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The impact of COVID-19 pandemic on parcel delivery pattern in Sydney

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Abstract

The COVID-19 pandemic has changed the goods distribution patterns for both Business to Business (B2B) and Business to Customer (B2C) segments. This paper investigates the pandemic impacts on B2B and B2C parcel delivery changes in the Sydney metropolitan area. For this purpose, initially, the spatial pattern of the parcel delivery in 2020 has been compared with that of 2019 (before the pandemic) using GIS software. Based on this analysis, a significant reduction in parcels and freight deliveries to the CBD has happened during the lockdown, while the inner and outer metropolitan areas have experienced higher demand for parcel deliveries. After defining metropolitan areas with significant demand changes, major factors were identified that have contributed to the pattern. The changes are correlated with employment, internet access, and population factors. The results will support logistics stakeholders in their future practice of mitigation and disaster preparedness actions for pandemics.

Key words: Urban freight, Parcel demand, COVID-19 pandemic, Business to Business (B2B), Business to Customer (B2C)

1.Introduction

In Australia, like many other countries, the new coronavirus disease (COVID-19) has impacted not only human health but also broad ranging social and economic activities. The COVID-19 pandemic has infected more than 30,000 people and killed 910 persons in Australia as of July 2nd, 2021 (Australian Government 2021a). The adverse impact of COVID-19 on the world economy is comparable to the global financial crisis of 2008–09 or could even be worse (Loayza & Pennings 2020) and there has been impacts in many sectors such as manufacturing operations, resilience of global supply chains and logistics, as well as the automotive sector and tourism industry (Singh, Kumar, Panchal, & Tiwari 2021).

In Sydney, the most populous city in Australia, the COVID-19 pandemic has led to practicing new rules, such as social distancing and self-isolation, closure of many stores, and an exponential increase in the number of people working from home (WFH). This situation has caused a surge in the number of home deliveries and significantly changed the spatial pattern of freight distribution in the metropolitan area.

1.1 Change in delivery demand during COVID-19

Increased WFH, social distancing, and growth in shopping and entertainment in local areas resulting from COVID-19 have changed goods distribution demand and patterns across metropolitan areas. In Belgium, a survey indicated that the average loss in revenue of small retailers due to the COVID-19 pandemic was more than 70% (Beckers & Verhetsel 2021). It has been changing business activities in different sectors, including urban freight transport. Kiba-Janiak et al. (2021) investigated the impact of the pandemic on e-commerce and e-customers' behaviour in Brazil and Poland. They reported that both countries experienced a drastic increase in the number of home deliveries after the pandemic occurred. By applying a multidimensional statistical analysis, they concluded that the increase in parcel demand could lead to increased sustainability and environmental problems (Kiba-Janiak, Cheba, Oliveira, & Marcinkowski 2021).

Research also shows that North America and Europe have experienced a 100% and 50% increase in online orders during the last year, respectively (Gulc 2021). Although the pandemic has affected the number of deliveries for both B2B and B2C couriers, it's impact has been different for these two groups of couriers. For instance, while B2C increased more than 400% in Sweden and reached 50% of total deliveries, at the same time, B2B has decreased by about 25% (AIT 2020). Similarly in Poland, B2B shipments were 18.7% of total deliveries in 2020, while B2C e-commerce reached 76% (Gulc 2021).

1.2 Characteristics of B2B and B2C sectors

The rationale for the above differences is the structure of B2B and B2C sectors. Buyers and sellers in the B2B environment are both companies and act as partners with a regular plan for shopping (Du, Li, & Chou 2005; Kumar & Reinartz 2018). Therefore, their demand is consistent and is not affected by disruptive events such as pandemics (Du et al. 2005). On the other hand, the demand in the B2C market is instantaneous, and the number of its transactions is more than B2B's (Du et al. 2005; Glynn & Woodside 2012). Hence, the B2C sector possess the potential to be more affected by different events and is less predictable than B2B in the normal situation. For instance, during Christmas or Mothers' day, the demand for B2C can fluctuate dramatically (Becerril-arreola 2013). However, during the disruptive events, particularly long-lasting challenges such as the COVID-19 pandemic, the trend for both B2B and B2C sectors might be different from the regular freight pattern that should be investigated.

This research aims to answer two main questions: a) how pandemics affect the pattern of parcel deliveries, and b) what factors contribute to the change. To answer these research questions, the changes in delivery demand in Sydney metropolitan area during COVID-19 have been analysed. The analysis has been done using GIS software to investigate the shift in demand patterns and using the Chi square test to determine influencing factors. The results will provide a greater understanding of freight demand drivers during pandemics. The insights will support urban logistics stakeholders to improve the performance of deliveries during pandemics and disruptive events in general.

2. Method and material

2.1 Case study and data acquisition

Sydney, the most populous city and one of the fastest growing metropolitan area in Australia, is selected as the case study. The area that investigated in this study is shown in Figure 1. The boundaries in this figure are postcodes, and the parcel demand changes were analysed at this level.

To investigate the impacts of the COVID-19 pandemic on parcel deliveries in Sydney, changes in demand have been analysed based on data provided by a major & Business to Consumer (B2B & B2C) courier as well as a major Business to Consumer (B2C) courier. The range of data for the former is from January 2019 to December 2020, and the latter is from March 2019 to February 2020. The resolution of the data for both couriers is at least at the postcode level. The similarities of data sets in terms of range and resolution provide the unique opportunity to compare the pattern of delivery changes in the two segments during the pandemic.

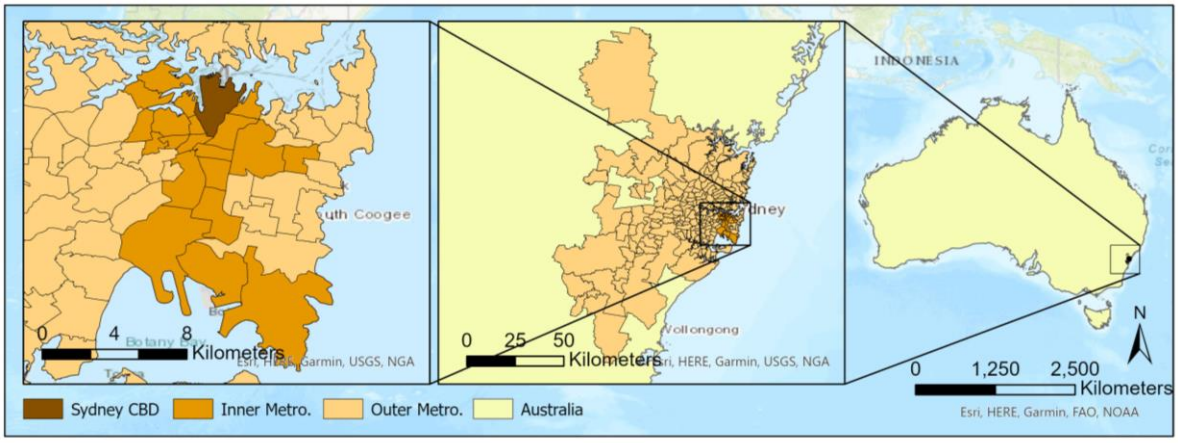

Figure 1: The study area, located in Sydney greater area, in New South Wales, Australia.

2.2 Methods

To spatially analyse the parcel demand changes in the Sydney metropolitan area that has occurred during the pandemic, three steps have been followed: 1) data preparation, 2) visualisation and analysing the pattern for parcel demand changes, and 3) identifying the factors that contribute to the changes (Figure 2). During the data preparation step, parcel delivery changes for each postcode were calculated by subtracting the amount of parcel deliveries in each month of 2020 from the data for the same month of 2019 (before the COVID-19 pandemic).

In the next step, visualisation and spatial analysis of the patterns of parcel demand changes, the prepared data was imported to the GIS software to convert the statistical data to the spatial data as maps. After preparing the maps for comparative month-versus-month demand changes, postcodes were categorised to display the pattern for the demand changes. Here postcodes were categorised based on the Manual method into nine groups. Manual interval method allows to manually add class breaks and to set class ranges that are appropriate for the data rather that

setting the classes based on the equal breaks or standard deviation. This method enables us to set a similar class range for categorising the areas based on demand for each month, where data ranges differ from month to month. Therefore, the demand changes in each postcode are more trackable and comparable for different months.

The final step involved finding reasons for parcel demand changes in Sydney greater area during the pandemic. To do so, most important factors that might potentially act as driving factors for demand changes were identified based on suggestions of experts as well as the literature. The factors identified include average income, internet accessibility, population and population density, average age, and the employment features (including total number of employed, professional employed, and labour employed). To evaluate whether the factors identified influence demand changes, the Chi-square test was applied. This test was used to find a whether there is a statistical significant relationship between two categorical variables (Mchugh 2013). Here, the Chi-square test was applied to investigate the dependency or independency between parcel delivery changes in Sydney and the selected factors. The higher the Chi-square value, the more certainty there is that a statistically significant relationship exists between factors (Fisher 1950; Schervish 1996).

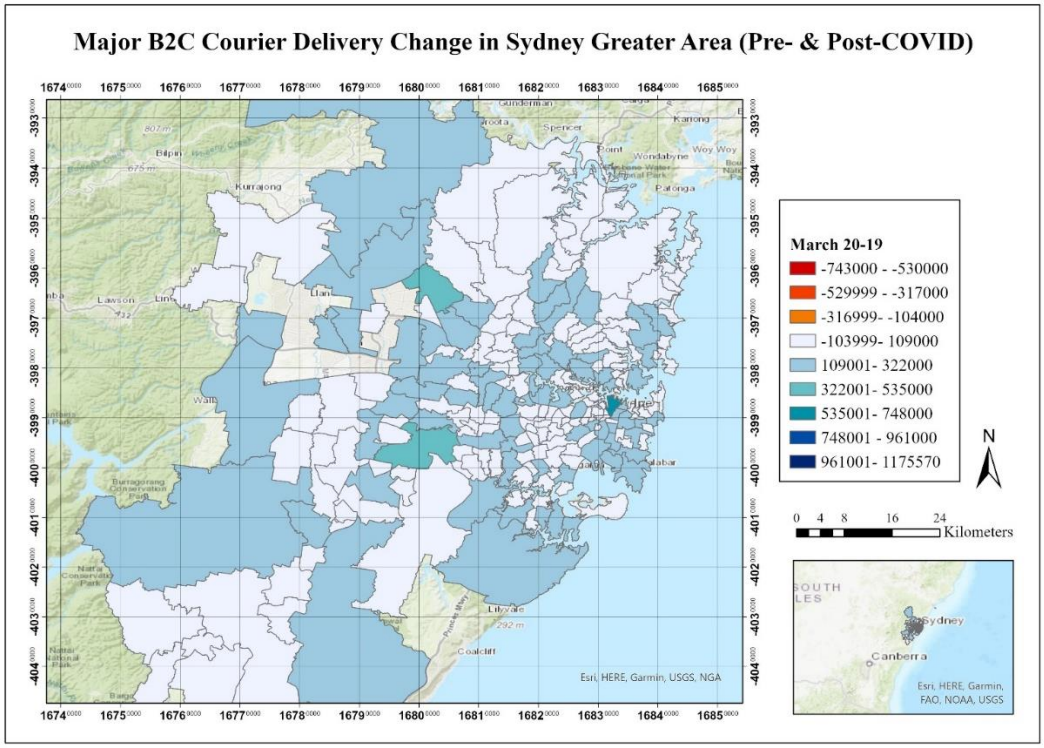

Figure 2: B2C demand change before COVID-19 (March 2020 compared to March 2019)

To be able to apply the Chi-square test to the potential factors, they were categorised by the median and standard deviation based methods. Also, the data of each factor was divided into three groups, low, medium, and high. For instance, to categorise the average income, a median-based method was applied. Here, the median of average income was calculated for all postcodes. Then, the postcodes with an average income lower than 80% percent of the median, were considered in the low-income group. Postcodes that have an average income of more than 80% and less than 120% of the median were described as a moderate income. Finally,

postcodes described as being in the high-income group are those having more than 120% of the median income.

To make sure that all aspects of parcel demand changes were investigated, demand changes in April, October, November, and total demand changes (based on the data from both B2C and B2B & B2C couriers) were tested separately against the selected variables. Demand changes in April were chosen to be analysed because it is the first month that restrictions were placed by the government. Also, in October and November, the parcel demand is more logical in comparison with the demand in December, which is more affected by social events such as Christmas and associated retail promotions.

3. Results

3.1 B2C demand for parcel deliveries

A major B2C courier provided monthly demand data for all postcodes within greater Sydney from March 2019 to February 2021. Figure 2 shows the B2C demand changes before the pandemic based on the data for March 2019 and March 2020 in different postcodes.

In the map presented in Figure 2, the demand changes are categorised into nine groups. The darker the blue, the more parcel demand growth occurred. On the other hand, the red categories show decreases in parcel demand changes. The numbers next to each category represent the range of demand changes in this category. For example, postcodes in the dark blue category experienced growth of between 961,001 to 1,175,570 in March 2020 compared to March 2019, and the parcel demand in dark red areas means the demand was reduced by -743,000 to -530,000.

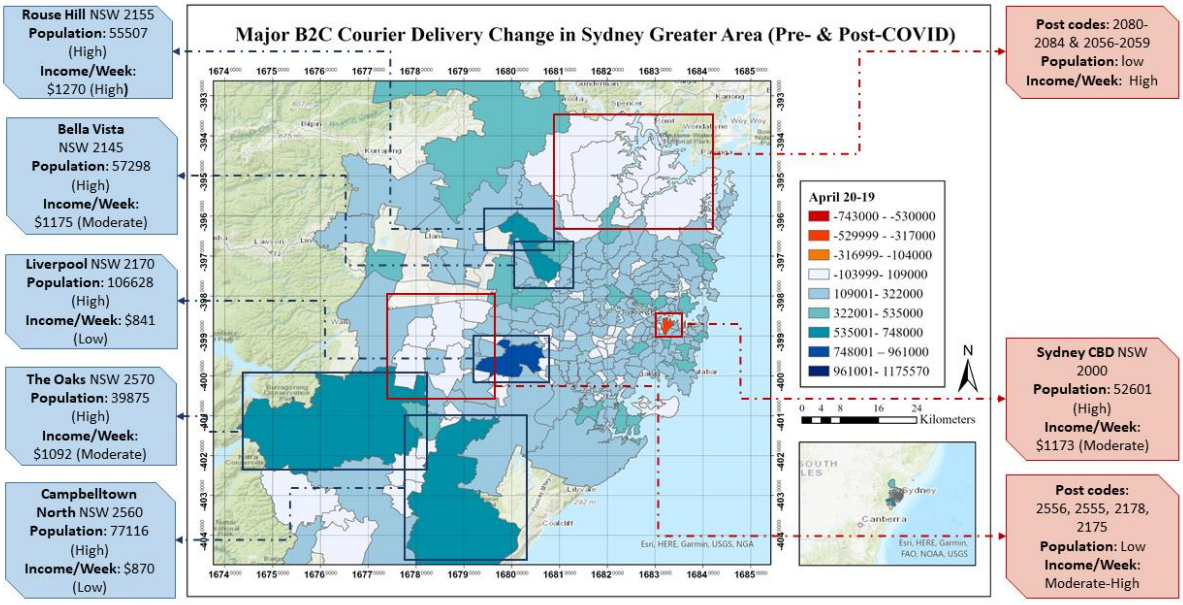

Figure 3: B2C demand changes after COVID-19 (April 2020 compared to April 2019)

By applying the same methodology, the parcel demand in April 2020 is compared with the demand in April 2019 (shown in Figure 3). In this map, the postcodes and hotspots that

experienced a high increase or decrease in parcel demand changes are highlighted. The map provides additional information, such as the population and income of highlighted areas. For instance, the red postcode in Figure 3 is Sydney CBD with the 2000 postcode, a population of 52,601, and an average income of A$ 1,173 per week. It also mentions that the population and income of Sydney's CBD are high and moderate respectively, in comparison with all other postcodes.

3.2 B2B & B2C demand for parcel deliveries

A major courier delivering both B2B & B2C consignments provided monthly demand data from January 2019 to December 2020 at the postcode level in greater Sydney that enabled us to analyse the demand changes before and during the COVID-19 pandemic. The changes in B2B & B2C delivery demand before COVID-19, like B2C's, represent a uniform pattern (Figure 4) with no significant changes in deliveries based on the data for March 2019 and March 2020 (before COVID-19).

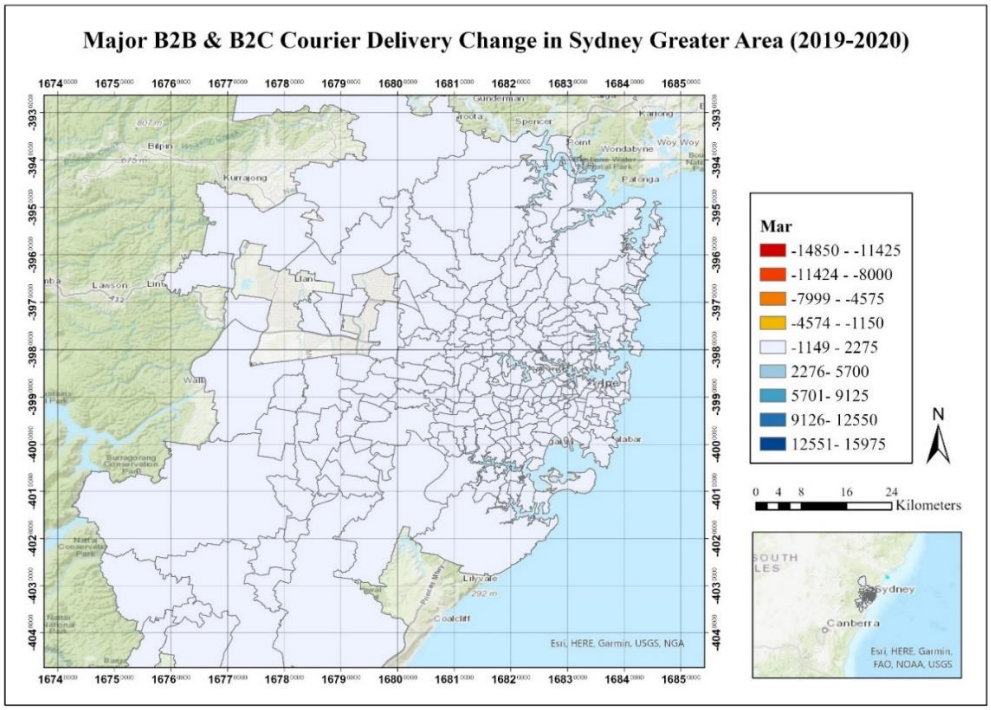

Figure 4: B2B & B2C courier demand changes before COVID-19 (March 2020 compared to March 2019)

By comparison, the demand changes between April 2020 and the same month in 2019 is illustrated in Figure 5. Highlighted areas are those that are mostly affected by the pandemic.

To accurately determine the parcel delivery pattern in Sydney, the case study is divided into three zones. Postcode 2000 (Sydney's CBD) is considered the first zone. The second zone is the inner metro, including all postcodes around the CBD, and the rest of the postcodes are categorised as outer metro areas. The amount of parcel delivery in each zone, for both B2C and B2B & B2C couriers, is normalised based on delivery in March 2019. It enables us to compare the rate of delivery changes in different zones. These changes for both couriers are illustrated in Figure 6.

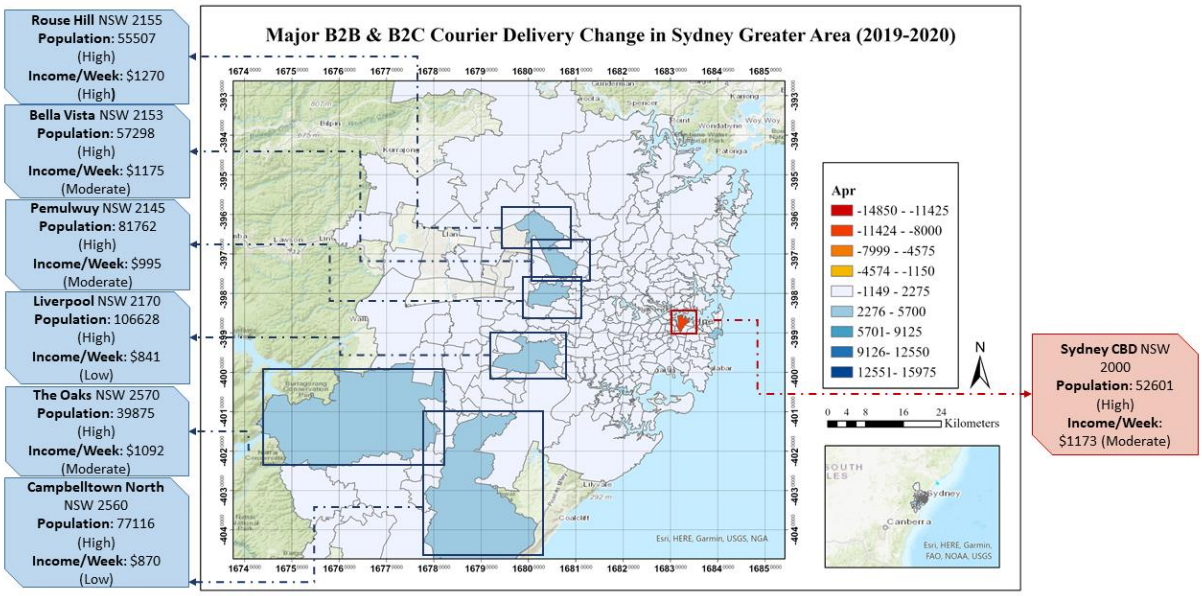

Figure 5: Changes in B2B & B2C demand pattern caused by COVID-19 pandemic (April 2020 compared to April 2019)

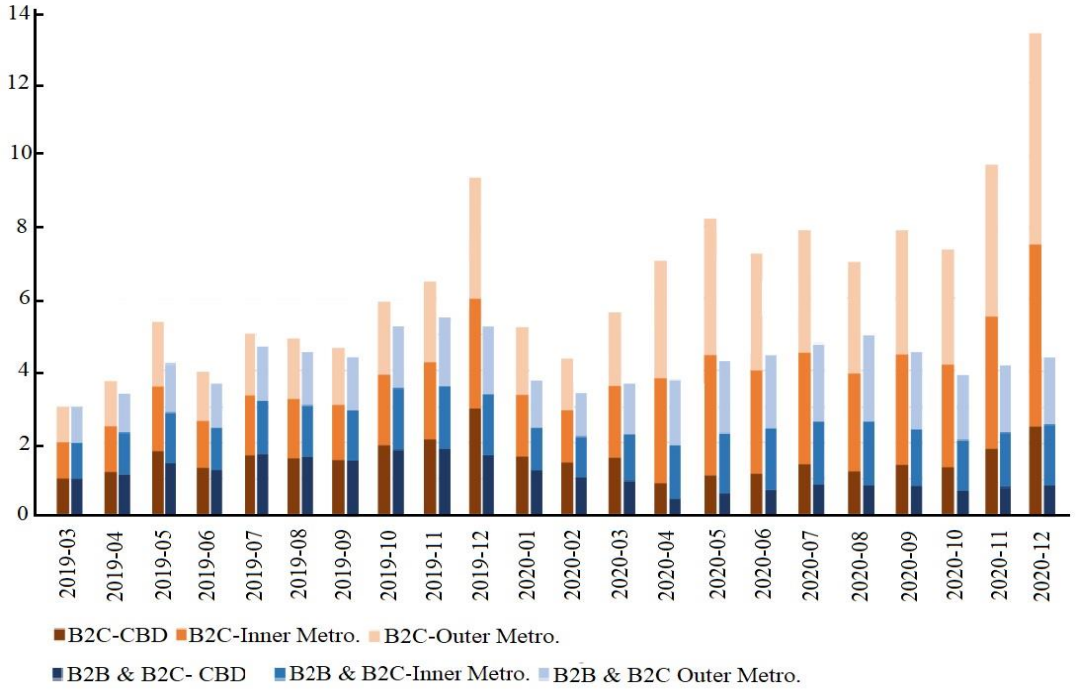

Figure 6: Trends in parcel demand in Sydney before and during COVID-19 pandemic

Later, as discussed in Section 2, the Chi-square test is applied as the final step. Table 1 shows the relationship between demand changes in various periods of time and the selected variables. The variables with Chi-square value higher than the significant level (0.05) are considered as the dependent variables in the table, such as the total employment with April delivery changes, while the rest have been considered as independent.

Table 1: Relationship between parcel demand changes and selected variables

	Total Employed	Professional Employed	Labour Employed	Average Income	Internet Accessed	Average Age	Population	Density
April Delivery Changes	Dependent	Dependent	Dependent	Independent	Dependent	Independent	Dependent	Independent
October Delivery Changes	Dependent	Dependent	Dependent	Independent	Dependent	Independent	Dependent	Dependent
November Delivery Changes	Dependent	Dependent	Dependent	Independent	Dependent	Independent	Dependent	Dependent
Total Delivery Changes	Dependent	Dependent	Dependent	Independent	Dependent	Independent	Dependent	Dependent

4. Discussion

Based on the data from B2C and B2B & B2C couriers, the pattern of Sydney's parcel demand in March 2020 was similar to March 2019, which indicates that a large proportion of areas experienced little or no growth in demand, with a few postcodes including the CBD, faced moderate growth. The maps in Figure 2 and Figure 4 produced by GIS show this trend.

The findings from spatially analysing the demand changes in Sydney greater area for B2C and B2B & B2C couriers during the COVID-19 pandemic demonstrate a significant drop in parcel delivery in CBD. However, the outer metropolitan areas, especially western postcodes, have experienced considerable growth for both segments immediately post lockdown in April 2020. This trend can be seen in Figures 3 and 5 that represent the pattern of parcel delivery changes in B2C and B2B & B2C segments, respectively.

Unlike the usual trends of B2C and B2B & B2C demand, the drastic changes in both couriers has been observed during the COVID-19 pandemic. This represents an unbalanced pattern with a significant increase in the delivery demand in the inner and outer metropolitan postcodes and a reduction to the CBD's demand. The pattern of parcel delivery in Sydney before and during the pandemic is shown in Figure 6. Based on this graph Sydney's CBD experienced a massive decrease in parcel delivery in April 2020 in both B2C and B2B sectors. Afterward, the delivery volume in both couriers was gradually increased, which indicates that the CBD is recovering and backing to the new normal situation.

Unlike the parcel delivery trend in the CBD, the inner and outer metro postcodes have experienced a considerable increase in the amount of delivery immediately after starting the pandemic. In 2019, the rate of delivery changes in the CBD and the inner and outer metro postcodes was more or less equal. However, the pandemic has disturbed this balance, and from April 2020, parcel delivery in the inner and outer metro areas increased faster than in the CBD. This trend is more noticeable in B2C rather than B2B & B2C.

The reason for the enormous changes in B2C deliveries during the pandemic relates to the several restrictions put in place by the NSW government, including lockdown, social

distancing, and limited capacity for public transport and offices that led to a high proportion of office workers and customers working from home.

Overall, throughout the Sydney CBD, the parcel demand drop started in March 2020, and the lowest amount of deliveries were in April 2020. ABS statistics reported an increase in the unemployment rate to 6.2% in 2020. Since then, business survival initiatives, such as the increase in JobKeeper allowance and loans for small and medium-sized businesses, were put in place by the Australian government (O'Sullivan, Rahamathulla, & Pawar 2020). On the other hand, from 27 April 2020, the JobSeeker allowance was doubled for six months (ending in September), which contributes to keeping the balance in B2C deliveries (The Guardian 2020). Hence, a gradual increase in the amount of parcel delivery has been observed after April 2020. It is due to the gradual increase in office occupancy as well as easing the COVID-19 restrictions and supportive initiatives by the government, aimed at economic recovery and supporting return to work in the CBD.

Based on the Chi-square test, the observed parcel demand changes are dependent on levels of employment, internet access, population, and the population density. These factors acted as drivers for the demand changes during the pandemic. Defining the factors is the fundamental and a highly crucial step to model and predict the impact of pandemics on demand changes to be prepared for the future disasters. Yet, it is unknown based on our present knowledge whether the factors have positive or negative impact on the delivery changes that has been considered as the future line for the present study.

5. Conclusion

The COVID-19 pandemic and the responsive measures, such as lockdown, social distancing, and limited capacities for offices, has altered the goods distribution pattern in many metropolitan areas all around the globe. While in some countries, both Business to Business (B2B) and Business to Customer (B2C) couriers experienced a drastic increase in delivery demand, in others, only B2C's demand grew, and B2B's declined. These variations are due to characteristics of B2C and B2B environments in different countries, including the structure of buyers and sellers, as well as the frequency of shopping which are discussed in the introduction.

In this research, the Sydney greater area is selected as the case study, and the parcel delivery data are collected from two major couriers. The focus of one of the couriers is on B2C customers, while the other one covers both B2C and B2B clients. The range of both datasets is two years, and their resolution is at the postcode level. To demonstrate the impact of COVID-19 on Sydney's goods distribution, first, the demand changes before and during the pandemic have been analysed spatially. Based on our analysis, the demand in Sydney metropolitan areas decreased during the pandemic, while some outer postcodes, especially in western areas experienced an increase in parcel demands.

Based on the observations, both B2C and B2B & B2C couriers experienced an increase in parcel delivery to CBD from March 2020 onward. The reason is the government's supportive measures and people returning to CBD offices. In a different trend, an increase in both couriers

have been observed in the inner and outer metro areas from the beginning of the pandemic. This is mainly due to a big proportion of office workers practicing working from home as well as the closure of several stores and shopping centres.

The major factors that might be relevant to the demand changes have been examined through the Chi-square test to determine those that are correlated with the changes. Based on the results, demand for parcel delivery in Sydney was found to be dependent on different levels of employment, internet access, population, and the population density.

Although the insight presented contributes to future disaster preparedness and mitigation plans, future studies need to be done on how the factors that are correlated with delivery changes act. To what extent each of the factors affect the delivery change and in what direction, negative or positive. In addition, in this study, mainly demographic factors have been investigated, while other factors, such as the status of the logistic systems or the provided civic services, might also be relevant to the observed changes.

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