

Article

The Impact of COVID-19 on the Choice of Transport Means in Journeys to Work Based on the Selected Example from Poland

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Abstract: In recent years, the problem of overusing cars has been amplified by the COVID-19 pandemic. To understand this problem, we analyzed the results of a survey dedicated to mobility patterns of employees of the Wrocław University of Sciences and Technology conducted in June and July 2021. Consideration was given to the share of different means of transport and their changes in pre-, through and post-COVID-19 periods and factors such as the distance, population and public transport standards specific for various journeys. Overall, we found that the pandemic strongly influenced the choice of transport means. We did not identify any significant influence of the distance or population on the share of transport means between various periods. However, regardless of the period, dependencies between the public transport standards and the share of transport means were evident.

Keywords: COVID-19; transport mode choice; journeys to work; case study



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1. Introduction

The use of specific transport means for journeys, especially in daily destinations such as “to work”, has a profound influence on the environment. In this context, the choice of a car typically has the most negative influence due to the emission of CO₂ [1]. The wide spread of COVID-19 in 2020 [2] affected the choice of transport means, as reported by numerous studies [3–11]. Changes in mobility policy aiming at reducing the spread of contagions greatly strengthened this relationship [12,13], while the increasing use of cars (and decreasing use of public means of transport) has been widely observed [14]. This is envisaged to be a long-term trend [15].

A private car has been the most frequently chosen means of transport for commuting to work for several decades. This has been shown by research results from Poland and the whole world [14,16,17]. This leads to increased vehicle traffic on the road network and to the enlargement of negative effects of traffic. It causes the excessive emission of CO₂, CO, NO_x and other pollutants, which adversely affects the surrounding environment [1,18]. Efforts have been devoted to reduce the use of cars in favor of other means of transport. Psychological conditions influencing the choice of the means of transport have been examined and competitive modes of transport have been proposed, including inter alia, bicycles or public transport [5,19–25].

In recent years, the problem of overusing cars has been compounded by the COVID-19 pandemic. A significant change in the selection of the means of transport during every day societal journeys is the cornerstone of mobility policies in many countries around the world [6,25–27]. However, during the pandemic, there has been a decline in the number of people using public transport, while the number of people using cars has increased [28–36]. This is likely to have significant consequences in the future [36–42], because it exacerbates the problem of the excessive production of CO₂, CO, NO_x and other pollutants.

In this paper, we analyze the results of a survey dedicated to mobility patterns of employees of the Wrocław University of Sciences and Technology (WUST, Politechnika

Wrocławska) conducted in June and July 2021. The survey focuses on transport means used in journeys to work in relation to three periods: pre-, through and post-COVID-19. The rest of the paper is organized as follows: The construction of the survey and the population sample are described in Section 2. The main results from the survey are provided in Section 3, considering the share of different groups of transport means and their changes between different periods. In Section 3, the results are analyzed in regard to the traveled distance, population size and public transport standards too. The overall results are discussed in Section 4, followed by conclusions in Section 5.

2. Materials and Methods

2.1. Description of Survey

WUST is one of the largest universities in Poland, and is located in the central part of Wrocław (see the black point in area no. 1 on Figure 1 representing the main campus). Wrocław is the fourth large city in Poland, with more than 640 thousand residents (see Table 1). As an element of the prepared “Mobility Plan”, specific surveys were created. The first survey was dedicated to employees. The survey was a part of broader works named “mobility plan”. These works started in late spring 2021 (not ended yet) and were not planned cyclically. The surveys were conducted from the end of June to the beginning of July. This was in fact no vacation. In this period, a part of the restriction was canceled (telework) and others were left (masks, limits on public transport). It consisted of 18 questions about the ways and conditions of traveling to the university. Information about the survey and an invitation (link) to complete it were sent by e-mail to all 5795 active employees of WUST. Over 1300 people (approximately 23% of the recipients of the e-mail) used the link; however, only 815 responses were obtained in full. In total, 391 respondents were women and 375 men (approximately 6% did not provide their gender). Therefore, the women/men ratio was almost at unity (51%/49%). In total, 312 people (38.3%) were research and teaching staff, 279 people (34.2%) were administrative staff, 90 people (11.0%) were teaching staff, 64 people (7.9%) were technical staff, 70 people (8.6%) were others (this last group included PhD students). In the group of actual employees, an approximately 20% response rate to the survey was obtained. PhD students were omitted from further analyzes as they represented a rather specific group. PhD students are not typical teachers, although they carry some limited teaching duties. They are also enrolled as students in some advanced courses. Consequently, the number of scheduled activities of an atypical PhD student is not as high as in the case of typical employees or even students at earlier stages of an academic pathway. They are typically on campus fewer days a week and live nearby, and they have no children, hence, the associated responsibilities. For these reasons, they were not considered in the survey of employees.

Table 1. Parameters characterizing the origins of the journey (ATU) to WUST.

ATU ¹		Distance	Population Size	PTS ²
No.	Name	(km)	(30.06.2021)	
1.	Wrocław	0–17.9	641,201	H
2.	Długoleka	9.3–19.7	35,714	M
3.	Czernica	10.9–25.9	18,240	L
4.	Siechnice	8.9–15.1	24,775	H
5.	Żórawina	12.4–21.2	11,569	M
6.	Kobierzyce	15.7–24.7	22,323	M
7.	Kąty Wr.	14.7–28.3	26,390	H
8.	Miękinia	19.1–27.9	18,072	H
9.	Oborniki Śl.	20.6–35.8	20,349	H

Table 1. Cont.

ATU ¹		Distance	Population Size	PTS ²
No.	Name	(km)	(30.06.2021)	
10.	Wisznia Mł.	13.8–18.1	10,660	L
11.	Oleśnica	22.9–43.5	51,071	H
12.	Jelcz Laskowice	21.4–26.4	23,264	M
13.	Oława	27.3	48,301	H
17.	Sobótka	36.3–42.4	12,825	L
24.	Trzebnica	26.5–44.6	24,485	H
43.	Lubin	74.7	87,982	H

Notes: ¹ ATU—analyzed territorial unit (description in text). ² PTS—public transport standard (description in text).



Figure 1. Considered area.

The most important for further analyses were the questions connected with the choice of transport means in the journey to work. In the survey, six options were taken into account: on foot, by bike, by public transport means (bus, tram, train or multiple as one possibility), by car as a driver, by car as a passenger and by motorcycle (or similar). In this paper, we aggregated the number of possibilities to only three main groups: on foot or using bikes (group PB), using public transport (group T) and using cars (as a driver or passenger) or motorcycles (group CM). Three periods were considered in the survey:

pre-, through and post-COVID-19 pandemic. The pre-pandemic period was associated with “normal” conditions, in which the journeys to work were performed. The through-pandemic period considered specific conditions such as teleworking, limitations (especially in public transport means), quarantine and individual human behaviors. These influence of course the choice of transport means. However, at the time of the survey (late June of 2021), the restrictions were temporarily lifted and work was predominantly realized in a normal operating regime. Consequently, we observed the “normal” number of journeys. Still, these journeys were conducted under pandemic conditions, including the requirement of wearing masks and limitations as to the number of places available on public transport. The post-pandemic period was forecasted and illustrated the plans of employees.

2.2. Area from Which the Employees Journeyed from

The employees of WUST lived in Wrocław and in surrounding areas. We considered the specific territorial units (called the analyzed territorial unit (ATU)) that were the municipalities in general. In two cases (ATUs no. 11 and 13), there were two municipalities each (separated by the city and villages). First, we considered Wrocław (ATU no. 1) and 31 closely located ATUs creating the agglomeration. Next, we added 16 other areas outside the agglomeration connected with Wrocław (a comprehensive survey from 2018 identified the journeys between these areas). All of the units were presented in Figure 1. We divided the units into three groups: ATUs with significant numbers of questionnaires (more than 3) were marked with green markings, ATUs with fewer numbers of journeys with yellow markings, and ATUs with no journeys to WUST with no markings. In the next analysis, we considered only 16 ATUs with numbers of journeys higher than 3 (the green ones). Figure 1 contained the main rail network too, considering the used lines (solid green line) and not used for passenger transport in the year 2021 (dotted green line).

We collected the basic parameters characterizing all ATUs (in Table 1). They were the number and the name, distance to WUST (in kilometers), population size (on 30 June 2021) and categorized standard of public transport (as a PTS parameter). Public transport Standards (PTS) were categorized as follows: H (high) with the dense transport network, short time of journey (up to 30 min) or high speed of journey by longer distances (unit no. 43) and short intervals between the trains or buses in the timetable (30 min or less in rush hours); M (medium) intermediate between high and low; L (low) with not dense transport network, long time of journey (more than 1 h) and long intervals between the trains or buses in the timetable (more than 1 h).

3. Results

The usage percentages of different transport means for journeys to WUST are shown in Table 2. The third column shows the number of employees (who completed the survey) arriving from the selected ATUs. The groups were presented in three periods: pre-pandemic, through-pandemic and post-pandemic. They were considerable differences in the shares between the units in all periods. We identified the ATUs with a high use of public transport means (12, 43 and 9) and with a high share of motorized transport (7 and 17). Interesting differences were found between the selected periods (Table 3).

Table 2. Shares of use of transport means for individual areas.

ATU ¹			Mean of Transport Pre-Pandemic (%)			Mean of Transport through-Pandemic (%)			Mean of Transport Post-Pandemic (%)		
No.	Name	Number of Employees	PB	T	CM	PB	T	CM	PB	T	CM
1.	Wrocław	590	33.1	33.5	33.5	33.0	18.0	49.0	35.2	26.2	38.6
2.	Długołęka	31	7.7	12.8	79.5	7.9	7.9	84.2	10.3	10.3	79.5
3.	Czernica	37	2.4	12.2	85.4	2.6	5.3	92.1	2.3	9.1	88.6

Table 2. Cont.

ATU ¹			Mean of Transport Pre-Pandemic (%)			Mean of Transport through-Pandemic (%)			Mean of Transport Post-Pandemic (%)		
No.	Name	Number of Employees	PB	T	CM	PB	T	CM	PB	T	CM
4.	Siechnice	21	10.3	20.7	69.0	3.7	14.8	81.5	7.1	17.9	75.0
5.	Żórawina	5	0.0	33.3	66.7	0.0	0.0	100.0	0.0	25.0	75.0
6.	Kobierzyce	5	0.0	20.0	80.0	0.0	0.0	100.0	0.0	0.0	100.0
7.	Kąty Wr.	8	0.0	0.0	100.0	0.0	0.0	100.0	10.0	0.0	90.0
8.	Miękinia	12	10.5	42.1	47.4	6.7	20.0	73.3	5.9	35.3	58.8
9.	Oborniki Śl.	5	16.7	50.0	33.3	16.7	33.3	50.0	16.7	50.0	33.3
10.	Wisznia Mł.	5	0.0	20.0	80.0	0.0	20.0	80.0	0.0	20.0	80.0
11.	Oleśnica	14	5.9	35.3	58.8	6.7	6.7	86.7	10.0	35.0	55.0
12.	Jelcz Laskowice	6	0.0	62.5	37.5	0.0	33.3	66.7	0.0	50.0	50.0
13.	Oława	6	0.0	42.9	57.1	0.0	25.0	75.0	0.0	25.0	75.0
17.	Sobótka	5	0.0	0.0	100.0	0.0	0.0	100.0	0.0	0.0	100.0
24.	Trzebnica	8	11.1	44.4	44.4	20.0	30.0	50.0	20.0	40.0	40.0
43.	Lubin	4	28.6	57.1	14.3	28.6	42.9	28.6	16.7	50.0	33.3

Notes: ¹ ATU—analyzed territorial unit (description in text).

Table 3. Percentage changes in the shares of the particular means of transport.

ATU ¹			Trough- and Pre-Pandemic (%)			Post-and Pre- Pandemic (%)		
No.	Name		PB	T	CM	PB	T	CM
1.	Wrocław		−0.1	−15.4	15.5	2.2	−7.3	5.2
2.	Długołęka		0.2	−4.9	4.7	2.6	−2.6	0.0
3.	Czernica		0.2	−6.9	6.7	−0.2	−3.1	3.3
4.	Siechnice		−6.6	−5.9	12.5	−3.2	−2.8	6.0
5.	Żórawina		0.0	−33.3	33.3	0.0	−8.3	8.3
6.	Kobierzyce		0.0	−20.0	20.0	0.0	−20.0	20.0
7.	Kąty Wr.		0.0	0.0	0.0	10.0	0.0	−10.0
8.	Miękinia		−3.9	−22.1	26.0	−4.6	−6.8	11.5
9.	Oborniki Śl.		0.0	−16.7	16.7	0.0	0.0	0.0
10.	Wisznia Mł.		0.0	0.0	0.0	0.0	0.0	0.0
11.	Oleśnica		0.8	−28.6	27.8	4.1	−0.3	−3.8
12.	Jelcz Laskowice		0.0	−29.2	29.2	0.0	−12.5	12.5
13.	Oława		0.0	−17.9	17.9	0.0	−17.9	17.9
17.	Sobótka		0.0	0.0	0.0	0.0	0.0	0.0
24.	Trzebnica		8.9	−14.4	5.6	8.9	−4.4	−4.4
43.	Lubin		0.0	−14.3	14.3	−11.9	−7.1	19.0
Average changes:			0.0	−17.7	17.7	0.6	−7.2	6.6

Notes: ¹ ATU—analyzed territorial unit (description in text).

The presented percentage changes in the shares of individual means of transport showed a change in the trend through- and post-pandemic. In ATUs no. 7, 10 and 17, the choice of public transport did not change through- and post-pandemic. As a result, most employees in these units were not using public transport prior to the pandemic and, therefore, remained the same. In the remaining cases, employees switched, on average, from approximately 17.7% using public transport to individual transport during the pandemic. Analyzing the situation pre- and post-pandemic, it was expected that the number of employees giving up public transport would fall, but it was still lower than pre-pandemic by approximately 7.2%. There was also growing interest in walking and cycling to work.

The above-collected remarks are illustrated more distinctly in Table 4, where we showed only the shares of public transport ranking the units according to shares from the pre-pandemic period. The comparison of the percentages of employees using public transport showed the greatest popularity in the following ATUs: 43, 8, 9, 12, 13 and 24. According to the PTU parameter, the given units were classified as H (high) with the exception of 12, which was marked as M (medium). In these units, the number of employees choosing public transport oscillated between 43% and 62.5%.

Table 4. The share of public transport arranged from the highest to the lowest value.

ATU ¹ No.	Name	Percentage of Employees Using Public Transport (%)		
		Pre-Pandemic	Through-Pandemic	Post-Pandemic
12.	Jelcz Laskowice	62.5	33.3	50.0
43.	Lubin	57.1	42.9	50.0
9.	ObornikiŚl.	50.0	33.3	50.0
24.	Trzebnica	44.4	30.0	40.0
13.	Oława	42.9	25.0	25.0
8.	Miękinia	42.1	20.0	35.3
11.	Oleśnica	35.3	6.7	35.0
1.	Wrocław	33.5	18.0	26.2
5.	Żórawina	33.3	0.0	25.0
4.	Siechnice	20.7	14.8	17.9
6.	Kobierzyce	20.0	0.0	0.0
10.	WiszniaMł.	20.0	20.0	20.0
2.	Długoleka	12.8	7.9	10.3
3.	Czernica	12.2	5.3	9.1
7.	KatyWr.	0.0	0.0	0.0
17.	Sobótka	0.0	0.0	0.0

Notes: ¹ ATU—analyzed territorial unit (description in text).

The order of ATUs was more or less unchanged observing all periods. The units with a higher share of public transport pre- COVID-19 kept this level through- and post-pandemic. Higher differences occurred in the units with a small number of questionnaires.

4. Discussion

ATUs no. 3, 10 and 17 were classified as L (low). Due to the long journey time through a not too dense communication network (lack of trains), a large number of people used individual means of transport. In each of these units and periods, 80–100% of employees chose private means of transport. The low level of use of public transport means (20, 0 and 0 % in following periods) occurred for ATU no. 6 too. Despite the classification of this unit

to class M (middle) of PTS (according to a distinct number of bus connections), we found the important influence of the lack of rail lines.

The frequent selection of private means of transport also covered ATU no. 2 classified as M (medium) and ATU no. 7 classified as H (high). In the first case, the share was approximately 80%, and in the second case 100%. Both units had a good rail connection with Wrocław, but this form of public transport did not cover the whole area of the municipality. The municipalities were highly populated (see Table 1), and public transport was not fully integrated, so the potential of the rail was not fully realized.

Similar results as discussed above were reported in some previous studies. Before the pandemic, the choice of means of transport was predominantly shaped by factors such as satisfaction, experience, pricing, emissions, distances and land use [5,19,22–25]. In the identified cases, the share of public transport means decreased by approximately 18% on average, with employees switching to individual transport means during the pandemic [33–35].

We did not identify any significant influence of distance or population on the changes between percentages in any periods (pre-, through and post-pandemic). However, dependencies between the shares in transport means and the standards of public transport were evident. However, this aspect needs more detailed studies. The standards (PTSs) should be more detailed and defined in relation to spatial diversity. The hypothesis that the influence of standards on the shares was stronger than the influence of the pandemic itself is intriguing, but should be confirmed by other studies.

5. Conclusions

The presented analyses of a survey conducted on a representative sample of employees of WUST revealed long-term implications of the COVID-19 pandemic for transport and the environment. The proportion of public transport means used for journeys to work through the pandemic period decreased in comparison to the pre-pandemic period. Although the survey results suggested this trend to be reversed in the post-pandemic period, it should not bounce back to the pre-pandemic levels. This was most likely caused by employees who used public means of transport such as trains, trams or buses in the pre-pandemic period that did not go back to these practices in the post-pandemic period. Therefore, it was concluded that the consequences of the pandemic for transport and the environment are negative and are likely to worsen, inter alia, the carbon footprint. Beyond the abovementioned effects, it was found that the influence of the standards of the public transport means (referred herein as PST) on the mobility patterns could be stronger than that of the pandemic itself; however, this issue requires further investigation.

The presented study was conducted on a rather specific sample of a population of (university) employees based around a single workplace, and for this reason should be considered in the context of other studies on this matter. Plans have already been determined to conduct similar surveys on students of WUST and at other universities and entities employing a considerable number of people in Wrocław. Despite these limitations, the present study confirmed findings from other studies dedicated to the COVID-19 pandemic and its influence on transport means observed all over the world.

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