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Case Study

Open Access

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Using Open Data to Monitor the Status of a Metropolitan Area: The Case of the Metropolitan Area of Turin

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Abstract: The paper presents and discusses the method adopted by Compagnia di San Paolo, one of the largest European philanthropic institutions, to monitor the advancement, despite the COVID-19 situation, in providing specific input to the decision-making process for dedicated projects. An innovative approach based on the use of daily open data was adopted to monitor the metropolitan area with a multidimensional perspective. Several open data indicators related to the economy, society, culture, environment, and climate were identified and incorporated into the decision support system dashboard. Indicators are presented and discussed to highlight how open data could be integrated into the foundation's strategic approach and potentially replicated on a large scale by local institutions. Moreover, starting from the lessons learned from this experience, the paper analyzes the opportunities and critical issues surrounding the use of open data, not only to improve the quality of life during the COVID-19 epidemic but also for the effective regulation of society, the participation of citizens, and their well-being.

Keywords: open data, monitoring, COVID-19, Turin, metropolitan area

1 Introduction

The COVID-19 pandemic is changing everything: something unexpected happened at the end of 2019, and we are currently experiencing only the beginning of an event that will impact the entire world for many years

(McKibbin & Fernando, 2020). Each country is currently dealing with a different phase during this epidemic as doctors, scientists, psychologists, economists, and engineers are contributing to the study of the past, the present, and the future of this event. We already know that the effects of the COVID-19 epidemic will have a social, economic, and medical impact on our society that will last for many years. With attention to data growing in the years before this event, the widespread use of data has been observed since the beginning of the epidemic, aimed at understanding the evolution of the phenomenon and trying to model the daily increase in positive cases and changes in the curve of the epidemic (Hu et al., 2020; Wang, Ng & Brook, 2020). Among others, the John Hopkins University Dashboard (Dong, Du, & Gardner, 2020) was one of the first business intelligence tools developed at the beginning of the epidemic in China, when no one thought a pandemic would affect our world. With the progression of the epidemic, countries have started to communicate and publish data about the spread of the virus, making them available for individual analysis and modeling: in Italy, one of the countries most affected by the epidemic (Remuzzi & Remuzzi, 2020), the Civil Protection Department, the national body that deals with the prediction, prevention, and management of emergency events, publishes daily data¹ about new cases, also specifying the number of individuals who have recovered and deceased. Various criticisms (Fetzer et al., 2020) have been made by the media and online newspapers (Boseley, 2020; Madrigal, 2020; Battiston, 2020) about the way how these data are recorded and shared, but it is still too early to conduct a serious and complex evaluation of the correct measurement and use of data because, at least in Italy, the epidemic is still in full swing. However, the massive use of data that we are now observing offers the opportunity to reflect and experiment it to understand and address

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¹ <https://github.com/pcm-dpc/COVID-19>

policy challenges that are affecting our cities and society as a whole.

In fact, the importance, necessity, and value of Open Data have been made public and widely recognized in the course of this pandemic (Xu, Kraemer, & Group, 2020). The Open Knowledge Foundation in 2005 defined Open Data as “*data that can be freely used, shared, and built-on by anyone, anywhere for any purpose.*” Nowadays, the importance and value of Open Data have been accepted and there are many excellent examples of the enhancement of this kind of data all over the world (European Data Portal, 2019; Verhulst & Young, 2016). DataUsa,² a web portal in which citizens can access a large amount of US data about jobs, administration, population, cities, and so on, is an excellent example. As for Italy, the Italian National Institute of Statistics (ISTAT)³ regularly publishes data and updates about censuses, research, and surveys. Despite this attention, in many cases, the availability of open data runs into several problems, including availability, limited data updates, data granularity, and difficulties with the automation of data collection (World Wide Web Foundation, 2017). These problems can prevent researchers and data scientists from effectively using data for the social benefit of entire communities (Zuiderwijk et al., 2012). Compagnia di San Paolo, a large foundation originating in the banking sector and located in Turin, one of the biggest cities in Italy and second in the country in terms of the number of confirmed cases of COVID-19 at the beginning of May 2020, began to reflect on this, and the connection with the COVID-19 epidemic, in March 2020.

With the rise of the epidemic in Piedmont and the metropolitan area of Turin (>2,250,000 inhabitants) in February 2020, the Impact Innovation Department of Compagnia di San Paolo began to explore how events could be monitored daily. We aimed to develop a dashboard that would allow us to analyze the transformation of Turin, one of the largest Italian cities, as a result of the COVID-19 epidemic, possibly adopting several perspectives inspired by the biopsychosocial model adopted in many fields, including medicine and psychology (Engel, 1977). The main aims of the following commentary are to summarize the rationale behind the implementation of the system of daily monitoring and the consequent lessons learned. We identified six requirements for the development of the monitoring system: (1) Data about COVID-19 would only form part of a wider data collection and subsequent data integration project, given that since the beginning of the epidemic many valid dashboards

had already been published (Dong, Du, & Gardner, 2020). (2) To speed up our work, we would only use open data. Given the rapid progression of the epidemic, we decided it would be too arduous to set up partnerships with public and private institutions to obtain their data. We violated this requirement in two cases; we used the data of our foundation to obtain information about grant requests from local institutions. These data are freely published only at the end of the year. In another case, we received data from a specific institution: free access to data would have been possible, but it requires a long bureaucratic process. Considering the rapid evolution of the epidemic, we decided to allow an exception to our rules. (3) Data would be gathered daily, as we wanted to preserve the “monitoring” concept, trying to ensure maximum data granularity. This data availability would have been useful also for future complex analysis. (4) Data should cover several topics, including the economy, society, environment, pollution, weather, and culture. We agreed to stop the research if we had not found at least a satisfactory amount of data in these domains. (5) Data should be available from 1st January. (6) Although we needed data about the municipality of Turin, we would accept a limited amount of data about Piedmont as a whole.

2 Methodology

The scouting activity described in the following paragraph was performed to enable a deep comprehension of the impact of the COVID-19 epidemic in the metropolitan area of Turin. The development of a monitoring dashboard that summarized the evolution of several dimensions of the territory and the availability of data for statistical analysis were the main use of data we collected. The main idea behind the dashboard was to understand the simultaneous change easily and quickly through visual trends, especially considering the effect of the lockdown imposed after the rise of positive cases. The availability of open data also provided an interesting dataset for several statistical analysis; research that dealt with the correlation among the rise of positive cases and changes in several dimensions of the area of Turin was recently published (Candela & Mulassano, 2020). This study was based on this scouting activity of data in eight domains: epidemic, philanthropy, economy, society, culture, traffic, pollution, and climate.

To collect a significant amount of information, we decided to adopt a broad concept of open data: we

² <https://datausa.io/>

³ <https://www.istat.it/>

considered all data that were freely accessible in several ways. This is something different from the common idea of open data, mostly linked to a platform specifically designed to provide data in open data format. Thus, we assumed, for instance, Twitter data as open data because, even if manually, we were able to collect data about specific trending topics without any restriction.

2.1 Epidemic

To maintain an equal balance across the eight domains, unlike most of the analysis and display tools developed for the epidemic measurements, only three types of data about the spread of the virus were used: total confirmed cases in Piedmont, total confirmed cases in the metropolitan area of Turin, and daily new confirmed cases in Piedmont. Data are provided each day by the Civil Protection Department. These measurements allow visual analysis of the epidemic curve to be carried out visually and effectively, comparing the municipality of Turin with the entire region. These are the same indicators adopted by the World Health Organization in its daily situation report (2020).

2.2 Philanthropy

This domain includes data regarding the daily relationship between the country and the Compagnia di San Paolo Foundation. Compagnia di San Paolo is the largest philanthropic private foundation in Turin and nationwide, distributing over 170 million euros annually, mostly within the city of Turin and the Piedmont region (ACRI, 2018). Data are provided by our information systems or third-party tools. These are not open data because they are owned by Compagnia di San Paolo and are not available to citizens except in the annual report, where they are reported in aggregate form. Five types of data are collected each day in this domain: the number of grants requested from the foundation, the number of visitors and views on the official website (using the Google Analytics tool), and the number of visitors and views on the official LinkedIn Page (through LinkedIn statistics page). While we are aware of all the limitations and approximations, we believe these data reflect the relationship between a wounded country and an important institution that can provide help in such a critical situation.

2.3 Economy

We identified five types of data about the financial market that reflect the health of Piedmont and the city of Turin. To ensure a broader perspective, we choose the FTSE MIB index, the benchmark stock market index for Borsa Italiana, the Italian national stock exchange. The index consists of the 40 most-traded stock categories on the market. To gain a detailed picture of Turin's companies, the stocks of four companies that have their headquarters or a historical role in the city were identified: *Intesa San Paolo* – one of the largest banks in Italy, *Iren Energia* – a utility company, *Centrale del Latte* – a food company that specializes in the fresh milk and dairy-cheese sector, and *Basicnet* – a multi-brand sportswear and clothing company. The data are available on many financial websites and we record the daily closing stock prices. Several studies (Masoud, 2013) have demonstrated an association between stock market performance and economic growth (Pan & Mishra, 2018; Ho & Iyke, 2017; Krchnivá, 2016).

2.4 Society

Data regarding citizens were difficult to find. We choose three indicators and two of which, the daily number of tweets including the “coronaviruspiemonte” hashtag and the number of daily Google searches made in Piedmont that includes the keyword “Coronavirus”, reflect the population's degree of interest in this event. These data are freely available doing an ad-hoc search on Twitter and Google Trends. Several studies (Odlum & Yoon, 2015; Achrekar et al., 2011) have shown that there is a correlation between targeted conversation traffic on social media and the spread of the epidemic and that this can be used to monitor the epidemic. We are also collecting data about daily electricity consumption in Piedmont. This is an estimate based on electricity consumption across Piedmont according to historical usage data. These data are provided by Links Foundation, a research body of Compagnia di San Paolo that operates nationally and internationally in many fields of applied research including energy, and these data are not available in open data format.

2.5 Culture

Collecting daily data about culture also presented a significant challenge for two main reasons: first, although there are several annual reports about cultural participation, daily data are rare and private. Second, the Italian lockdown closed cinemas and theaters, interrupting all cultural activities. We already knew that, for instance, the number of citizens involved in cultural activities would have been equal to zero and we needed more useful data. Estimates about the traffic on the cultural website were considered in our multidimensional analysis because citizens are currently at home and many cultural institutions are offering services, such as virtual museum tours. Therefore, we are currently collecting data about the traffic on four websites: “La Stampa”⁴, the most popular newspaper in Turin; the national digital book rental site *Medialibrary*⁵; and two of the most important cultural sites in Turin, the *Egyptian Museum*⁶ and the *Palace of Venaria*⁷. Amazon’s Alexa service is the tool that we are using to collect daily data. As the tool is configured to make global comparisons, we could only collect data for very popular websites.

2.6 Traffic

Daily traffic data in the city of Turin are freely provided in open data format by 5T, an in-house company of the city of Turin and the Piedmont region that manages the Mobility and Infomobility Center of the Turin metropolitan area and the Piedmont region (Arneodo, Castelli, & Botta, 2017). We collected four types of data: the number of vehicles on the road, the number of kilometers traveled, the average number of vehicles per hour, and the number of vehicles in areas subject to traffic restrictions.

2.7 Pollution

The Regional Environmental Protection Agency (ARPA) in Piedmont provides data about daily pollution. We are specifically collecting data about particulate matter, nitrogen dioxide, and ozone. The data are completely in open format.

⁴ <https://www.lastampa.it>

⁵ <https://www.medialibrary.it>

⁶ <https://www.museoegizio.it>

⁷ <https://www.lavenaria.it>

2.8 Weather

The Atmospheric Physics Meteorological Station of the Department of Physics of the University of Turin publishes daily open data about several meteorological phenomena. We are collecting a subset of these data including air temperature, relative humidity, wind speed, and cumulative rainfall. Table 1 summarizes the 31 indicators that we are collecting daily.

3 Results

The Innovation Impact Department of Compagnia di San Paolo Foundation has begun to monitor in detail what is currently happening in the metropolitan area of Turin, one of the largest cities in Italy and second in the country in terms of the number of COVID-19 cases. We aim to use open data to perform a multidimensional analysis of the transformation of a city resulting from the epidemic. We have just started to collect data and the project will last for many months. We are already analyzing some possible phenomena correlated to the spread of the virus, however, as said, it is too early to carry out a complex statistical analysis because we are in the middle of this event and we need more data. However, many lessons can be learned from this experience regarding the potentiality and problems of data, both open and private, for society and policies. Some of the following insights have already been highlighted in previous research (Machova & Lnenicka, 2017).

3.1 The Need for More Open Data

The importance of open data for society and communities is beyond discussion: there are many projects and excellent examples of how this specific sub-group of data can be used with significant positive consequences (Verhulst & Young, 2016). Nonetheless, our scouting activity showed how difficult it is to use open data to perform a multidimensional investigation of the activities of a city. These difficulties relate to time and space because we rarely found open data daily. Nowadays the majority of local government bodies use information systems to provide services to the community. For transparency reasons in particular (Reggi & Dawes, 2016), they are sensitive to the need to publish data and there are excellent examples of how cities share data in near real-time⁸. In

⁸ <http://citydashboard.org/london/>

Table 1
Set of Collected Data Daily for the Multidimensional Monitoring of COVID-19 in the Piedmont Region and the City of Turin

Cluster	Indicator	Source	Type of data
<i>Epidemic</i>	Total confirmed cases – Piedmont region	Civil Protection Department	Open data
	Total confirmed cases – city of Turin		
	New positive cases – Piedmont region		
<i>Philanthropy</i>	Number of grant requests submitted to Compagnia di San Paolo Foundation	Informative systems of Compagnia di San Paolo	Private data
	Number of visitors and visualizations of the official Compagnia di San Paolo website	Google Analytics	Private data
	Number of visitors and visualizations of the official Compagnia di San Paolo LinkedIn Page	LinkedIn Analytics	Private data
<i>Economy</i>	FTSE MIB Index – benchmark stock market index for the Borsa Italiana	Financial websites	Open Data
	Stock values at the closure of four companies located in Turin: Intesa San Paolo (banking); Basicnet (clothing); Centrale del Latte (Food and Beverage); and Iren Energia (utilities)	Financial websites	Open Data
<i>Society</i>	Number of tweets containing the hashtag “#coronaviruspiemonte”	Twitter	Open Data
	Research trends in Piedmont region for the keyword “coronavirus”	Google Trends	Open Data
	Estimate energy consumption in Piedmont region	Links Foundation	Private Data
<i>Culture</i>	Website ranking of the online version of the most popular newspaper in the Piedmont region “La Stampa”	Alexa Internet by Amazon Company	Open Data
	Website ranking of two main cultural places in Turin, Egyptian Museum and the Palace of Venaria		
	Website ranking of Medialibrary.it, the official site of library system for digital book borrow		
<i>Traffic</i>	Number of circulating vehicles – city of Turin	5T Company website	Open Data
	Number of kilometers covered – city of Turin		
	Average number of vehicles per hour – city of Turin		
	Number of vehicles in traffic limited areas – city of Turin		
<i>Pollution</i>	Particular Matter PM10 value	ARPA in Piedmont	Open Data
	Nitrogen dioxide value		
	Ozone value		
<i>Weather</i>	Air temperature	Atmospheric Physics Meteorological Station of the Department of Physics of the University of Turin	Open Data
	Relative humidity rate		
	Wind speed		
	Cumulated rain		

ARPA, Regional Environmental Protection Agency.
All data are available daily.

many cases, unfortunately, data are aggregated monthly or even annually, making it impossible, or particularly challenging, to find the right way to access these data. With the availability of daily data on the epidemic, it is crucial to ensure the same degree of data granularity as that of other data, especially those collected automatically. Local open data that cover the many different aspects of a large city are limited. We are aware that this is not an easy task and that some truly relevant aspects are missing in our experiment, especially for data that cannot be collected automatically. For instance, we are not taking into account people's psychological response to this event, although we know that the epidemic is affecting and will affect the psychological well-being of citizens (Brooks et al., 2020). These data are not easy to collect, especially considering that we want to deal with daily data. However, among others, researchers at the Computational Story Lab of the University of Vermont Complex System Center have attempted to develop a happiness monitoring system called "Hedonometer" (Dodds et al., 2015) using tweets from Twitter. In Italy, Allisio et al. (2013) attempted to monitor the happiness of a city using a similar approach, but the research was stopped.

3.2 The Need for Smarter Open Data

We have already discussed the need for data granularity, however, there is another technical aspect that has to be highlighted: our data are currently drawn from many websites and the development of data scraping solutions would require too much time. Therefore, we are collecting data manually and entering them twice a week. In some cases, data are deleted each day, so we are forced to collect them every day. Although the city of Turin and the Piedmont region have published several interesting open data websites, these data are different and often aggregated at least every month. Administrations provide a smart platform with all available open data. This solution could allow researchers to easily access data and focus their efforts on data analysis and data interpretation.

3.3 The Need for Faster Open Data

There is another important topic connected to our experience: our scouting activity had to deal with the long-winded bureaucratic processes required to obtain permission to use data. In many cases, public administration data are not open simply because they are not used by anyone and there are few reasons for

starting a project that makes data accessible. According to the Open Data Maturity Report of the European Open Data Portal (2019), the share of unique visitors per month on an open data portal, as a percentage of a country's population, is <0.005%. This is probably the reason why we received an encouragingly positive reply when we asked local institutions in Turin for open data (i.e., data about the use of public transport, data about Internet use), but an official request requires the involvement of all the institutions that manage the data. Considering that our project requires the daily monitoring of an event which we hope will be over, at least partially, in a few months, we had no time available to begin a complex negotiation among institutions, with a consequent loss of time and data. As mentioned above, given the limited use of open data by citizens, widespread publication of data by local institutions in a short space of time is unrealistic, however, some kind of solution needs to be implemented so that data that are not open, but could be, can be requested and obtained quickly.

3.4 The Need for Private Open Data

Finally, we cannot deny the role and potentiality of the data owned by private companies for public good. There is extensive literature about so-called "data philanthropy" (George, Yan, & Leidner, 2019; McKeever et al., 2018) or "data collaboratives" (Susha et al., 2017), where private companies share their data for the public good. In response to the COVID-19 epidemic, there are many examples of the use of private data by research groups; however, these data are rarely available to citizens as they are usually shared between a for-profit company and a non-profit institution, like a research institute. This is the case, for instance, of a very interesting study conducted by Isi Foundation, a non-profit Italian research institute that used data provided by Cuebiq Inc., an American "location intelligence company" that collects anonymous smartphone data about the geographical location of users. These data are normally used for marketing strategies, but in this specific research, they were used to analyze how much travel was taking place despite the travel restrictions imposed in Italy (Pepe et al., 2020). While Cuebiq does provide data through their honorable Data for Good program, which is an excellent example of data philanthropy, aggregated data were not published in open format. These data could have been particularly relevant to our project. Therefore, while awareness of the potentiality of private data for the good of society is growing, with many examples applied during this critical situation, we feel that the next step

should be to share the data in aggregate form, while fully respecting privacy laws.

4 Conclusions

We are experiencing an event that cannot be studied and really understood without adopting a multidimensional perspective. The COVID-19 epidemic is already affecting and will affect our societies for a long time. It is also allowing us to experience, evaluate, and learn the opportunities and problems related to the use of data. Most research and studies are attempting to forecast the epidemic curve and several institutions are recognizing the importance of using and sharing open data to predict the future evolution of the epidemic. The Organisation for Economic Co-operation and Development (OECD), among others, has launched a call for evidence to understand how open government data are helping to address the COVID-19 crisis. Most of this high-quality research is measuring the associations between epidemic and single aspects of our society. Conscious of the challenge and the inevitable limitations, we have however adopted a different approach based on the daily monitoring of many indicators (social, economic, and environmental) influenced by these events.

In short, we are studying a city affected by COVID-19. Given the short time available, we decided to rely on open data and this experiment is teaching us many lessons. Beginning with the potentialities: in a very short time, without a significant commitment, we were able to build a multidimensional monitoring system, tracking the metropolitan area of Turin in terms of its economy, traffic, environment, weather, electricity use, online interest in culture, and so on. This is useful not only for daily monitoring but also to provide data for a multivariate statistical model that will help us to understand this shocking event in depth (i.e., can we assume there has been a positive role of the epidemic for the air quality of the city, allowing for temperature and wind speed?). However, we have encountered some issues related to the time-consuming negotiation needed to obtain administrative data that is not directly open and we have not covered some relevant aspects, such as the psychological well-being of the population, use of public transport, use of the Internet, and supermarket purchases. In some cases, these data are not available because they are not collected at all; in other cases, data are private and are not shared or are shared only for specific purposes with specific institutions.

In summary, our research is demonstrating that open data are an excellent resource for monitoring and studying the well-being and condition of a metropolitan city. This is not limited to what is happening now but could be applied and extended to everyday life. A multisystemic approach using open data that cover many different aspects could result in a deeper understanding of the dynamics of a metropolitan area, helping politicians and administrators strengthen services and design new solutions.

Considering the philanthropic activity of the Compagnia di San Paolo Foundation, which is relevant to the country but obviously limited compared to government and local institutions, this approach might serve to understand the real needs of citizens and therefore calibrate its interventions. In this respect, open data could be an effective “strategic philanthropy” tool (Kania, Kramer, & Russel, 2014).

Applying this argument to public institutions, we can assume that open data, used wisely and effectively, could have no disruptive effects for central and local administration. There are several interesting studies regarding the potentialities of open data for the monitoring and management of a city, including urban development (Neves, Neto, Aparicio, 2020), Integrated City Management Platforms (Westraadt & Calitz, 2020), and above all, their relationship with the concept of Smart Cities (Beckwith, Sherry, & Prendergast, 2019; Oio, Curry, & Zeleti, 2015).

Our preliminary scouting activities have however shown that, at least in the case of the metropolitan area of Turin, the open data system is still immature, especially where, as in our case, an attempt is made to make high-level use of them, which is different and more complex than the mere recovery of a single item of data. The COVID-19 epidemic is teaching our world many lessons that we should learn and keep in mind, one of which is the potentiality of open data for the well-being of citizens and societies.

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