Impact of COVID-19 pandemic in rapid transit ridership in Monterrey, Mexico.

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September 5, 2020

Abstract

In the following report, we make a comparison of passengers transported by Monterrey's rapid transit system (Metrorrey) between the years 2018 and 2020. We show the decrease of ridership expected from the movement restrictions imposed as a response to the current coronavirus pandemic.

Introduction

The metropolitan area of Monterrey is the third-largest in the country [2]. It is located in north eastern Mexico, south from Texas. Means of transportation in the city include a system of public buses, a rapid transit system, taxis, ride-sharing apps and personal vehicles. The rapid transit system, named Metrorrey, consists of two lines: line one is elevated and line two has an elevated and a subway component [3]. Metrorrey transported an average of 15.3 million passengers per month in the past two years. As many places around the world, Monterrey has imposed restrictions in the movement of their residents to stop the spread of the coronavirus epidemic. In the next section, we show a brief analysis of Metrorrey's ridership data, and use our results to observe how impactful the movement restrictions have been on rapid transit ridership.

Data Analysis

We obtained Metrorrey's ridership data corresponding to the January 2018 - June 2020 period from [1]. To perform a month-to-month comparison between different years, we only considered data from the first six months of each year. That is, we restricted ourselves to the January-June period for 2018, 2019, and 2020 (see table 1). Data analysis was performed with R Version 4.0.0 [6] on a Jupyterlab Notebook [5].

We processed the data found at [1] directly in R [6]. In order to extract information about the months we were interested in, and to create table 1, we used the following script[1]:

```
df <- read.csv(file = 'Tabulado-metrorrey.csv')
passng = df$Pasajeros.transportados..... Miles.de.pasajeros.
passng = passng[!is.na(passng)]
passng2018 = passng[1:6]
passng2019 = passng[13:18]
passng2020 = passng[25:30]
table <- data.frame(c("jan", "feb", "mar", "apr", "may", "jun"), passng2018, passng2019,
 passng2020)
names(table) <- c("month", "2018", "2019", "2020")
library("xtable")
xtable(table)
```

	Month	2018	2019	2020
1	jan	13529.98	14534.62	15220.38
2	feb	14404.83	14511.12	15548.33
3	mar	15102.95	14659.78	12554.89
4	apr	14991.67	14826.92	5653.46
5	may	15999.97	16515.39	4933.48
6	jun	14314.63	14750.24	7208.06

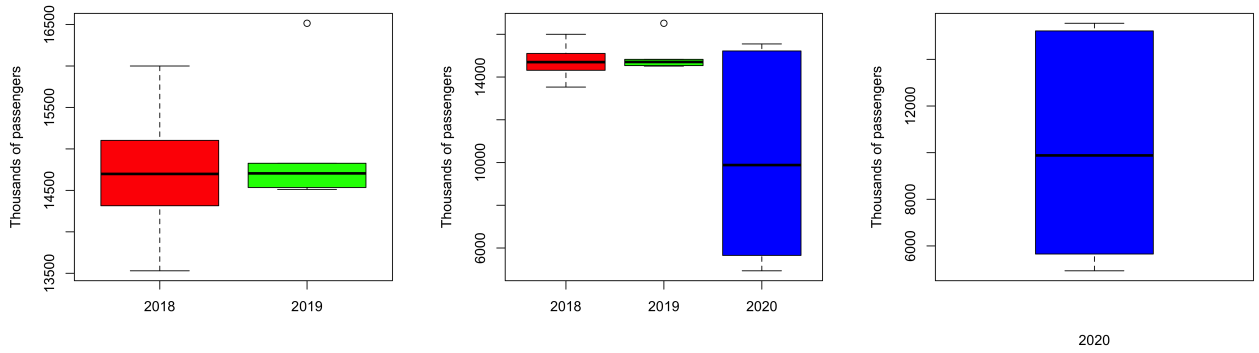
Table 1: Ridership data (in thousands) to be analysed

[1]The script and a Jupyter [5] notebook showing how we performed the data analysis and created the graphics in this report can be found at `https://github.com/palafox794/AppliedProbabilityModels/tree/master/Assignment1`

A summary of the data is shown in table 2, where it can be seen that the smallest values (the minimum, and the first quartile) for ridership in 2020 differ drastically from those of previous years. This can be further shown with the boxplots in figure 1, the violin plots[2] in figure 2 and the bar plot in figure 3.

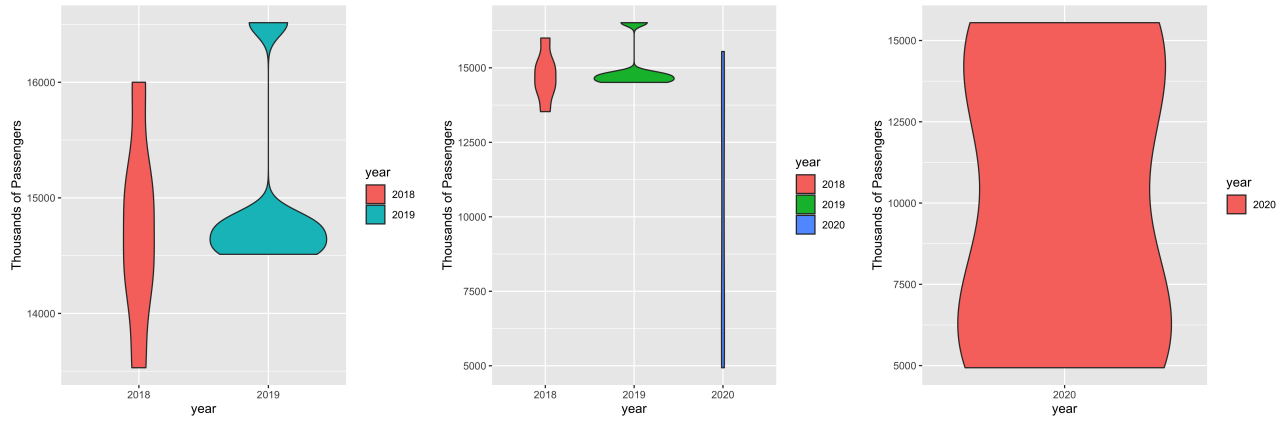
	Year (first half)	Min	1st Qu.	Median	Mean	3rd Qu.	Max.
1	2018	13530	14337	14698	14724	15075	16000
2	2019	14511	14566	14705	14966	14808	16515
3	2020	4933	6042	9881	10186	14554	15548

Table 2: Ridership data summary. Passengers in thousands.



(a) (b) (c)

Figure 1: Boxplots of January-June ridership in different years.



(a) (b) (c)

Figure 2: Violin plots of January-June ridership in different years.

Conclusion

We observe that government measures to reduce mobility in Monterrey Metropolitan area had a noticeable impact, at least with respect to Metrorrey's passengers ridership. For instance, close to 5 million people rode Metrorrey on May 2020, an 11.5 million decrease when compared to May 2019. Further analysis is needed to establish if this reduction in mobility was similar in other ways of public transport. It can also be of interest to study whether this reduced mobility stopped the spread of covid-19 in a significant way.

[2]To read more about violin plots, see [4].

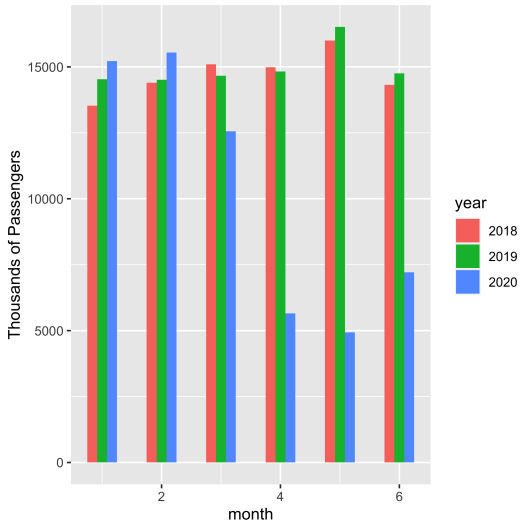


Figure 3: Bar plot of the data analysed.

References

[1] Instituto Nacional de Estadística y Geografía. Transporte Urbano de Pasajeros. Principales características del Sistema de Transporte Colectivo Metrorrey. `https://www.inegi.org.mx/app/tabulados/?nc=100100049`.

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[5] Thomas Kluyver, Benjamin Ragan-Kelley, Fernando Pérez, Brian Granger, Matthias Bussonnier, Jonathan Frederic, Kyle Kelley, Jessica Hamrick, Jason Grout, Sylvain Corlay, et al. Jupyter notebooks—a publishing format for reproducible computational workflows. In *Positioning and Power in Academic Publishing: Players, Agents and Agendas: Proceedings of the 20th International Conference on Electronic Publishing*, page 87. IOS Press, 2016.

[6] R Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria, 2020.