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Mobility Behaviour in View of the Impact of the COVID-19 Pandemic—Public Transport Users in Gdansk Case Study

Adam Przybylowski [1,*], Sandra Stelmak [1] and Michal Suchanek [2]

[1] Department of Transport and Logistics, Gdynia Maritime University, 81-225 Gdynia, Poland; sandra@stelmak.pl
[2] Department of Economics and Management of Transport Companies, University of Gdansk, 80-309 Gdańsk, Poland; michal.suchanek@ug.edu.pl
* Correspondence: a.przybylowski@wn.umg.edu.pl

Abstract: The COVID-19 pandemic, like an earthquake, shocked our civilization and is still having a devastating effect on our lives. Guaranteeing an appropriate level of safety in the conditions of an epidemic is a highly problematic issue due to the subjectivism of social individuals, their diverse attitudes, and past life experiences. Taking into account the World Health Organisation (WHO) guidelines regarding the pandemic, authorities all around the world have reacted by issuing the necessary sets of advice and legal acts. This resulted in immediate and severe implications on mobility styles. The purpose of this paper was to investigate the impact of COVID-19 on mobility behaviours with special regard to public transport users, in terms of their willingness to travel and their safety criteria perceptions. The city of Gdańsk, in Poland, located on the Baltic Sea, has been taken as an example. The hypothesis was as follows: the epidemic phenomenon may substantially affect mobility behaviours in terms of subjective levels of safety and the mental comfort of public transport users, resulting in avoiding this form of transport. In accordance with the survey results, carried out among the users, 90% of respondents resigned or limited their usage. Almost 75% of them plan to return to using public transport when the epidemic situation has stabilized. The others, unfortunately, have completely lost hope that public transport will ever be safe. These results indicate decisively that the future of public transport in cities, and the willingness of passengers to use it once the epidemic is over, depends majorly on the perceived comfort and safety during the epidemic. This means that transport policies should be focused on enhancing these perceptions and making sure that the image of public transport is not in further decline; otherwise, it could mean an almost impossible effort to encourage passengers to return to using sustainable modes of transport in the future.

Keywords: mobility behaviour; public transport users; COVID-19 pandemic; Gdansk agglomeration

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1. Introduction

On 11 March 2020, the World Health Organisation (WHO) announced COVID-19 [1] as a global pandemic [2]. This phenomenon has been compared to a natural disaster [3] and continues to have numerous and serious social and economic implications in different sectors, including transport, travel, and mobility. The emergency has obliged several governments to prohibit unnecessary mobility circulation, and to adapt the mobility of essential workers and goods to safeguard health and contain the propagation of the virus. Authorities and operators all over the world had to act quickly and find rapid and efficient solutions to guarantee safe mobility. These actions have had a tremendous impact on the usual advantages of mobility [4], consequently shaping new trends [5,6] within activity-travel behaviours [7], including public transport. This has put in danger the possibility of making mobility more sustainable in agglomerations worldwide [8–10] and has also caused severe financial challenges to the city authorities.

The purpose of this paper is to investigate the effects of the COVID-19 pandemic on mobility behaviours with special regard to public transport users, in terms of their

willingness to travel and their perceptions of safety criteria. Restrictions related to public transport entered into force in Poland on 31 March 2020, establishing some specific orders and bans, for example, no more than 50% of all seats in a vehicle were allowed to be occupied. In addition, recommendations for travellers have come into force where some strict rules to be followed have been defined. At the same time, cities were able to introduce their own rules or changes regarding public transport operations before the introduction of official regulations. In this paper, the city of Gdańsk, located in the Baltic Sea Region [11], has been taken as an example. The hypothesis is as follows: the epidemic phenomenon may seriously affect mobility behaviours in terms of subjective levels of safety and the mental comfort of public transport users, resulting in avoiding this form of transport.

2. Research on Mobility during the COVID-19 Epidemic: State-of-the-Art Review

Mobility choices [12] concern travel data [13] and depend on many factors [14]: age [15], sex, family status, life stage, holding a driving license, and access to a car, as well as such features as accessibility, fares, travel time, comfort, safety, punctuality, reliability, directness, multimodality, sustainability, and so forth. [16]. The mobility pattern analysis, taking into account the needs of different stakeholders, is usually carried out to enhance and justify political decisions [17]. Some research requires urgent attention, given what is ultimately at stake in several countries: restoring the ability of public transportation systems to fulfil their societal roles [18].

Exploring the impact of the COVID-19 pandemic [19–23] on mobility behaviours [24–27] requires truly an interdisciplinary [28–31], multidimensional [32–34], and holistic approach [35–40]. Societies all over the world have had to change their mobility behaviours and habits in their own way. Restrictions and limitations have appeared in different countries at different times. Asia was one of the first regions with new restrictions implemented, limiting mobility and other social activities. Although the pandemic was a global one, its responses were local, depending on the local governance, socio-economic, and cultural contexts [41]. One study revealed a growing awareness of risk among citizens and reported many were engaging in protective behaviours with increasing frequency, but underestimated their risk of infection relative to the average person in the country. Social distancing and handwashing were most strongly predicted by the perceived probability of personally being infected. However, a subgroup of individuals perceived low risk and did not engage in these behaviours [42].

A growing number of publications reveal great concern [43–49] about the influence [24,25,50–52] that the coronavirus pandemic might have on mobility issues [53–56], including public transport users [44,48,57–59]. The conducted survey-based studies suggest that the pandemic has had a tremendous influence on mobility style changes, such as a drop in shared mobility or increased dependency on private mobility [60]. In accordance with research conducted during the lockdown in Spain, adults limited their walking time by 16.8% and the energetic activities by 58.2%. Following the results obtained in Chicago, there is a growing concern about equity in the context of shaping multimodal transportation solutions while such a pandemic crisis continues [7].

Although mobility has been significantly reduced by lockdown and an increase in teleworking, some inhabitants have changed their transport behaviours, switching to cars and, to a lesser extent, cycling. The first analyses indicate the severe challenges that public transport is faced with. They already show signs of structural change, and the path to return to the pre-pandemic situation will be a very long one. Moreover, it will depend mostly on actions in the field of health and safety, rather than transport. For systems based on electric means of public transport [61], the barrier to development may involve the higher cost of purchase, which in turn determines the support systems for public authorities at different levels.

Unfortunately, road users do not feel safe these days because of the contagion risk and ultimately choose private cars, especially for leisure activities. However, due to the lack of alternative modes of transport, many people still have to use public transport. In order

to keep mobility sustainable, safety concerns, feelings, and anxiety for the use of public transport in pandemic conditions should be determined and investigated [54,62]. Despite ongoing car domination in the modal split and an increased interest in the so-called "active" modes, in the urban functional area, public transport still remains one of the key modes, for example in Poland [63]. The pandemic resulted in a dramatic reduction in demand for public transport [58] and a considerable decline in farebox revenue. Actually, it is crucial that public transport operators focus on safety considering the need for social distancing. These days, great concern should be expressed regarding the people with lower-income jobs. This part of society must work outside their homes and continue to use public transport. Its operators should be encouraged to keep frequency and capacity, enabling travellers to keep a safe distance [64]. Since many public transport operators currently have financial difficulties, the authorities could support them with financial support in the meantime [65].

It seems that in the context of non-binding requests, soft measures, such as campaigns, to promote a reduction of non-essential travel, might be more effective if they properly convey the severity of the threat posed by the pandemic and appeal to the group, rather than the individual, emphasizing the behaviours of others [66]. Moreover, analysing behavioural changes in four Japanese metropolitan areas, based on Google and Apple mobility data, proved that regular patterns of behaviour have been significantly disrupted by the pandemic, and that behavioural inhibition manifests differently depending on urban structural and climatic factors [67]. Furthermore, the long-term effects may contribute to the emergence of more permanent changes related to smart working and other daily activities, thus reducing mobility needs and overall fossil energy consumption. These developments can promote research and new practices, stimulating sustainability transitions [68], improving understanding of the role of governance in transitions, and bringing to attention the ethical and policy implications of the shock effect in numerous dimensions.

On the other hand, results obtained in Italy showed that women were less likely to walk during the pandemic than men. The respondents preferred to continue remote work to reduce the risk of infection, and they restrained from daily travel needs to pursue isolation, being, at the same time, ready to use micromobility during the pandemic [4]. The results investigating mobility resilience and sustainability showed that the implementation of environmentally friendly strategies is not explicitly aimed at improving resilience. However, their influence matters in terms of response and recovery, and one benefit involves their positive effect on the environment and climate change.

Moreover, because of restricted mobility, trips to schools and offices have been reduced almost to zero [41]. People have preferred recreation, green spaces and active transport, perhaps showing the true needs that should be met in future cities. In another study, the findings revealed that the possibility of infection made citizens less eager to take risks; they reduced commuting to shops, retail, and even recreation locations, especially in high-population-density countries and among older subpopulations specifically exposed to the virus and its consequences. Among all modes of transport, a huge change in mobility has been noted, as companies, schools, and shopping centres have been closed [4]. Meanwhile, the developed best-worst method (BWM) has been used to analyse pre- and post-pandemic mobility behaviours. This tool appears to be simple and applicable to providing effective solutions in the analysed context [69]. In order to increase the quality of life, including the quality of public health, there is a need for policies to promote urban regeneration, green infrastructures, ecosystem services, and truly sustainable mobility [70].

Considering the COVID-19 impact, mobility patterns have been also explored in relation to risk-taking attitudes. This element plays a crucial role in forecasting the reduction in human mobility and increasing social confinement worldwide. It seems that risk-averse regions accommodated their behavioural activities earlier and better when confronted with COVID-19 [71]. Taking into account mild and less restrictive Swedish government regulations related to social distancing behaviours, some interesting findings have been noted, based on mobile phone data. There has been a 64% average increase in the population daytime presence in residential areas and a 33% average decrease in industrial and commercial

areas. The results also revealed that residents limited their mobility significantly to their home proximity, regardless of the socioeconomic and demographic features of a district [72].

The smartphone user data may be useful for following activity and controlling the evolution of the epidemic, in order to support public health decision-makers [73]. The research results obtained by Polish scientists show that there is a slightly negative relationship between public transport mobility changes and new COVID-19 cases. They also prove that the adoption of severe restrictions resulted in effective social distancing on public transport, regardless of the local state of the epidemic, substantially minimizing mobility [74]. However, while using digital technologies [75,76] to track and trace mobility [47,77,78] in order to combat the pandemic outbreak, we also have to remember the legal, ethical, and privacy challenges and barriers [79].

In the end, we may observe quite a different approach in various countries to shaping mobility behaviours among their inhabitants during the pandemic. Paris and Milan are good examples; their city authorities temporarily have turned car lanes into bike lanes and sidewalks. Likewise, the popularization of cycling and walking as a healthier and more responsible form of mobility has intensified. These kinds of solutions are also present in Berlin, Mexico City, and Vancouver, and in Paris, the epidemic was treated as a challenge and opportunity for mobility behaviour development, not as a direct threat to functioning public transport.

3. Materials and Methods

In order to achieve the aims of this work, heuristic methods were used. The diagnostic survey method was also implemented to identify mobility behaviours with special regard to the level of safety and comfort of passengers. The study was conducted with a questionnaire among 302 respondents using public transport in Gdańsk, an important agglomeration and a popular tourist destination in northern Poland in the Baltic Sea Region [80]. The research concerned passengers' mobility behaviours before and during the COVID-19 pandemic. The target group of the study included people over 18 with access to public transport infrastructure. It was a random sample, not limited to gender, occupation status, or other factors. Among the respondents, 73.64% of them were women and 26.36% were men. The majority were residents of the city of Gdańsk, and 84.84% of the respondents were 18–30 years old, 12.64% of them were 31–45 years old, and 2.17% were 46–60 years old. There were a few respondents over 60. The responses were collected in May and June 2020. The questions in the questionnaire were divided into two main parts: the first part regarded the most relevant issues related to public transport before the outbreak of the coronavirus epidemic; the second part concerned the same issues, but already in the course of the coronavirus epidemic.

Before the pandemic, 57% of the respondents declared using public transport every day, and 24% of them were using it a few times a week. Only 19% of the passengers were using public transport less regularly. This shows the scale of frequency regarding the use of public transport in Gdansk, which resulted from an existing transport infrastructure of relatively good quality and quite an optimal public transport organization system in the city. Moreover, accessibility to numerous means of transport gives its users the possibility of reaching their destination in a more convenient way. There were 70% of respondents using at least two means of transport in Gdansk. However, the respondents still often claimed that they use public transport because of a lack of a private vehicle—64% of people who participated in the survey.

Only one fifth use public transport because they take care of the natural environment, which shows a kind of mobility behaviour and pro-ecological awareness of the inhabitants of Gdańsk.

The respondents were asked about their use of public transport and the factors affecting their feelings of comfort (Table 1) and safety (Table 2) in public transport vehicles before the pandemic.

Table 1. Factors affecting the feeling of comfort in public transport before the pandemic (% of answers).

Factor	Definitely Disagree	Disagree	Neither Agree nor Disagree	Agree	Definitely Agree
Number of passengers	3.3	2.3	3.6	21.5	66.9
Tidiness	2.6	3.0	6.0	42.1	44.1
Politeness of the driver	9.6	22.8	20.0	29.1	16.2
Behaviour of other passengers	4.3	1.7	7.3	28.5	56.0
Air conditioning	3.0	5.3	8.3	41.8	39.4
Emergency information	3.6	3.6	8.6	38.4	43.4

Source: Own calculations based on primary research.

Table 2. Factors affecting the feeling of safety in public transport before the pandemic (% of answers).

Factor	Definitely Disagree	Disagree	Neither Agree nor Disagree	Agree	Definitely Agree
Driving skills of the driver	5.6	4.3	8.9	34.4	44.4
Number of passengers	4.0	10.9	14.2	31.8	36.8
Technical state of the vehicle	3.6	5.6	7.0	39.7	41.7
Time of day (day/night)	7.6	13.9	12.3	30.5	33.4
CCTV systems	5.3	18.2	17.9	33.4	22.8
Behaviour of other passengers	3.3	0.7	2.3	14.9	76.5

Source: Own calculations based on primary research.

The majority of passengers declared that most of the factors are important or particularly important in creating a feeling of comfort during their public transport trips. Based on the percentages of "definitely agree" answers, one could argue that the number of other passengers in the vehicles and their behaviour are the most important factors, whereas politeness of the driver and air conditioning are the least important ones. The fact of the matter is that, in the majority of public transport vehicles, passengers have no contact with the driver unless they buy tickets; unless they have had a bad experience along the way, they are rather unlikely to point out the politeness of the driver as the determining factor for their feeling of comfort during a public transport trip.

Other passengers are also one of the key factors regarding the feeling of safety in public transport vehicles, with their behaviour being the key factor affecting that feeling. Driving skills and the technical state of the vehicle also significantly affect the feeling of safety, while the existence of CCTV systems was declared to be the least important, possibly due to a relatively low belief about their effectiveness.

Further results of the study show that not only was general transport behaviour affected by the pandemic but also the hierarchy of beliefs in terms of safety and comfort in public transport.

4. Results and Discussion

The COVID-19 epidemic upset the functional stability not only of public transport in the city, but primarily the lives of the inhabitants in every aspect. Implementing government restrictions concerning the limited number of passengers in public transport vehicles was a logistic challenge for this kind of transport. Public transport administrators had to adapt to a new policy that was updated as per the epidemic situation across the country. The implemented limited number of passengers and stay-at-home policies made stationary work and learning turn into e-learning and working online. Thus, the new reality could significantly affect the number of passengers using public transport. Inhabitants were more inclined to limit their mobility and social lives. However, they are not the only reasons for the citizens' mobility decrease.

In the survey, 44% declared a decline in using the public forms of transport, and 47% declared a full resignation from this type of travel. This means that only 9% of the respondents used public transport during the pandemic as often as before the pandemic. This shows the scale of changes in mobility behaviour due to the epidemic.

The survey participants have been asked about the reasons for limiting or resigning from public transport. In the group of respondents limiting their use, the most common answer (49% of people) involved a switch from a job or learning in a stationary mode to working online or e-learning. Nevertheless, they also pointed out fear of the new coronavirus infection (40%). Among one-third of the participants, their limited mobility was caused by the possibility of fulfilling their responsibilities online, and 14% changed their mode of transportation to a private one.

Among the respondents who resigned from public transport, the most common answers were similar, with one exception. The most important reasons also involved a change of work or learning mode and fear of infection with COVID-19. However, in this case, 42% of people declared changing their mode of transportation to a private vehicle, which makes a difference of about 22 percentage points.

The public in Gdańsk feels less safe using public transport than before the pandemic, which significantly affects attitudes towards using this kind of transport in everyday life. This shows the size of changes in habits and adaptation to the new epidemic reality for the inhabitants of Gdańsk. The respondents were asked about the factors affecting their feeling of comfort (Table 3) and safety (Table 4) in public transport vehicles during the pandemic.

Table 3. Factors affecting the feeling of comfort in public transport during the pandemic (% of answers).

Factor	Definitely Disagree	Disagree	Neither Agree nor Disagree	Agree	Definitely Agree
Number of passengers	3.8	2.6	1.9	14.8	77.0
Tidiness	3.2	3.8	11.5	27.6	53.8
Politeness of the driver	14.1	21.8	27.6	21.8	14.7
Behaviour of other passengers	3.8	3.2	6.4	23.7	62.8
Air conditioning	4.5	7.1	18.6	301	39.7
Emergency information	5.1	7.7	18.6	34.6	34.0
Fear of becoming infected	11.5	12.2	12.2	21.8	42.3
Fear of insufficient disinfection	11.5	12.2	17.3	21.2	37.8
Fear of other passengers not following the hygienic regime	9.6	7.7	9.6	15.4	57.7

Source: Own calculations based on primary research.

Table 4. Factors affecting the feeling of safety in public transport during the pandemic (% of answers).

Factor	Definitely Disagree	Disagree	Neither Agree nor Disagree	Agree	Definitely Agree
Driving skills of the driver	8.3	11.5	12.8	34.0	33.3
Number of passengers	5.1	3.8	3.8	22.4	64.8
Technical state of the vehicle	6.4	6.4	9.6	40.4	37.2
Time of day (day/night)	48.1	16.0	19.9	25.6	26.3
CCTV systems	8.3	19.2	19.2	34.0	19.2
Behaviour of other passengers	3.8	1.9	3.2	23.1	67.9
Fear of becoming infected	12.8	11.5	13.5	21.8	41.0
Fear of insufficient disinfection	10.9	11.5	14.1	23.1	40.4
Fear of other passengers not following the hygienic regime	8.3	10.9	10.2	12.8	57.7

Source: Own calculations based on primary research.

In the case of factors affecting both comfort and safety during the pandemic, three additional factors were identified, and passengers were asked to decide to what extent they were important for them. Still, the most important factors for the feeling of comfort of passengers are the number and behaviour of other passengers, as well as the fear of other passengers not following the hygienic regime. Furthermore, the tidiness of the vehicle became a far more important factor than it had been before the epidemic.

Whereas the behaviour of other passengers was also a significant factor in feeling safe before the epidemic, the number of them was not that relevant. However, during the epidemic, the number of passengers became just as important, not only in terms of the feeling of comfort but also for the feeling of safety. The fear of other passengers not following the hygienic regimes is also an important factor for the feeling of safety, more than the fear of becoming infected. Factors such as CCTV systems or the time of day were not significantly important for the analysed passengers in Gdańsk.

During the implementation of the Polish anti-COVID-19 policy, the city authorities tried to meet new restrictions and the operations of public transport were limited. A miscalculation of the number of public transport vehicles to the number of passengers caused an overcrowding effect, and keeping a social distance was impossible. This could also be one of the reasons for the limitation or resignation from public transport. The situation was soon rectified, and the number of vehicles increased and the timetable was updated. Nevertheless, some people had already limited or resigned from public transport.

It is worth shaping the culture of mobility not only among Gdansk citizens, but primarily among all Polish citizens in this manner. Changes could bring measurable long-term benefits. Despite the significant scale of restraining mobility among the inhabitants of Gdansk, 74% of respondents declared openness and willingness to return to using public transport after the epidemic situation stabilizes. The return to public transport is directly associated with the passengers' sense of safety; therefore, the local government should take care of the inhabitants and create safe mobility conditions within the city, especially during the pandemic and imminent climate crisis.

In order to verify which groups of passengers are the most likely to resume using public transport services after the epidemic, cross-analyses under Pearson's chi-square test were conducted. One of the variables always involved a response to the question "How likely are you to go back to using public transport services after the epidemic?", while the second variable changed. The *p*-values for the tests are presented in Table 5.

Table 5. Pearson's chi-square independence test—*p*-values.

Variable	*p*-Values
How often did you use public transport before the epidemic?	0.13
How comfortable did you feel in public transport before the epidemic?	0.56
How safe did you feel in public transport before the epidemic?	0.78
Gender	0.64
Age	0.72
Socio-economic status	0.27
Place of residence	0.47
How comfortable do you feel in public transport during the epidemic?	0.00
How safe do you feel in public transport during the epidemic?	0.05

Source: Own calculations based on primary research.

Interestingly enough, the willingness to return to using public transport after the epidemic is correlated only with two of the analysed factors—the feeling of safety and the feeling of comfort in public transport during the epidemic. The declared feeling of comfort and safety before the epidemic and the frequency of its use before the epidemic turned out

not to be statistically significant, nor did the age, gender, socio-economic status, or place of residence. Given the assumption that these results are true, they indicate decisively that the future of public transport in cities, and the willingness of passengers to use it once the epidemic is over, depends majorly on the perceived comfort and safety during the epidemic. This means that transport policies should be focused on enhancing these perceptions and making sure that the image of public transport is not in further decline; otherwise, it could mean an almost impossible effort to encourage passengers to return to using sustainable modes of transport in the future.

This survey could constitute the pilot study, opening possibilities to continue further research throughout Poland. The survey on passengers' openness and on the revival of their willingness to use public transport could identify their attitudes towards commuting, and show new development paths of mobility culture in Poland. Insightful research could help to point out opportunities and challenges faced by the Polish culture of mobility in the times of the pandemic.

The hypothesis stating that the phenomenon of the epidemic may seriously affect the subjective levels of safety and mental comfort of public transport users, resulting in avoiding the use of this form of transport, has been positively verified. The findings confirm that these feelings not only affect current transport decisions but are also likely to affect the transport behaviours of the respondents in the future. As far as potential future research trends are concerned, they should be focused on the analysis of the extent to which it is possible to encourage passengers to resume using public transport in the future, mostly by enhancing their perceived levels of safety and comfort throughout the epidemic, and straight afterwards.

5. Conclusions

The COVID-19 pandemic has indeed severely influenced numerous social and economic human activities. Mobility is one of them; people mostly stay home, and therefore, there has been a significant traffic decrease and a significant influence on the modal split. Authorities and operators all over the world had to respond quickly to the pandemic, and find rapid and efficient solutions to guarantee safe mobility. Unfortunately, the use of sustainable commuting forms, such as public transport and shared mobility services, drastically declined. People have preferred private vehicles, such as cars and bicycles, and walking during the lockdown.

Finally, if accompanied by a wise and bold reallocation of space, soft modes, such as walking and cycling, can benefit from the momentum experienced during the COVID-19 crisis. However, public transport remains the backbone of sustainable transport, moving large numbers of passengers over long distances. The decongestion of public transport was desirable even before the outbreak of the pandemic, given that, during rush hours, buses and subways in many cities were packed—with negative effects on both the customer experience and the health of the passengers. Sharing systems with a view to a flexible integration of public transport services were already being defined. Accompanied by serious sanitising measures, the flexibility deriving from on-demand and sharing services complementary to public transport can counteract the otherwise inevitable preference for a private means of transport, leading, as a result, to a smarter and more sustainable transport system.

Sustainable mobility culture should be shaped gradually and within a long-term perspective for a change. However, as we may observe, one strong and unpredicted factor may be sufficient for disrupting this process. City authorities should provide favourable conditions to reshape mobility behaviours and help inhabitants change their mindset about mobility modes. Meanwhile, multimodality and radical modal shifts will occur if policy-makers integrate the offer of new and traditional mobility services within local transport policies. An innovative approach is needed, such as data sharing or interoperability, in order to deal with and stimulate safety issues.

The research conducted in the city of Gdansk shows evidence of a change regarding mobility behaviours in relation to the existing threat of the virus. In order to improve

the functioning of cities during the epidemic, it is crucial to explore the needs of citizens. Long-term loss of confidence towards collective forms of transport may mean significant budget and image troubles. Therefore, it should be ensured that passengers who return to regular use of public transport feel safe. In addition, measures should be implemented so that the group of people who completely gave up this form of mobility will come back in the future. However, more in-depth research is necessary to focus on the needs of the local community, especially during the second wave of the pandemic.

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