not been limited to the increase of situational awareness but was extended to the prediction of outbreak status and the design of intervention plans (Cori et al., 2017; Desai et al., 2019). Indeed, by understanding heterogeneity in infection transmission in time, place and person, it is possible to determine risk factors and design effective interventions (Budd et al., 2020).

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While the impact of inter-organizational data sharing within the research community during the health emergency was recognized (Rios et al., 2020), data sharing initiatives for policy-making and intervention design have not been equally successful. In the last few years, several attempts have been made by the authors to identify factors affecting information sharing in the public sector. The framework developed by Yang and Maxwell (2011) summarises the main insights from existing literature, providing a comprehensive overview of factors impacting data sharing initiatives and classifying them into technological, organizational and political factors (Yang & Maxwell, 2011). Leveraging a multiple case study, this paper aims to investigate factors influencing data sharing in the context of a health emergency.

In order to provide a clear and in-depth understanding of the data sharing process and the factors hindering the success of initiatives, the concept of data sharing is extended to include all the phases of a data lifecycle. Previous studies on factors influencing data sharing initiatives limited the concept of data sharing to the activity of making data available to other organizations, thus disregarding other elements of data sharing. Other scholars broke down the data sharing process into a three-phase process, comprising a data deposition phase, an integration phase and a translation phase (Zhang et al., 2020), therefore including the last phase of a data lifecycle, which involves the translation of data into actionable knowledge shared among actors belonging to the ecosystem. In this paper, the hypothesis put forward by the authors and summarized by Yang and Maxwell are tested through the different phases of the process to gather insights on the impact of the health emergency on factors influencing data sharing and to shed light on interventions put in place by regional and local authorities to facilitate data sharing across organizations. To this end, we rely on multiple case studies. The Lombardy and Veneto regions were selected because the epidemic was initially concentrated in these two regions. The first hotspots of COVID-19 cases were identified in two geographical areas located in the Lombardy and Veneto regions, and stringent measures were introduced to contain the epidemic (Sebastiani et al., 2020). The analysis of the case study is used to gain concrete, in-depth knowledge about inter-organizational data sharing in the context of epidemics.

The remainder of this paper is organized as follows. In the next section, the research studies related to inter-organizational data sharing factors are presented. Section number three describes the research context by providing an overview of the Italian healthcare system with a focus on Veneto and Lombardy. In the fourth section, the methodology adopted for case selection, data collection, data coding and case analysis is introduced. In the fifth section, the multiple case studies are presented. Results and conclusions are discussed in the final section.

2. Related Research

The elements of data sharing have been systematized by authors (Zhang et al.,

2020) because of the apparent importance of defining supporting elements for successful implementation of data sharing processes. The overall data sharing process involves three fundamental elements of data management: data deposition, data integration and data translation (**Figure 1**). The first element refers to the provision of data made accessible to other organizations. Secondly, data integration involves the combination of data coming from different sources into a database that provides a unified view of them. The final element, i.e. data translation, refers to the last phase of the data lifecycle, translating data for effective use by multiple stakeholders. Indeed, the data sharing process is not an objective but rather an effort to translate data into actionable information.

The topic of inter-organizational data sharing has been widely investigated by authors seeking to understand the reasons behind the failure of such initiatives. Although several attempts have been made to systematize factors affecting data sharing in the public sector's (Bigdeli et al., 2013; Fan et al., 2014; Janssen et al., 2016), Yang and Maxwell (2011) research provides a comprehensive model based on an extensive literature review. The framework provided by the two authors seeks to summarize existing research on factors impacting the success of data sharing practices in a combined model. The framework developed includes several factors that have an impact on data sharing in the context of public sector, including a public sector organization's adoption of information sharing systems, but it also includes the use of information sharing with other organizations that are not part of the public sector. Some of the factors influencing data sharing practices were classified by authors into variables that directly impact the dependent variable and variables, the effect of which is mediated by an intervening variable referred to as the mediator (indirect effect).

The conceptual framework developed at the inter-organizational level adopts three different perspectives introduced by Dawes (1996) and Zhang et al. (2005): the technological, organizational and policy perspectives (**Figure 2**). With respect to the technological perspective, authors emphasized the challenge deriving from integrating heterogeneous databases having inconsistent data structures and definitions (Bajaj & Ram, 2003; Gil-Garcia et al., 2009; Matsunaga et al., 2007) and heterogeneous IT systems (Atabakhsh et al., 2004; Chau et al., 2002; Chen et al., 2007; Fedorowicz et al., 2007; Gil-Garcia et al., 2007; Gil-Garcia et al., 2009; Lam, 2005; Pardo et al., 2004; Zhang & Dawes, 2006). Hindering interoperability of IT systems, the problem of heterogeneity in terms of hardware and software

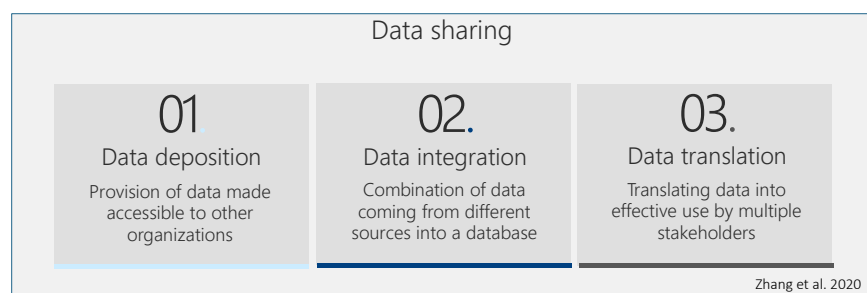


Figure 1. Data sharing elements adapted from Zhang et al. (2020).

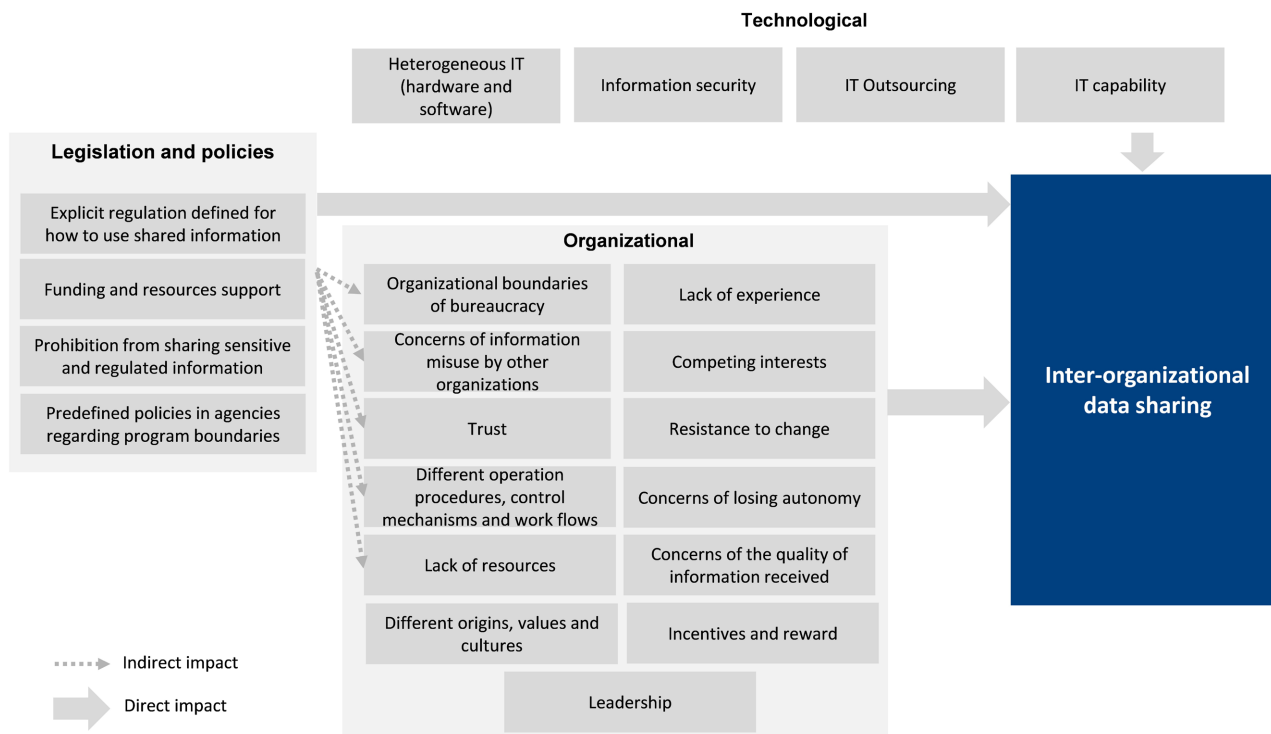


Figure 2. Factors influencing information sharing (Yang & Maxwell, 2011).

has been addressed by introducing technical solutions aimed to combine harmonized datasets and standards for data format, variables and metadata. Nevertheless, technical solutions are not widely available to public health agencies (McNabb, 2010; Virnig & McBean, 2001), and the usage of standards is not widespread in the public health context.

A second technological issue concerns the need for guaranteeing the security and confidentiality of data, which can be handled by introducing access authorization and authentication for accessing data shared (Chau et al., 2002). A further element increasing the complexity of inter-organizational data sharing is produced by the fact that IT systems are often outsourced to contractors. Hence, organizations may be not fully aware of specification details on the IT system adopted (Beyah & Gallivan, 2001; Sullivan & Ngwenyama, 2005). Finally, the IT capability of the organization is another determinant of the success of data sharing activities (Akbulut et al., 2009; Fedorowicz et al., 2007; Kettani & Mahdi, 2008; Lam, 2005). Nevertheless, researchers pointed out those technological factors are less critical when compared to organizational and political barriers (Atabakhsh et al., 2004; Brazelton & Gorry, 2003; Landsbergen & Wolken, 1998; Landsbergen & Wolken, 2001).

From the organizational perspective, the authors suggested several factors influencing the data sharing process between different organizations. Complexity in inter-organizational data sharing may originate from different origins, values and cultures of the organizations involved. Differences in values may imply competing interests and, therefore, misaligned objectives among organizations

(Atabakhsh et al., 2004; Fedorowicz et al., 2007; Kim & Lee, 2006). According to Drake et al. (2004), cultural differences of people working within the organization influence the awareness of information that can be the object of sharing (Lam, 2005; Landsbergen Jr. & Wolken Jr., 2001). In this respect, the authors pointed out the relevance of the awareness of the existence of information and the trust put on the quality of the information received as factors enabling data sharing between organizations. Furthermore, even when organizations are aware of the presence of information outside their boundaries, they may lack awareness on the potential benefits of data sharing. According to the authors, the limited benefits perceived by organizations are linked to a lack of experience. As a result, the less awareness of existing information and on the potential benefits deriving from data sharing activities, the higher the impact on existing data sharing initiatives taken (Lam, 2005; Landsbergen & Wolken, 2001). In the context of inter-organizational data sharing, trust represents a pivotal factor enabling information sharing to work in practice (Chau et al., 2002; Dawes, 1996; Landsbergen & Wolken, 2001; Pardo et al., 2004). Trust is the willingness of organizations to rely on the future use of information from another organization (Karlsson et al., 2017). The concept of trust has also been investigated in relation to the concerns of autonomy loss and information misuse by other organizations. Researchers indicate that their concerns for information misuse by other organizations can affect data sharing by increasing the fear of incurring liabilities for the sharing organization. This may hold true also in the case of collaborating organizations where one of the two organizations consider as misuse what is considered as legitimate use by the other organization (Bellamy & Raab, 2005; Chau et al., 2002; Zhang et al., 2005). Another element facilitating cross-boundary data sharing is leadership through the provision of vision, guidance and resources. Leadership can be exercised with different approaches, such as executive involvement, formal authority and informal leadership (Gil-Garcia et al., 2007). Researchers pointed out that differences in procedures add complexity to the process and may hamper the data sharing activities (Canestraro et al., 2009; Pardo et al., 2004). Differences in operation procedures, control mechanisms and workflows refer to how and to what extent working processes support information sharing activities. As there might be a need to adapt the working processes of one organization to the other, individuals belonging to the organization may be reluctant to change because of inertia and loss of personal benefits (Lazer & Binz-Scharf, 2005).

A lack of resources can also hinder data sharing initiatives. The lack of resources is related to the importance of data sharing activities and to the expected benefits (Karlsson et al., 2017). As organizations have limited resources, if benefits of information sharing activities are expected in the long run, these activities may be postponed to give priority to more urgent needs (Bigdeli et al., 2013; Fan et al., 2014; Landsbergen & Wolken, 2001; Zhang & Dawes, 2006). This is particularly true in the public health settings, where resources are chronically lacking (Morse, 2007; Pisani & Abouzahr, 2010; Rudolph & Davis, 2005). Furthermore,

as collecting, structuring and storing data is a resource consuming activity, organizations may be unwilling to share data without being compensated (Chau et al., 2002; Pardo & Tayi, 2007). Personal and institutional incentives are therefore required to foster data sharing activities (Fan & Yu, 2007; Lopez, 2010).

With regard to the political and policy perspectives, legislation and policies impact data sharing activities across organizations. Legislation and policies refer to the regulatory frameworks required to guide information sharing between organizations. In the context of inter-organizational data sharing, Dawes (1996) pointed out the issue of the legal framework and the need of defining interagency agreements and common legislations for authorities, which was confirmed afterward by several studies (Gil-Garcia et al., 2009; Lam, 2005; Pardo & Tayi, 2007). Bigdeli et al. (2013) identified environmental factors such as politics and legislation as the most relevant factors influencing information sharing between public organizations, emphasizing the role of central government in facilitating data sharing. However, according to existing literature, legislations and regulatory frameworks have both negative and positive effects on data sharing practices. On the one hand, legal regulatory frameworks can produce increased trust between participants and lower risk concerns, thereby facilitating relationship building among participants (Atabakhsh et al., 2004; Landsbergen & Wolken, 2001; Zhang & Dawes, 2006). Legislations and policies can, therefore, positively influence the data sharing process in an indirect manner with trust as a mediator. Furthermore, support from policymakers can ensure the sustainability of the data sharing project by providing funding and resources (Dawes, 1996; Zhang et al., 2005). On the other hand, laws and legislations on personal and sensitive data have a direct negative effect on information sharing practices as information sharing between organizations may not be allowed by legislation (Dawes, 1996; Gil-Garcia et al., 2007; Gil-Garcia et al., 2007; Zhang et al., 2005). To solve this problem, authorities should clearly define the conditions under which sharing of sensitive and confidential data is allowed (Dawes, 1996; Lam, 2005; Landsbergen & Wolken, 2001).

Figure 3 shows the research framework adopted for the purpose of the study and adapted from previous research (Yang & Maxwell, 2011; Zhang et al., 2020).

3. Research Setting

The Italian healthcare system is a region-based national health service providing free universal coverage at the point of delivery and is organized at three different levels: national, regional and local. Taking a stewardship role, and national health authority (Ministry of Health) sets objectives and principles determining the core benefits package of services delivered to the population and allocates resources across regions. Monitoring the overall health system, the Ministry of Health is supported by a number of permanent government agencies: 1) The National Institute of Health (ISS) carries out scientific research, surveillance, public

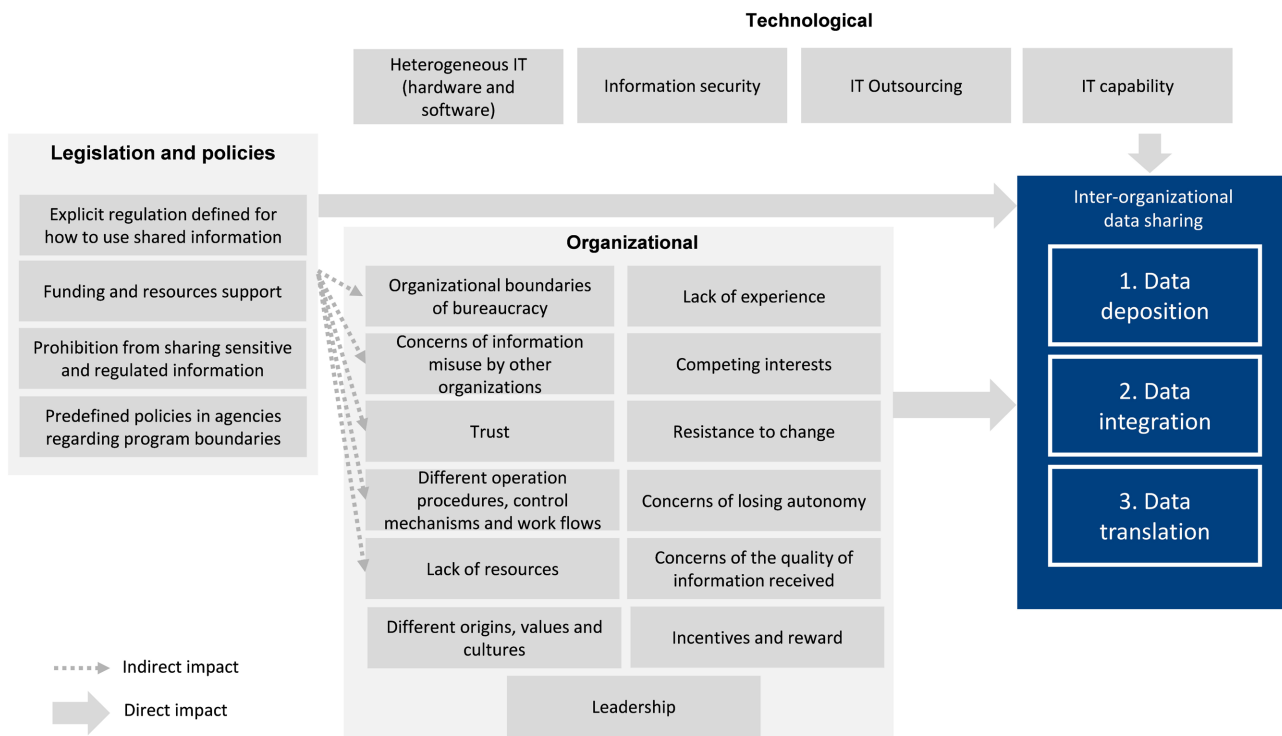


Figure 3. Research framework (adapted from Yang & Maxwell (2011) and Zhang et al. (2020)).

health promotion and knowledge dissemination, 2) the National Agency for Regional Health Services (AGENAS) acting as the interface between the Ministry of Health and regional authorities, 3) the National Centre for Disease Prevention and Control (CCM) coordinating national and regional authorities for surveillance, prevention and health emergency response, 4) the AIFA, the national authority for pharmaceutical regulation, and 5) the National Institute for Scientific Research (IRCCs).

The regions are in charge of organizing and managing the healthcare services. Legislative activities carried out by regions include the definition of general principles and organization of the regional healthcare system, the definition of criteria for financing healthcare providers and the technical and management guidelines for service provision and planning. From an executive perspective, the various Regional Department of Health is in charge of drafting the three-year Regional Health Plan, coordinating health and social care and managing Local Health Care Trust (LHTs). Regions may be supported by regional agencies in the executive functions by providing technical and scientific support to Local Health Care Trust (LHTs). During the COVID-19 pandemic, the regional agency for health services oversaw the regional level surveillance process, including the collection and the integration of different data flow coming from different local nodes for the real-time monitoring of the virus spread. LHTs are responsible for delivering public health and community health services and direct primary care (Ferre et al., 2014). Representing the linchpin of the healthcare system, local health units and social-care units are in charge of delivering health services to

the population living in the surrounding area. Besides delivering medical services, LHTs have access to health services delivered by hospital enterprises, private accredited providers and the national hospitals for scientific research, with whom supply agreements are established. A network of general practitioners (GPs) provides family medicine services. Secondary and specialist care is delivered either directly or through public hospitals, national hospitals for scientific research and accredited private providers (Ferre et al., 2014). Also referred to as hospital trusts, hospital enterprises are organizations converted to autonomous enterprises responsible for delivering healthcare services. Research hospitals are organizations that integrate scientific research into clinical care, ensuring the provision of diagnostic and treatment services according to standards of excellence, both in ordinary hospitalization, including day hospital and day surgery, and outpatient procedures. Private accredited health providers are private clinics that are compliant with the requirements and standards defined by municipalities, regions and local health providers. Differences in the level of decentralization of the regional organizations are the results of exclusive authority in executive planning and delivery of health services. Tuscany, for instance, designed a highly centralized system where most of the hospitals are controlled by LHTs. The Lombardy region, on the other hand, opted for a more decentralized structure converting the main hospitals to hospital enterprises free to financially negotiate with LHTs.

An overview of the Italian healthcare system adapted from the previous study is presented in Figure 4.

In the Veneto area, the healthcare service is provided by nine local health and social-care units, two public hospital enterprises, (*Azienda Ospedaliera di Padova* and *Azienda Ospedaliera Universitaria Integrata di Verona*), one national

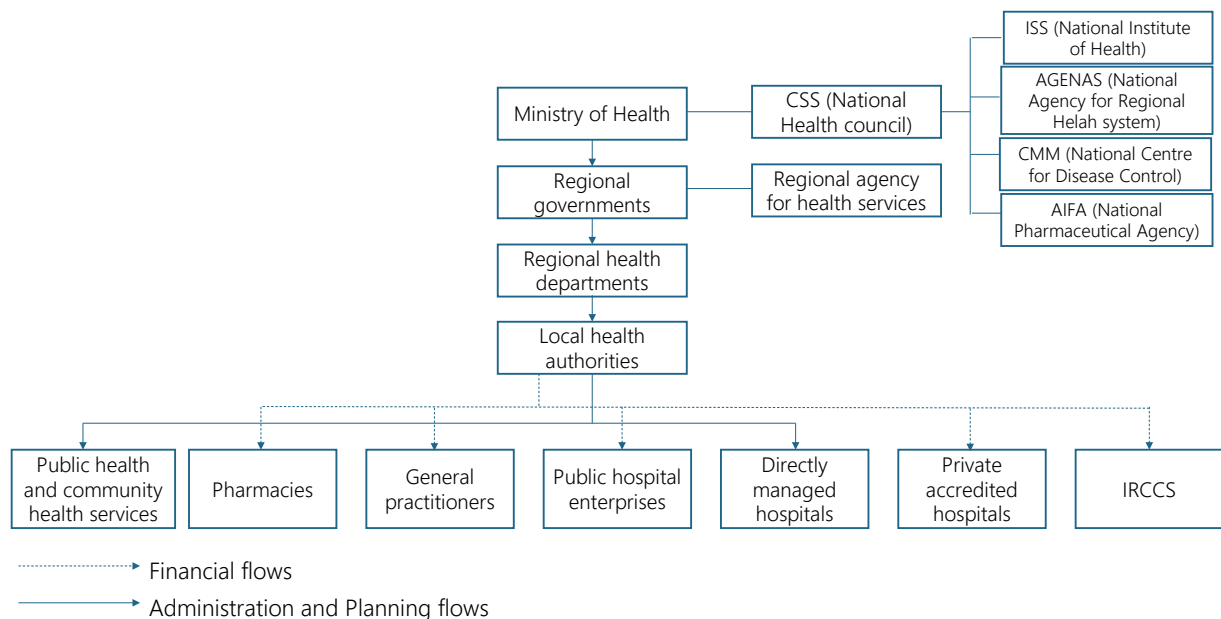


Figure 4. Overview of the Italian healthcare system (Adapted from Ferre et al. (2014)).

hospitals for scientific research (*Istituto Oncologico Veneto*) and private accredited providers ([World Health Organization, 2016](#)) serving a population of about 5 million people. In Lombardy, the healthcare system serves a population of about 10 million people, providing healthcare services through eight Local Health Care Trust, 27 hospital enterprises and four national hospitals for scientific research.

Health information management

Local and regional health authorities are responsible for the collection, processing and dissemination of data relevant to protect public health. Over the last decades, several projects were carried out with the aim of increasing the digitalization level of healthcare organizations and fostering coordination among local, regional and national information systems. As a result of the decentralization of NHS, heterogeneity in the level of digitalization of information flow between regions is observed. A recent project referred to as the ARCHES Project took a census of health electronic databases existing in Italian regions describing the main characteristics such as structural peculiarities, accessibility, completeness, accuracy, geographical variability and the potentialities of their use in epidemiology. As of 2019, 23 and 14 regional healthcare utilization databases were developed by Veneto and Lombardy, respectively. Considering the geographical distribution of HUDs across regions, the number of HUDs ranges from 39 to 6, with Veneto and Lombardy Region ranking fourth and eleventh respectively out of 19 regions ([Skrami et al., 2020](#)).

4. Methodology

Drawing the attention of scholars, factors influencing inter-organizational data sharing have been widely investigated by academicians seeking to provide an explanation for the failure of data sharing initiatives. Building on existing valuable knowledge on the topic, this study relies on a multiple case study with data sharing process as a unit of analysis. The usage of a case study as a research strategy fits the need of examining contemporary phenomenon and processes in a real-life context ([Yin, 1981](#)). Enabling the explanation of the impact of contextual characteristics on the phenomenon that is the object of the study this methodology proved to be in line with the need of investigating data sharing practices in the context of the outbreak. The choice of a multiple case study allows researchers to provide more robust results by seeking convergent evidence ([Yin, 2009](#)).

Following an empirical sampling strategy, the cases were selected according to the impact of the outbreak in the geographical area. Veneto and Lombardy were selected as the epidemic was initially concentrated in these two territories ([Sebastiani et al., 2020](#)). On 23rd and 24th of February, the first two hotspots of COVID-19 cases were identified in Lombardy and Veneto regions. Moreover, considering the overall impact of the outbreak as of September 2022 in terms of an absolute number of positive cases, these two areas were the most affected regions in Italy. Overall, in these two regions, 3.54 mln and 2.25 mln positive cases were reported respectively.

In order to provide a comprehensive picture of the two regions, documental analysis methodology was combined with semi-structured interviews. The documental analysis focused on secondary sources. In the first step, the use of secondary sources provided the background information required to investigate the case. These sources included regional planning legislation reports, websites and press articles. The available grey literature was then exploited to derive insights to be analyzed as part of the research process. In this phase, conference proceedings and presentations, white papers and other reports were exploited to derive hypothesis on insights and to develop the questionnaire. The primary source of information for this study is semi-structured interviews representative of regional bodies dedicated to the management of information and data flows across the region. For the interview, open-ended questions were formulated to guide the discussion with informants. We conducted semi-structured interviews of 60 minutes with the IT director of the regional body of the Veneto regional health system and with the general manager of the Regional Body for Innovation and Procurement of Lombardy Region. All the interviews were recorded, transcribed and coded. Materials and insights were verified by informants. The triangulation of information collected from multiple sources contributed to the increase of reliability and credibility of results by reducing bias (Yin, 2009).

The data analysis phase included a structured content analysis procedure. Categories and codes were defined according to the theoretical research framework. Examining data paragraph by paragraph, we identified constructed codes in the text. Codes were then associated with categories and linked to the different stages of data sharing process identified by Zhang in 2020, namely the data deposition, integration and translation phases.

5. Case Study

From the beginning of the SARS-CoV-2 outbreak, the Veneto and Lombardy regions adopted an emergency plan to manage the health emergency. To manage the medical activity, local measures adopted to deal with the health emergency, preventing the breakdown of the regional healthcare system, included the creation in every hospital of separated pathways for patients with COVID-19, the increase of the ICU (Intensive Care Unit) and Medical Ward capacity and the development of specific process flows and protocols for the management of COVID-19 patients to be shared among hospitals (Pasin et al., 2020). Two different strategies were adopted for controlling the spread of the virus. Veneto Region adopted the territorial model of management, as opposed to the in-hospital management, which implies the increase of swab tests among population, enabling early treatment of patients and reduction of hospital admissions (Mugnai & Bilato, 2020). On the contrary, Lombardy Region strengthened hospital services to meet the increasing demand for hospitalization and intensive care (Odone et al., 2020). What the two strategies have in common is the central role of surveillance

process and tools for the early identification of positive cases and for the management and control of clusters. Data on swab tests were integrated in real time in an integrated bio-monitoring system, which collects and integrates information on work, school and family members of positive cases. The biosurveillance system adopted is a data-driven and cloud-native system that collects data coming from different sources, integrates and harmonizes them to foster monitoring activities. The System, named Eng-DE4Bios, has been developed by one of the main players in the field of digital transformation of public and private companies and organizations in collaboration with Veneto Region and the Regional agency for health services. The real time monitoring process enables 1) the geo-localization of positive cases, 2) the identification of clusters, 3) the development of targeted intervention plan, 4) the prediction of the outbreak evolution, and 5) the evaluation of the action plans in terms of effectiveness.

Information flow

Initially, the surveillance platform was designed to collect COVID-related health data, namely molecular and serological test results from laboratories and hospital admissions from emergency departments. Combined and integrated with personal data gathered through Regional or National registers, these data enable the development of a dashboard on the health conditions of citizens. Involving several organizations as data owners, the collection of health data from laboratories and hospitals was one of the most critical activities. Although the Health Information Exchange system was already deployed for sharing information among healthcare stakeholders such as laboratories and hospitals, the IT infrastructure and procedures turned out to be inadequate for this purpose. In the emergency context, the priority was the early implementation of the data sharing system and the involvement of the most critical data owners. Hence, new technological solutions able to satisfy the need to respond promptly and effectively to emergency were adopted. According to the informant for Veneto Region: “If we would have asked them (laboratories) to respect all the constraints the electronic health record is subject to in terms of security, authentication procedure and a number of other elements, we could not have been able to involve them in such a short time”. Cloud-based storage services were used to collect and manage data objects sent by laboratories and hospitals. Simpler data format (.csv) used for sharing information contributed to speeding up the implementation of the data sharing processes by fostering the involvement of organizations. In this phase, the deposition of data was managed centrally to ensure standardization of data records in terms of data format and data content. Technical specification together with descriptive guidelines provided clear indications on data records type, mandatory fields, and subfields to data owners. In the first place, just few selected information was gathered from laboratories. As claimed by the informant for Veneto Region “If you collect few but relevant data you can easily standardize and process them. If the project were built from the beginning with the idea of collecting as much information as possible probably...no, almost cer-

tainly we would not be where we are now". Standardization of data format and content was further supported by assistance to data owners during the initialization phase.

At a later stage, both regions scouted further available information flows to be integrated with health COVID data aiming at providing relevant insights to local and regional authorities. In Veneto Region, information flows combined with health data included data on healthcare workers' profiles and workplaces, information on residential care homes and their residents, information on family members of citizens from the tax registries and information on individuals' employment, workplace and work colleagues. To what concern workplace information, it is worth highlighting the relevance of the project *Back2Veneto* carried out by Veneto Region to involve companies located in the Veneto area in the healthcare ecosystem. The project entailed a handbook for companies, including the establishment of a COVID manager within each company, an intervention plan and specific operational instructions. Regional authorities incentivized the integration of this information flow to facilitate early identification of clusters within companies' facilities. The combination of other sources of information with health COVID data was pivotal for enabling the timely identification of clusters in specific sites in Veneto area. In this connection, the informant claimed several times the relevance of timeliness, even at the expense of data quality. The specificity of the context and the distinctive feature of the health emergency context were emphasized by the informant claiming that during such a health emergency, what matters is to timely have data even if they are not accurate. One of the main weaknesses of traditional contact tracing activities is indeed the time required to do interviews and collect data. When the number of positive cases increases, delay in the information gathered through contact tracing activities may occur, hence limiting the timeliness of interventions. In these cases, having the possibility to rely on other information flows may enhance the effectiveness of the monitoring activities. In Lombardy Region, other information flows included the list of healthcare workers' profiles and workplaces. In this area, there were no already available aggregated information flows with a unique personal identifier on family data and residential care guests. Regarding the involvement of private companies, regional authorities did not provide guidance for data sharing.

The platform

The platform was first designed to provide timely and updated information on the health conditions of individuals. Automated integration and harmonization processes of COVID-related health data gathered from multiple sources enabled real time processing of data. The integration process includes the cleaning of data and the combination of personal identifying information with health COVID data. In this phase, errors attributed to mistakes in the deposition phase were identified and individually checked. The check procedure activated a prompt feedback loop. Laboratories and hospitals were contacted to clarify the technical

specifications of data records in terms of content and data format. According to both the informants, the major difference with data integration procedures under ordinary circumstances was the timeliness. In the emergency context, the feedback loop was activated within a few hours to prevent errors and reworks. A schematic representation of the bio-surveillance systems with a focus on data sources, data flows and data users are presented in **Figure 5**.

Developed to provide specific insights to several stakeholders, the platform first aimed at informing the local task force on the real-time evolution of the outbreak, providing simulation tools and insights on clusters requiring attention, such as nursing homes and working place. Secondly, dashboards with real-time updated epidemic indicators are provided to healthcare professionals to monitor the state of the pandemic and to evaluate the availability of the workforce in healthcare facilities. Thirdly, it is aimed at informing GPs on the current health state of their patients. In Lombardy Region, data users include also municipalities having access to data for the control of territory acting as delegate of the prefecture. In Veneto Region where private companies were involved in the ecosystem, occupational doctors have access to information on the health state of workers enabling the implementation of the proper protocols. According to the informant for Veneto Region, although at the beginning involving other actors requires resources, the extension of the ecosystem positively impacted the efficiency of the management and control of the virus spread: “You have to train doctors, provide assistance if anything happens, in other words, it was not easy. However, at the end, the effort made has allowed us to prove that at times like this even the involvement of other actors beyond the boundaries of the healthcare system...is very useful because the more you activate additional resources, the better”. Stressing the issue of the lack of resources as one of the main problems for contact tracing activities, the informant emphasized the role of the enlarged ecosystem in the management of the outbreak.

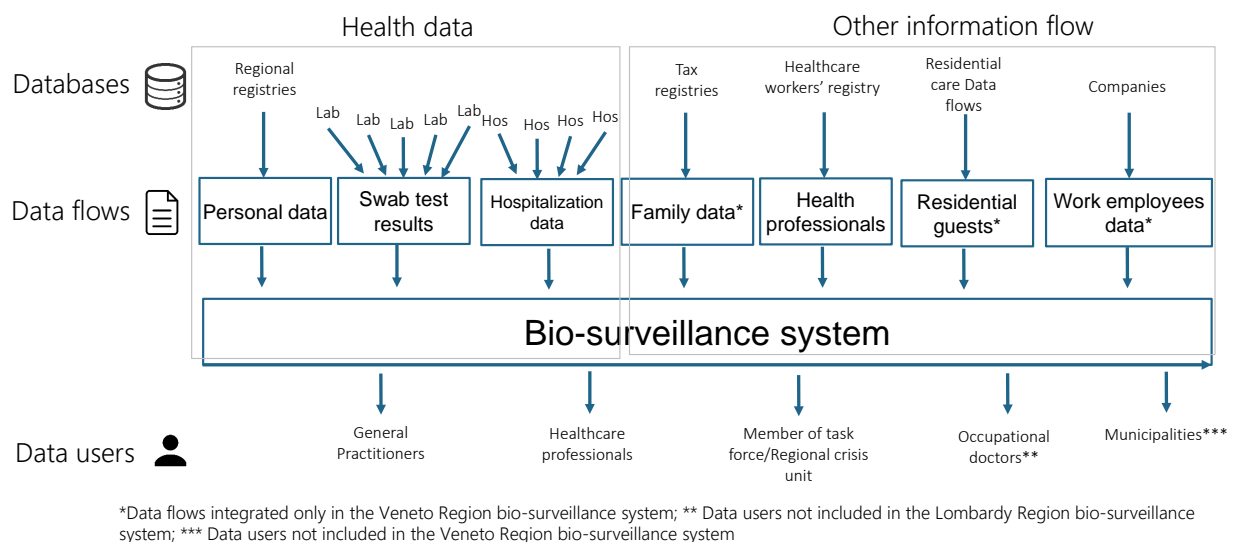


Figure 5. Overview of the bio-surveillance systems.

The training and assistance provided to data users facilitate the usage of shared data. Emphasizing the relevance of a common semantic for enabling effective data sharing, the informant for Lombardy Region claimed: “We have to create data in the same way, we have to share it in the same way, and we have to read it in the same way”. Although common syntax and semantics among platform stakeholders ensured the usability of data, the constantly evolving protocols and procedures constituted a challenge for surveillance activities. On the one hand, the establishment of protocols and procedures *ex novo* facilitated the diffusion of a common syntax and semantic even among different stakeholders. According to the informant for Veneto Region: “In this case, a new phenomenon, new actor, it was easier to set a common context in which inserting and reading data. Paradoxically, where context is already well-established this process (data sharing) can be more difficult and time-consuming”. On the other hand, protocols, and procedures were subject to change over time. One example is the evolving protocol for defining patients as cured of COVID-19 infection. At first, two negative molecular swabs were required to change the patient’s status to negative. Later, the absence of symptoms for a number of days was considered sufficient to determine full recovery. To the informant, an agile approach for project management is fundamental to rapidly adapting to changing rules: “At the beginning, we knew the bare minimum and we developed it. Then, through several sprints we realized the remaining part. During an emergency, applying traditional methods for project management does not work”.

6. Discussion and Conclusions

The analysis of the data sharing processes put in place for the management and control of the virus spread provides relevant insights on major challenges and proposed solutions enabling inter-organizational data sharing in the health emergency context. In this study, we analyzed surveillance practices carried out by two Italia regions for the management of the outbreak. Using a deductive research approach, the factors influencing data sharing activities in the public sector framed by [Yang and Maxwell \(2011\)](#) were tested in the emergency context. Moreover, the factors hindering data sharing activities were associated with a specific phase of the sharing process. According to [Zhang \(2020\)](#), the elements of data sharing include the data deposition, integration and translation phases.

The data sharing processes put in place significantly impacted the timeliness of information shared, hence enhancing the promptness of the measures taken to limit the spread of the virus. Moreover, the involvement of different stakeholders in the ecosystem has contributed to the management of the health emergency. Limited resources for contact tracing activities and clusters monitoring were indeed one of the main issues during pandemic. Extending the surveillance ecosystem to GPs and occupational doctors by providing access to data was crucial for effective management of the health emergency. However, this research study illustrates the complexity of developing a data sharing system able

to collect data, integrate them and translate them into actionable knowledge in the context of the health emergency.

During the COVID-19 pandemic, health data deposition phase, the heterogeneity in terms of data structure impacted data sharing activities. To achieve standardization in terms of data format and content, technical specification and general guidelines were provided to data owners and assistance was guaranteed during the initialization phase. Contrary to what is claimed by authors (Karlsson et al., 2017), data sharing past experiences did not impact the success of data sharing. The available IT infrastructures and sharing procedures adopted at regional level to manage health data were recognised as inadequate to implement a data sharing process that enables prompt response to the health emergency. Technology and legal requirements for data sharing practices would have limited the timeliness of the process and hindered the early involvement of other organizations that were not part of the public healthcare system. To fasten and to promote data sharing among the most relevant actors, new technological solutions and different data format were put in place. Further relevant information flows were then integrated with health data to provide significant insights for monitoring the virus spread in specific locations. The lack of available aggregated flows and the lack of unique identifier providing the possibility of aggregation with health data was one of the main barriers hindering data deposition and data integration, respectively. However, these two factors can be attributed to the lack of resources for aggregating and organizing raw data. In Veneto Region, private companies provided information on employees and workplaces to further enhance the effectiveness of monitoring activities. Conversely, in Lombardy Region, the lack of a specific project promoted by regional authorities for incentivizing data sharing by defining protocols and expected benefits prevented data sharing. This confirms the relevance of leadership as suggested by Gil Garcia et al. (2007). According to these authors, the role of formal authority is important for successful implementation of inter-organizational IT projects. The collaboration among different actors, especially when public sector is involved, needs institutional legitimacy (Dawes & Préfontaine, 2003). Besides supporting the collaborative effort and the trust building among actors (Pardo et al., 2006), leadership could also positively contribute to the data sharing initiatives by increasing awareness of expected benefits among actors involved.

Data integration of health data has been speeded up by an automated data cleaning and integration process. In this phase, one of the main challenges was the management of errors in data format and content. Errors attributable to mistakes in the data deposition were identified, promptly activating a feedback loop to facilitate standardization of data records. The combination of health data with other information flows was enabled by the presence of unique personal identifier. When no unique identifier was associated with records in aggregated data flows, data integration was not possible. The usage of data shared for monitoring and controlling the virus spread, i.e. the data translation, was hindered by

the evolving semantic. Although several research studies highlighted the complexity of obtaining high quality health data for research and for informing decision-making (Lucyk et al., 2017), the novelty of the phenomenon requiring new protocols and procedures for translating data into information enabled the spread of common syntax and semantics across different stakeholders. In the context of the pandemic, the absence of well-established protocols and procedure for translating and coding information from patient enhanced semantic uniformity. On the other hand, protocols for coding information were subject to constant change. The evolution of semantic required an agile approach able to rapidly adapt to change and the constant provision of assistance to data owners and data users. Barriers identified in the context of the health emergency were summarized in Figure 6.

Based on our findings, some lessons can be learned with regard both to research and practice. From the theoretical perspective, the findings of this research study confirm some of the relationship between technological and organizational factors and the success of the data sharing initiatives in the context of emergency, as well as extend the proposed framework exploring further sources of complexity. First and foremost, the case study reveals the importance of harmonizing data with different data formats and content. The standardization of format and content of data represents indeed one of the key enablers of data sharing also in the emergency context. Contrary to what previous data sharing experiences revealed, the existence of data sharing practices established prior to the health emergency proved not to be fundamental enabler of data sharing activities

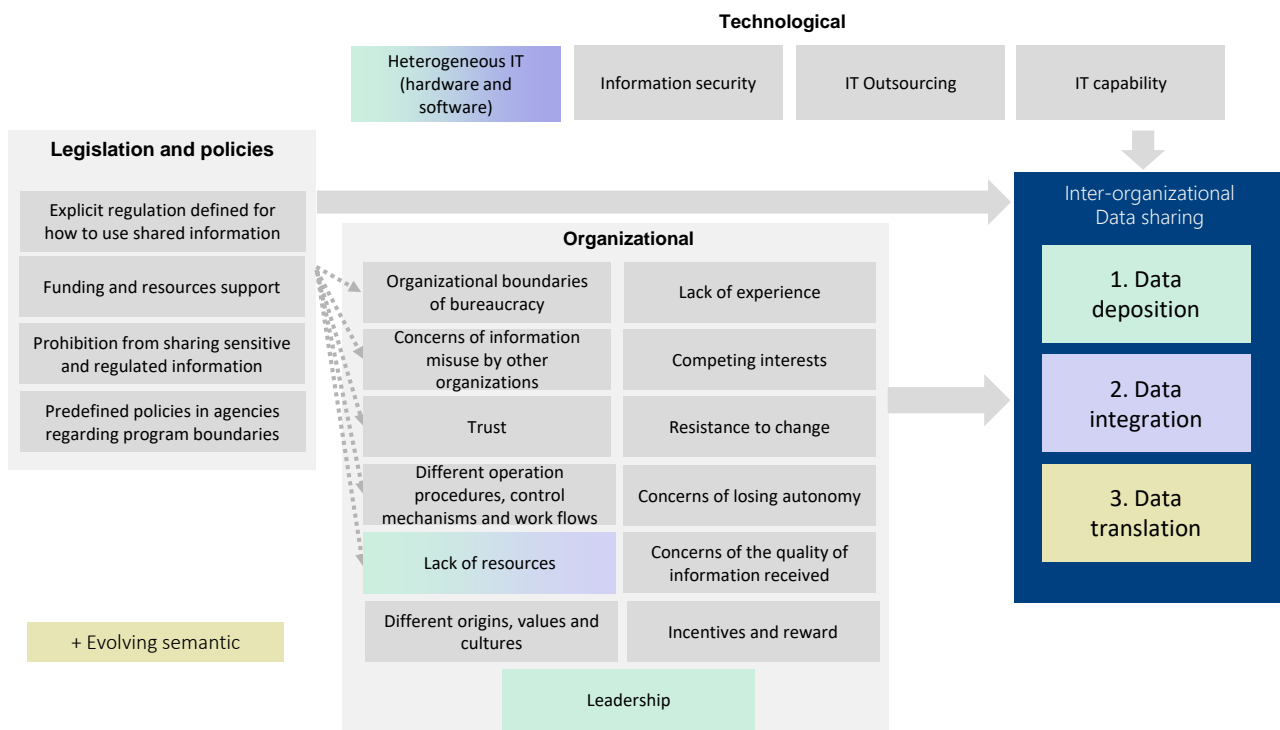


Figure 6. Barriers to data sharing in the context of the health emergency.

during health emergency. The lack of resources for combining and reorganizing raw data was found as a barrier to the data integration phase during the health emergency. The case study also revealed the role of formal authority in fostering data sharing initiatives during the health emergency, especially when it requires the engagement of several actors. Moreover, the case study revealed that the semantic and syntax evolving over time during COVID-19 hindered data translation into actionable knowledge. An agile approach was required in order to constantly adapt to change, hence enabling effective translation of data into decision making. The hypothesis put forward through the analysis of the multiple case study may help detecting additional avenues for future research. Furthermore, the decomposition of data sharing process into three different activities provides a new research perspective for the analysis of factors influencing data sharing.

Besides providing insights on factors influencing data sharing activities in the context of the health emergency, this paper has some practical implications as well. By revealing the factors that hindered inter-organizational data sharing, this research study highlights to practitioner the aspects that need to be assessed for the successful implementation of data sharing activities. Furthermore, revealing the actions put in place by Veneto and Lombardy Region to cope with major issues that arose during the initialization of the activity may help practitioners in detecting the factors that facilitate data sharing initiatives.

While our study through the analysis of a multiple case study allowed us to analyze the data sharing process across organizations in the context of the health emergency, additional work is needed to further test the relevance of the factors influencing information sharing. The selection of two cases was indeed pivotal to better investigate the phenomenon in the context of the health emergency. On the other hand, selecting two cases hindered the possibility of exploring the level of heterogeneity across a different geographical area, hence investigating the impact of both characteristics internal to the healthcare system and external variables on the influence of specific elements. Moreover, further research could also increase the level of generalizability of results, testing the factors influencing the data sharing process in contexts other than the public health and surveillance context.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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