The effects of travel containment measures within COVID-19

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***Abstract*— The outbreak of COVID-19 has brought the world to a standstill. More than half of the world's population was in lockdown at the beginning of April. People were urged not to go out and avoid public transport. A few figures to take stock of the situation: around 4 billion people subject to various movement restrictions worldwide, air traffic is reduced by about 90% and shared mobility platforms activity reduced to 2% to 5% of their regular business. The current crisis, which is impacting both the supply and demand for transport, appears to be a privileged moment to rethink mobility and place it on a more sustainable trajectory. The Covid-19 crisis has a significant repercussion on demand and supply of mobility in Victoria as the Victorian government has put citizens in lockdown to limit the spread of COVID-19. This research aims to investigate the travel containment measures (government restrictions) taken in response to the COVID-19 emergency have on Victorian's mobility as this insight is vital to estimate parameters appropriate for the different stages of the crisis, before and after the implementation of prevention policies.**

***Keywords-*—Mobility, COVID-19, Corona Virus, Traffic Volume, SCATS data, Travel containment measures**

I. Introduction

The Novel Coronavirus initiated an explosive outbreak over the world after its first reporting on December 2019 in Wuhan, Hubei province, China[1]. This virus generally transmits through human-to-human interaction and can also survive on the exposed surfaces for a different period [2]. In March 2020, the World Health Organization (WHO) declared the epidemic of this Coronavirus Disease 2019 (COVID-19) as a global pandemic and until now, 213 countries and territories around the world have reported the spread of COVID-19 [3]. Victoria has become one of the states with the highest number of confirmed cases of COVID-19 in Australia and the rapid escalation of prevalence is going on since its first identification on March 08, 2020 [4].

To prevent the exponential growth of viral spread, a large number of public health interventions and multiple control measures have been already implemented worldwide considering global and local context [5]. Several behavioral risk-reduction strategies, including compulsory use of masks, frequent handwashing, avoidance of individual interactions, and maintenance of basic hygiene are mandated as control measures to mitigate the individual risk [6]. Both pharmaceutical and non-pharmaceutical countermeasures are resorted to alleviate societal risk and prevent the spread of COVID-19. The measures include complete lockdown of cities, social-distancing, restrictions of traffic movements within the national and regional territory, prohibitions of international traveling, mandatory quarantine of travelers as high-risk groups, isolation of suspected and confirmed cases, increase of testing capacity, responsive use of drugs, and surveillance of active case [7]. Maintaining social distance and avoiding physical contacts can reduce the risk of spread significantly which has already been proven from the transmission model [8]. Some models also suggested that the execution of at least 3 months of social distancing measure is a cornerstone to demur the peak effects of the virus on the pandemic situation which could be extended intermittently whenever required [9].

Besides the initiatives, some other interventions have also been embedded considering the local demand to reduce exposure. Curbing the educational and business operations, closure of non-essential businesses and factories, limiting or shutting the markets and shopping mall exception for essential needs, maintaining sanitary cordon, and restriction on large scale social gathering are certain strategies imposed by several state governments [10]. Furthermore, some governments-imposed curfews and several types of lockdown for reducing vehicular traffic volume to keep people stay-at-home where masses are reluctant to follow the rules [11, 12]. The state government of Victoria has also enforced some of these measures following the predecessor countries experienced the COVID-19 [11], even though the parameters and methods of enactment differ notably considering local context. Declaration of general holiday, closure of educational institutions and garments factories, deployment of forces, restriction on the religious and social gathering, shutting down the shopping centers, and prohibition of inter-district movements as well as public transport are some of the containment strategies adopted in Victoria [13]. All of the approaches are prerequisites for controlling the movement of people to prevent virus transmission [14]. Usually, exposure is greater if people spend a long time in a viral loaded space or public gathering. Potential risk of transmission also increased if vehicles plying on the roads frequently. The more volume of traffic on the roads, the more people exposed to the virus and the more likelihood of transference of virus from the higher infected to the lower infected area [15]. As containment strategies are implemented for restricting people to go out of home and reducing vehicular movement on the road to limit the transmission of COVID-19, it is required to examine the effectiveness of such strategies to achieve their intended outcomes [16].

In search for a new healthy sustainable normal situation, while many dedicated researchers are working on the pharmaceutical arena, many of them are working on non-

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pharmaceutical arena to find the best countermeasures to assist the decision-makers for tackling the pandemic situation [17]. This study intended to ascertain the effectiveness of different containment strategies to control vehicular traffic on the roads for preventing the transmission of COVID-19 [18]. Hopefully, the findings would help the decision-makers to select effective measures to control traffic movements for preventing the virus transmission over the space at any pandemic scenario in the future [19].

II. RELATED WORK

The flow of vehicles in an urban network presents relevant aspects that justify more elaborate treatment than the coordination of a set of road arteries [20-22]. A brief review of some relevant techniques and models is then carried out is discussed in this section.

First, it is necessary to set out some basic definitions and principles in networks. A road network is a set of streets and avenues that intersect at intersections, which can occur at level or unevenness [23, 24]. The concepts of road, trajectory and circuit that are recorded in an urban network are well known. In general, stretches of streets or avenues have a certain sense of circulation and are therefore designated as directed [25, 26]. Mobility studies based on the analysis and optimization of a traffic network through the characterization of the infrastructure and its capacity include thorough field research necessary to know the origin/destination relationships and their main characteristics (travel reason, origin-destination parking (O-D), vehicle occupancy, travel time, etc.) [20, 27-30]. This allows to fine-tune the functional characteristics of the different elements of the system, including a detailed analysis of the intersections and their different methods of regulation [31, 32]. Vehicle flows can serve both to describe traffic and to predict or recommend a vehicle flow pattern in a network [23, 33].

GIS tools, allows the process vehicle volumes and identify areas of greatest concentration at different times of the day [34-36]. At the area level, for example, this helps to help identify the poles of generation/attraction of demand at different times of the day, for different days of the week and for different periods of the year, and to quantify their generative/attractive power.

III. METHODOLOGY

The main variables in this study correspond to vehicle traffic data and government decisions. Therefore, this section details the collection of data from those variables, as well as their processing. First, it starts with the description of the study area and the traffic data. Subsequently, details the government decisions are discussed. Finally, the methodology for analysing and visualising traffic data is detailed.

A. Study area

The state of Victoria is located in the south-eastern corner of mainland Australia and occupies approximately 3% of the area of land covered by Australia as a whole. Victoria has a population of over 6.6 million, the majority of which is concentrated in the area surrounding Port Phillip Bay, and in particular in the metropolitan area of the state capital and largest city, Melbourne, which is Australia's second-largest city.

Public Health Victoria presents a daily dashboard with key indicators for monitoring the COVID-19 epidemic: confirmed cases, deaths, outbreaks, and clusters under investigation. The detailed results of all the daily indicators are also available through data enthusiastic which follows the evolution of the epidemic. As of August 7, 2020, the Victoria state has 14,283 confirmed cases which was further categories as overseas, known local, unknown local (community), interstate and under investigation. Australian government department of health issues daily updates on the above-mentioned detail and the below Figure 1 provides a summary.

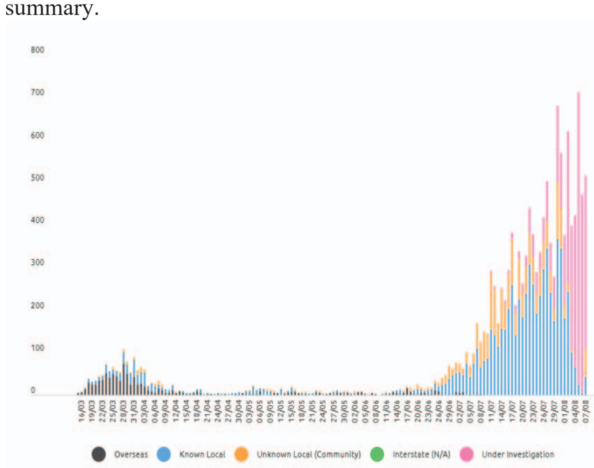

Fig. 1. Number of daily cases of COVID-19 reported in Victoria

B. Traffic data

SCATS (Sydney Coordinated Adaptive Traffic System) is one of the most widely used ATCSs in Australia and the world, developed by the Roads and Traffic Authority (RTA) of New South Wales, Australia in the 1970s [27, 37]. The system control involves the use of inductive loops below the road surface immediately before the stop line at the intersection of a road. The Induction loops are used to detect the presence of a vehicle in addition to measure the degree of saturation and traffic flow through an adjustment cycle [21]. The data collected through the induction loops is gathered in the local controller located at each intersection which is then transmitted to a computer regional. In Victoria, the SCATS system utilizes a wide coverage sensor network on major roads and junctions to monitor the traffic flow status. It is an official public urban traffic data source provided by VicRoads.

The SCATS volume data was collected from the Victorian Government Data Directory (https://www.data.vic.gov.au). The SCATS volumes provide structured data with fields such as the UID (unique identifier) of the sensor site, the name of the street section, the volume of passing vehicles every 15 minutes and the timestamps for the signals. Victorian Government Data Directory also provide supportive data set to the SCATS volume data that provides geographic information, e.g. latitudes and longitudes of the sensor sites.

Geospatial data describe any data related to or contain information about a specific location on earth's surface. Since the SCATS volume data and its supportive data set share the same nature of data, traffic sensor/device sites, the SCATS volume data set can be converted into a structured geospatial data set with points and road lines through a spatial join operation. The SCATS enabled sensor network is shown in Figure 2 in which each red dot is a SCATS sensor.

Fig. 2. The sensor network established around Victoria

Geospatial data describe any data related to or contain information about a specific location on earth's surface. Since the SCATS volume data and its supportive data set share the same nature of data, traffic sensor/device sites, the SCATS volume data set can be converted into a structured geospatial data set with points and road lines through a spatial join operation.

C. *Government decisions*

Government decisions affecting mobility were collected from the Australian Beurre of Statistics [38]. These measures correspond to restrictions on mobility within the Victoria state and Australia as the country.

- international travel restrictions
- border control measures for some states and territories
- shutting down of non-essential services
- social distancing rules and additional shutdown restrictions from 20th March
- easing of restrictions from mid-May
- restrictions reinstated in regions of Victoria from 1 July related to new coronavirus clusters.

D. *Analysing and Visualising*

Geographical Information Systems (GIS) has revolutionised the process of collecting and processing data, therefore, more and more data recorded in an analogue form are transformed into the digital format. To investigate the impact of COVID-19 government restrictions on Victorians mobility a framework is developed using QGIS. QGIS is a user-friendly, fully featured GIS application that can be expanded and customized by users to suit specific data processing and visualization needs. QGIS can also be used as a self-standing application for transport data analysis. Hundreds of other transport planning projects have used QGIS for the mapping and geographic analysis. Due to the application's user-friendly GUI, it is rapidly gaining popularity.

IV. RESULTS

The coronavirus pandemic is a serious public health threat. Travel containment measures and other coordinated restrictive measures are needed to save lives. However, these measures can also seriously slow down our economies and our mobility. This section presents Victorians mobility behaviors during COVID-19. Vehicular traffic on the Victorian roads during the health emergency during 2020 and the related road traffic data for the year 2019 along with daily coronavirus cases are used to perform the analysis of the impact of COVID-19 on mobility.

A. *Analysing the daily traffic volumes during COVID-19*

Road traffic on the streets of Victoria has undergone a significant reduction since the midweek of March. The Figure 3 elaborates daily median traffic volumes for each day since February to mid-July in Victoria.

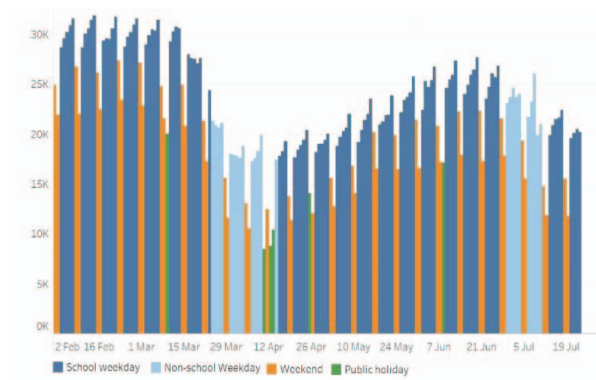

Fig. 3. Daily median traffic volumes

Between March and May there were the steepest drops, in vehicle traffic. From then on based on the progressive reopening and flexibilities carried out, a trend towards growth in traffic began to be noticed but with the growth of new cases (second wave) COVID-19 restrictions were imposed and the traffic volumes have again reduced.

B. *Comparing the traffic volumes during COVID-19*

A comparison of mobility with the previous year elaborates the impact of COVID-19 on traffic in the streets of Victoria. Figure 4 compares the weekly trend of journeys recorded by vehicles in 2020 with the journeys of the same weeks in the year 2019. The analysis is further categorized as weekdays, weekends (Saturdays and Sundays). During the analysis, the public holidays excluded.

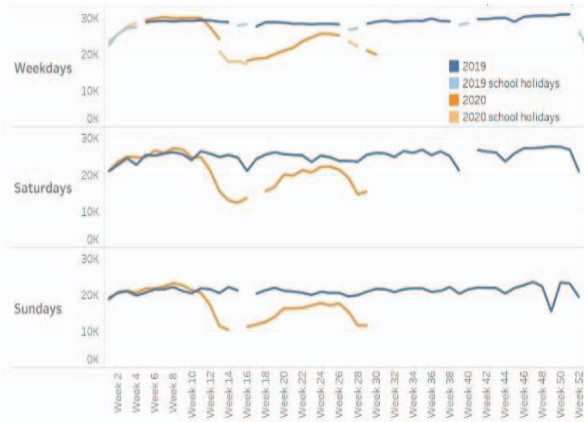

Fig. 4. Weekly median traffic volumes

It is evident that the streets of Victoria have undergone a significant reduction when comparing to the traffic volumes same week of the previous year.

C. Analysing the hourly traffic volumes during COVID-19

Hourly traffic volumes were analyzed to examine the mobility of Victorian during different times of the day. Figure 5 elaborates the impacts of COVID-19 on traffic volumes vary within Wednesdays of March to July.

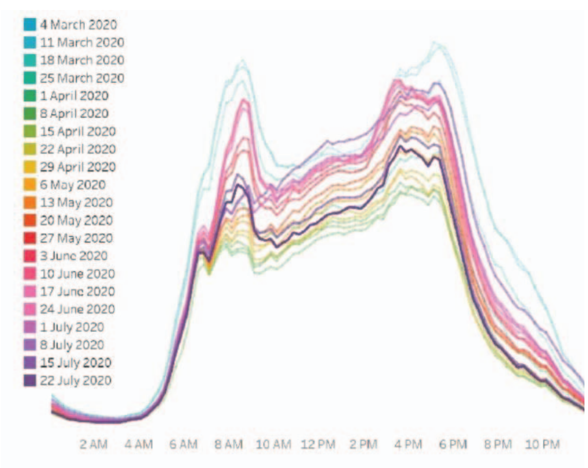

Fig. 5. Hourly median traffic volumes

In general, April, May, and mid-July (COVID-19 stage 3 lockdown) experience much higher reductions in traffic volume as compared to the same time range during early March.

D. Analysing the traffic volumes comparison to the COVID-19 travel containment measures

A clear reduction in daily traffic volume due to COVID-19 was identified in this study. Further investigation on how different COVID-19 travel containment measures contributes to the mobility the change of the traffic volume compared to a reference period prior to the emergency. Figure 6 examines the median traffic volumes compared to a reference period prior to the emergency.

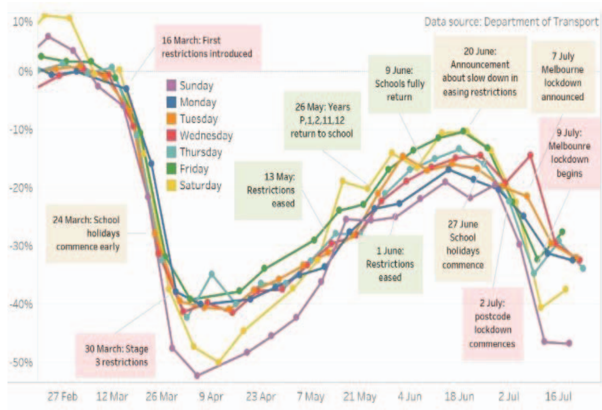

Fig. 6. Median traffic volumes compared to a reference period prior to the emergency.

This can be attributed how trip adjustment with the government travel restrictions imposed. As restrictions progresses, the behavior of travelers may change due to psychological adaptation to COVID-19 conditions.

E. Analysing daily COVID-19 cases of LGAs since July

local government areas (LGAs) in Victoria, sorted by region. Figure 7 presents the 79 Victorian LGAs.

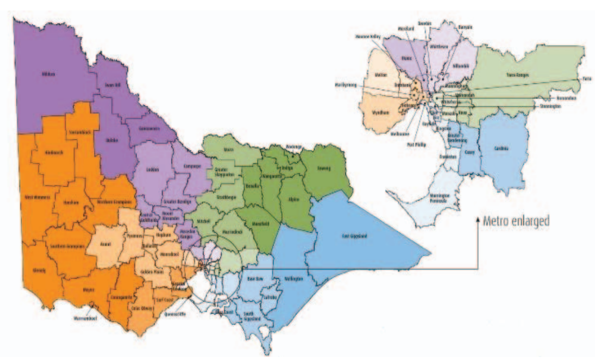

Fig. 7. Local government areas (LGA's) of Victoria

To understand what extent the movements on the LGAs are varies which contributes to the spread of COVID-19, cases needed to categorised based on LGAs. Figure 8 presents the 79 Victorian LGAs. Figure 6 illustrates daily COVID-19 cases per Victorian LGAs in July.

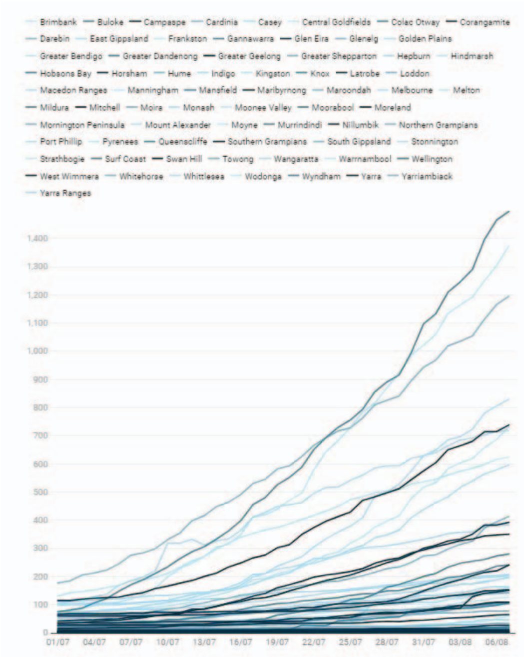

Fig. 8. Daily COVID-19 cases per LGA

F. *Analysing to what extent are the movements in the LGAs are varying*

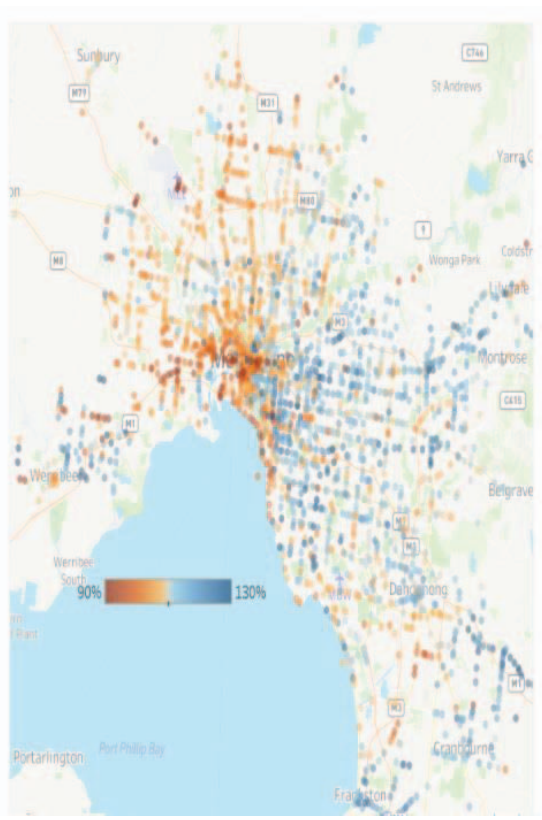

Fig. 9. Median traffic volumes compared to a reference period prior to the emergency.

Figure 9 illustrate a map view of the median traffic volumes compared to a reference period prior to the emergency. The LGAs with higher numbers of COVID-19 cases tend to have high traffic volumes even second wave restrictions were imposed, while LGAs with fewer cases have seen lower traffic volumes in April. Figure 7 and 8 illustrate which measures tending to isolate areas with reported cases can significantly reduce the number of infected. However, it is clear that only the restriction of inter-provincial mobility it is not enough to avoid an exponential growth in the number of infected that can overflow the capacity of health systems in Victoria.

V. Conclusion

The objective of this research will analyze the influence of COVID-19 on road congestion. This was the purpose of collecting traffic volume data, the number of contagions and laws imposed by the government that affected mobility and following conclusions are presented. First, a reduction in traffic was observed in the months of health emergency por COVID-19 compared to those of 2019. In addition, after the start of the restriction measures, the average daily transit had a similar reduction, the greatest decrease in which is found on weekends. From the constraint imposed stronger until the start of relief from the measures, there was a gradual increase in traffic. In general, a decrease consistent with the measures applied was observed i.e. increased restrictions reduced vehicle traffic while in ministrations, vehicle movement on the tracks analyzed was increased.

The study presents a methodological input to assess the process, government measures and the effects of such a pandemic in Victoria or other similar states in Australia. It allows to observe the influence of government restriction measures on the population. Finally, it supports the idea that in a similar new event, vehicular restriction. As the days go by and the measures taken by Victoria government begin to take effect, a change in the initial trend is expected. It is essential to monitor and evaluate whether the new trend manages to avoid the exponential growth of the number of cases. To do this, it will be useful to estimate parameters appropriate for the different stages of the crisis, before and after the implementation of prevention policies.

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