International Journal of Mathematical, Engineering and Management Sciences
Vol. 7, No. 3, 417-432, 2022
https://doi.org/10.33889/IJMEMS.2022.7.3.028

Application-Based Cab Services in India: Commuters' Barriers due to COVID-19

Vibha Trivedi
Jindal Global Business School,
O.P. Jindal Global University Sonipat, Haryana, India.
Corresponding author: vtrivedi@jgu.edu.in

Krishan Kumar Pandey
Jindal Global Business School,
O.P. Jindal Global University Sonipat, Haryana, India.
E-mail: kkpandey@jgu.edu.in

Ashish Trivedi
Jindal Global Business School,
O.P. Jindal Global University Sonipat, Haryana, India.
E-mail: atrivedi@jgu.edu.in

(Received on September 2, 2021; Accepted on March 7, 2022)

Abstract
The outbreak of the novel Coronavirus pandemic has brought the world to a standstill. The constant increase in the rise of cases and deaths has compelled nearly all countries to impose lockdowns and other restrictive measures. The restrictions on travel and other non-essential activities have raised some serious business concerns for ridesharing, carpooling, and cab rental services. This study aims to identify, analyze, and prioritize the commuters' barriers to App-based Ridesharing Services during COVID-19's first and second waves, and potential ways of adaptation for an anticipated third wave in Indian contexts. The hierarchy of barriers is established using the responses from sixty respondents and their analysis using the multi-criteria decision-making (MCDM) technique, the Analytic Hierarchy Process (AHP). 'Safety from contagion' was found to be the most significant and strong factor followed by the desire for personal space and personal security as the most important inhibitors for not choosing ridesharing services during COVID-19. Socio-economic status and the lack of reliability of service were not given much importance by the respondents. The current and potential implications for sustainable business and the environment are also discussed.

Keywords- COVID-19, AHP, Ridesharing, Transportation, Sustainability.

1. Introduction

The Corona Virus Disease (COVID-19) outbreak is considered to be the hardest and deadliest of all the other pandemics of this century, severely impacting the lives of the global population in numerous ways (Chakraborty & Maity, 2020). The pandemic has affected over 200 countries (Atalan, 2020), impacting more than 46 million people in the world, with more than 8.1 million people in India only as of October, 31st 2020 (WHO, 2020b). A pandemic of this magnitude not only impacts public health conditions at large but also the socio-economic ways of living (Chakraborty & Maity, 2020). Governments of several countries imposed strict measures to contain the spread of the disease by way of national-level lockdowns and social distancing measures. Lockdowns are policy interventions by respective governments to control the spread of deadly viral diseases at varying levels (Glover et al., 2020). These lockdown measures prohibited all social activities including local as well as long-distance traveling, dining out, visiting amusement parks, movie halls, and shopping malls (Atalan, 2020). The pandemic resulted in a paradigm shift in daily ways of life, affecting all the main facets of human life (de Haas et al.,

2020). Since the traveling patterns are the key drivers of socio-cultural as well as economic development of the nations, unsurprisingly, the economies were, and still are, severely impacted by such restrictions on all non-essential travels, leading to the closure of business activities, salary cuts, and massive job losses.

Tourism and hospitality have become the most affected sectors with the worldwide closure of schools & college campuses, work-places, cancellation of events (social, scientific, political), partial as well as fully controlled internal movement, restricted public transportation, restricted local as well as international travel (Nicola et al., 2020; Reeves et al., 2020). Close to 90% of the global population followed social distancing and was under prescribed isolation (Atalan, 2020) resulting in a decline in non-essential movements. There is already a 56% decline in traveling (Reeves et al., 2020) and COVID-19 is expected to bring a paradigm shift in traveling even after it appears to be over. Such uncommon disruptions in mobility businesses were unseen and, therefore, call for planning and preparedness to accommodate any further crisis of similar nature (Bian et al., 2021; Wang et al., 2022).

The pre-COVID era was dedicated to catering demand management with smart technological interventions and sustainable means of mobility (Budd & Ison, 2020). Before the outbreak, buying a car and leasing it for mobility services including taxis, cabs, cab rentals, ridesharing, and carpooling was an attractive business model in several countries. In India, the launch of several car rental services, including Uber and OlaCabs, provided employment and supplementary income generation opportunities to many people. But with the pandemic affecting the psychology of consumers of the public transport system, there is an urgent need for revised and safer travel platforms. With the relaxations in lockdowns in certain countries, people still prefer personal vehicles, leaving public transport for those who have no option (de Haas et al., 2020). Uncertainty still prevails for these as well as other related businesses. Owing to the novelty of the situation, this study pioneers the prioritization and analysis of the commuters' barriers during the pandemic. The main aim of this paper is to explore and analyze the factors that inhibit commuters from using App-based carpooling and ridesharing services during various waves of COVID-19. The authors would explore various factors reported in the literature and would analyze them using the multi-criteria decision support approach based on AHP. Furthermore, the authors would also pinpoint the various possible strategic options that these businesses may consider, to make them more resilient and adaptive to this disruptive environment. The study contributes by giving preferred decisions of commuters for better planning and designing the ride-sharing services in the post-COVID era. This would enrich the body of literature as well as assist the public transport system and firms in strategic planning. Some policy recommendations are also provided to strike a proper balance between the public's physical and economic health.

The rest of the exposition is as follows. The impact of COVID-19 and subsequent lockdown on cab service providers' shared ride services due to change in consumer-commutation behavior is discussed in the next section. The methodology is reported in Section 3. Section 4 explains the results while analyses and implications are reported in Section 5. Concluding remarks are presented in the last section.

2. Literature Review

2.1 Effect of Lockdown on Cab Companies/Pooled Rides/Shared Rides

Before the outbreak of COVID-19 and subsequent restrictions, the Indian markets and business environment were highly competitive. Shared-mobility services and on-demand ride services

such as Uber and OlaCabs were evolving dynamically and playing competitively in the market. Their key service offerings included door-to-door pick and drop services (Shaheen et al., 2016). Further, several other ride-sharing service platforms offered shared two-wheelers or four-wheelers for one-way drop, or round-trips at differential costs. For social benefits as well as in the interest of environmental sustainability, various internet-based services were also in place to facilitate the connection of the travelers with riders on certain followed routes (Patel & Patel, 2020; Shaheen et al., 2016). With the penetration of smartphones and internet services, these ride-sourcing platforms and their services were accessible to the larger population and became a competitive option for public mobility.

An unprecedented lockdown was a remarkable event resulting from the COVID-19 outbreak, declared a pandemic by WHO in March 2020 (WHO, 2020a). It was understood that the Corona virus was being transmitted through human contact, and there were asymptomatic carriers whose contribution was, though non-assessable, significant. One of the major sources of the rapid spread was the interconnectivity through a well-developed and competitive transportation system (Budd & Ison, 2020). Following this, as a first step, governments attempted to disconnect the potential connections by pausing the prevailing hypermobility. Further, the avoidance of human-to-human contact by way of social distancing was another move to slow down the spread of the virus across such a large population (Hendrickson & Rilett, 2020; Jabbari & MacKenzie, 2020). Thus, numerous countries observed intermittent lockdowns, while India observed the longest lockdown in human history (Shalini Umachandran, 2020).

The COVID-19 spread through human-to-human transmission and fomites (WHO, 2020c) made use of public transport and paid cab services a fearful ride. All the non-essential transportation activities were called off globally, influencing the concerned businesses adversely. The mobility businesses have been severely hit by the restrictions in travel as well as due to the public's fear of catching this disease, thereby indicating the human side of the COVID-led crisis (Hendrickson & Rilett, 2020). In countries where lockdowns are lifted, people would still avoid public transport and shared rides due to the fear of getting infected by others as there was a strong connection between usage of public transport and transmission of fatal respiratory infections (Goscé & Johansson, 2018; Hendrickson & Rilett, 2020; Jabbari & MacKenzie, 2020; Loa et al., 2022; Troko et al., 2011). There is significant anxiety among the general public due to the nature of COVID-19 transmission (Roy et al., 2020), and is expected to result in a sharp decline in travel volumes and patterns even after the pandemic is over (Reeves et al., 2020). Even cab drivers also chose to reduce the number of trips per day displaying their preference for security over earning a decent amount for daily living (Wang et al., 2022). An increased preference for personal conveyances over any other modes of transport- shared or non-shared private cab rides-might become a new normal (De Vos, 2020; Jabbari & MacKenzie, 2020). This might lead to a decline in demand for such services, which would further cause more employee layoffs as several layoffs have already been reported in the recent past (Indian Express, 2020; Srivastava, 2020). Even if the individual bookings and the car rentals might resume in the future, carpool and ridesharing might not recommence in the coming times. Since people are aware of the health hazards, they might not wish to share their travels with others. Moreover, people are expected to substitute short-distance travel by either cycling or walking to safeguard themselves.

The unpredictable nature of COVID-19 not only affected the travel volumes and patterns but also impacted several entrepreneurial ventures that were perceived to be the time-tested business models in India, including fast-food business, transport business, tourism-related businesses, to name a few.

The pre-COVID era was significantly conducive for such services because of several factors related to consumer attitude towards protecting the environment as well as safety features of the service provider (Alemi et al., 2018; Mäntymäki et al., 2019). Several people bought vehicles on auto loans and associated themselves as business partners with these service providers in anticipation of sustained business continuity. However, lesser demands have put them under financial debt, and they might soon end up moving away from this business model and searching for alternative income sources. This might have a detrimental effect on cab service businesses in India. These effects can be curbed during an upcoming third wave, which is likely to pose unseen challenges that would be more or less related to previous waves (Bian et al., 2021; Bignami et al., 2021; Rothengatter et al., 2021). Additionally, ridesharing services are chosen by customers for augmenting their efficiency which further helps enhance their respective performances. Thus, a reliable comeback post-lockdown is a must for ridesharing firms (Rasheed Gaber & Elsamadicy, 2021).

2.1 Ridesharing/Carpooling Factors

Organizational ridesharing has proved to be a significant business model in a shared economy (Shah et al., 2020) resulting in a curb of traffic congestion in urban areas (Berlingerio et al., 2017; Dewan & Ahmad, 2007; Z. Li et al., 2016). Numerous studies have been carried out that have attempted to investigate the impact of different factors on cab-sharing services (Cherchi et al., 2017; Delhomme & Gheorghiu, 2016; Kotoula et al., 2018; Kunhikrishnan & Srinivasan, 2018; Liakopoulou et al., 2017; Shaheen et al., 2016). There are several societal benefits associated with carpooling, including lesser environmental pollution, congestion, more energy conservation, and infrastructural utilization (Chan & Shaheen, 2012). Moreover, from the commuters' standpoint, individual benefits include increased cost and time savings. Despite these benefits, some reported barriers inhibit the use of carpooling as a service. Dueker & Levin (1976) reported that carpooling lacks the flexibility, reliability (Shah et al., 2020), and convenience of a private ride. Further, Bonsall, Spencer, & Tang (1984) emphasized psychological factors such as aversion to social situations and desire for personal space. During the pandemic, social encounters with strangers as well as surface sharing were the least preferred things (H. Li et al., 2011). Fear of getting an infection was the reason for the paradigm shift in behavioral patterns (Karpen & Conduit, 2020). The Government imposed lockdowns and social distancing measures even further inculcated the fear in the population (Zwanka & Buff, 2021). Thus, the novelty of the situation during the pandemic emphasizes understanding the barriers in the context of the pandemic. This would add value to the extant literature and help meet sustainable goals of the firms. To further explore the factors that prohibit the commuters to choose ridesharing platforms, unstructured interviews were conducted with a group of twenty frequent travellers that reported three additional factors in addition to the previously identified barriers. The mentioned factors were personal security, social status (Shah et al., 2020), and lack of safety from contagion during COVID-19. The identified eight barriers to carpooling services are mentioned below:

- Lack of flexibility (FLEX)
- Lack of reliability (REL)
- Lack of convenience (CONV)
- Desire for personal space (SPACE)
- Aversion to the social situation (AVER)
- Personal security (SECUR)
- Social status (STATUS)
- Safety from contagion (CONT)

3. Methodology

Analytic Hierarchy Process (*AHP*) was developed by Saaty (1980) as a theory of measurement to derive priorities from paired comparisons. It adopts a scale representing the relative strength of judgments. The methodology is useful in calculating the ratings of alternatives or criteria under observation. *AHP* has proved to be a very suitable approach for group decision support (Beynon, 2005; Bolloju, 2001; A. Trivedi & Singh, 2017a, 2017b). Further, there are theories to evaluate the consistency of decision-makers (Aguarón & Moreno-Jiménez, 2003; Saaty, 1980). *AHP* has been applied in a wide variety of studies focusing on decision support for smartphone adoption (V. Trivedi et al., 2021), vendor selection problems in telecommunication systems (Tam & Tummala, 2001), even in consumer studies measuring factors of loyalty behavior (Punniyamoorthy & Prasanna Mohan Raj, 2007). It has also helped researchers in finding solutions to firms' sustainability issues such as urban mobility issues (Gompf et al., 2021), electric-bike sharing (Bajec et al., 2021), Free-Floating Bike-Sharing systems (Cheng & Wei, 2020), car-sharing (Chen & Deng, 2018), Public-bicycle sharing system (Patel & Patel, 2020) and other sustainable sources of mobilities and their park and ride-related issues (Yaliniz et al., 2016). Solutions for managing traffic congestion and pollution due to urban transportation systems also received scholarly attention (Alkharabsheh et al., 2021). Several other MCDM methods are in practice for evaluations including TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) and PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation). However, TOPSIS is better suited for alternative evaluation as it does not have a pairwise comparison among criteria, Further, to apply PROMETHEE, the understanding of preference functions is needed which poses challenges to decision-makers. Therefore, due to the wide and varied applicability of AHP, the authors were motivated to use it to prioritize the factors inhibiting ridesharing during COVID-19. The methodological flow chart is given in Figure 1.

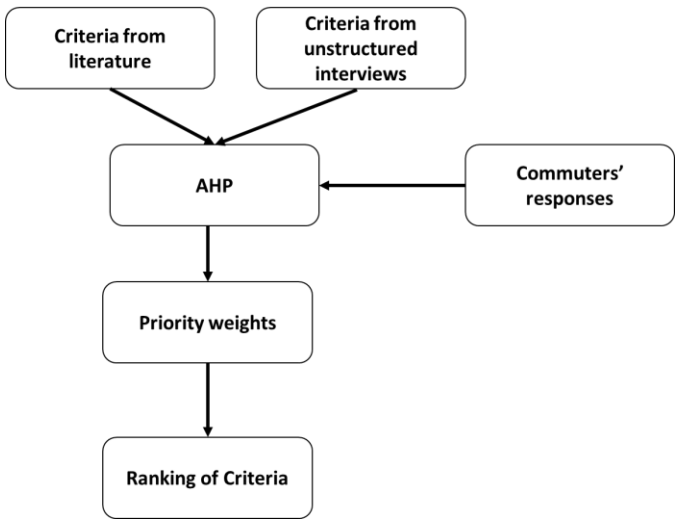

Figure 1. Methodological flow-chart.

To establish a preference hierarchy of the barriers, a structured questionnaire was administered to sixty commuters that were frequent users of carpooling before the outbreak of COVID-19. Initially, they were contacted telephonically and, later on, in-person to participate in the survey. All the respondents were in the age group of 25-35 years. The questionnaire and aim of the study

were duly explained to them and their queries during response filling were addressed. They were asked to carry out a pairwise comparison of criteria to establish their individual preferences. For a problem having *n* criteria, each decision-maker makes $n\ (n-1)/2$ judgments, which are further used to construct a comparison matrix. The conversion scale is shown in Table 1.

Table 1. Linguistic judgments and their fuzzy values

Linguistic Judgment	Scale
Equal importance	1
Moderate importance	3
Strong importance	5
Very strong importance	7
Extreme importance	9

The steps of *AHP* are summarized below:
Step 1: Collection of responses from *k* decision-makers (commuters)

Step 2: Using the responses to create a pair-wise comparison matrix.
A= $\{\bar{a}_{ij}\}_{n\times n}$ where $\bar{a}_{ij} \geq 0$ and $\bar{a}_{ij} = \bar{a}_{ji}{}^{-1}$

Step 3:The responses need to be checked for consistency using the consistency index proposed by (Saaty, 1980). The consistency index CI for a pairwise comparison matrix is given below
CI= $\frac{\lambda^{max}-n}{n-1}$
λ^{max} = largest eigenvalue of the comparison matrix,
n = dimension of the matrix or the number of decision criteria under consideration
The consistency ratio (CR) is given as
$CR = \frac{\text{CI}}{\text{RI}(n)}$
Where RI(n) is a random index that depends on the size of the matrix (Golden, 1989). The random index values of random matrices are given in Table 2.

Table 2. Random index values.

N	3	4	5	6	7	8	9
RI(n)	0.58	0.9	1.12	1.24	1.32	1.41	1.45

If the consistency ratio is equal to or less than 0.1, it is acceptable. Else, the decision-maker is encouraged to repeat the comparisons to achieve consistency.

Step 4: Aggregation of individual judgments is carried out by geometric mean operations.

Let a_{ijk}be the relative priority of criterion *i* in respect to criterion *j* for decision-maker *k*, the aggregated matrix is
$M_{ij}= \sqrt[k]{\prod_{k=1}^{k} m_{ijk}}$
Step 5: Normalization of matrix
$\bar{a}_{ij}{}^{*} = \frac{\bar{a}_{ij}}{\sum_{i=1}^{n} \bar{a}_{ij}}$

Step 6:
The relative weights of factors are calculated using the equation:

$$w_i = \frac{\sum_{j=1}^{n} \bar{a}_{ij}^{*}}{n}$$

The hierarchical chart is shown in Figure 2.

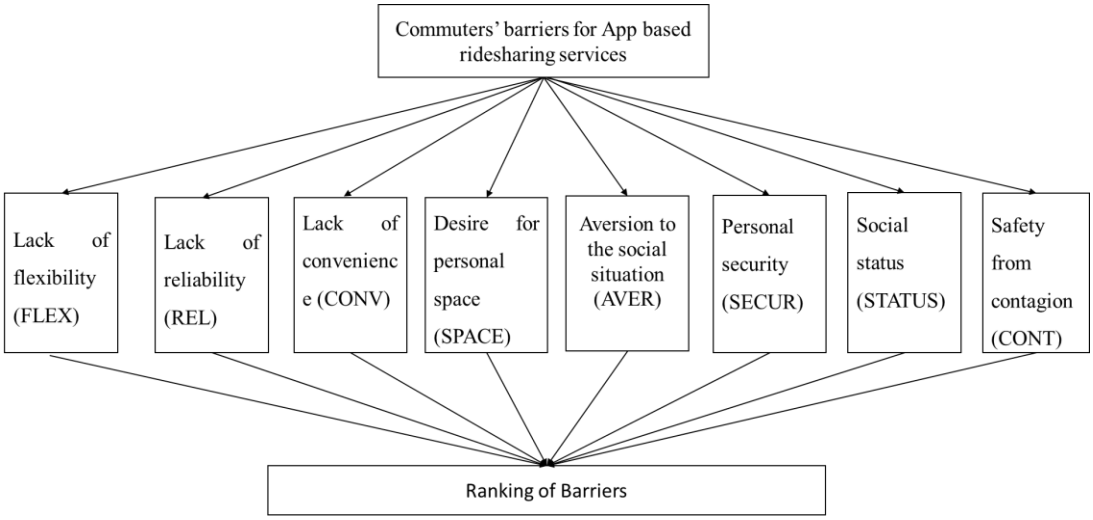

Figure 2. Hierarchy Chart.

4. Results and Analysis

The steps explained in the previous section were applied and the responses of the sixty commuters were analyzed. All the responses were checked for inconsistency by computing the consistency ratios. The computed consistency ratios for all the respondents came out to be less than 0.1 and were used further for aggregation using the geometric mean approach. The aggregation procedure was applied using Step 4 and the obtained aggregated matrix is shown in Table 3.

Table 3. Aggregated pair-wise comparison matrix.

	SECUR	SPACE	CONT	CONV	AVER	FLEX	STATUS	REL
SECUR	1.0000	0.5398	0.7311	0.9830	2.2982	1.9710	1.8955	2.5066
SPACE	1.8526	1.0000	0.9044	1.6350	3.5632	3.1425	2.5978	4.3312
CONT	1.3678	1.1057	1.0000	1.9818	3.7777	3.3429	2.7038	4.2140
CONV	1.0173	0.6116	0.5046	1.0000	2.3507	2.0212	1.6354	2.8877
AVER	0.4351	0.2806	0.2647	0.4254	1.0000	0.7297	0.7191	1.9108
FLEX	0.5074	0.3182	0.2991	0.4948	1.3705	1.0000	0.8672	2.0034
STATUS	0.5276	0.3849	0.3698	0.6115	1.3907	1.1531	1.0000	2.1255
REL	0.3989	0.2309	0.2373	0.3463	0.5234	0.4991	0.4705	1.0000

The normalization procedure was carried out using Step 5, and the normalized matrix is given in Table 4. From this normalized matrix, the final preference weights were computed to establish the ranking of the barriers. The final weights and the ranking of the barriers are presented in Table 5 and Figure 2 presents the preference ranking of barriers.

Table 4. Normalized matrix.

	SECUR	SPACE	CONT	CONV	AVER	FLEX	STATUS	REL
SECUR	0.1407	0.1207	0.1696	0.1315	0.1412	0.1422	0.1594	0.1195
SPACE	0.2607	0.2236	0.2098	0.2186	0.2189	0.2267	0.2185	0.2065
CONT	0.1925	0.2473	0.2320	0.2650	0.2321	0.2412	0.2274	0.2009
CONV	0.1431	0.1368	0.1170	0.1337	0.1444	0.1458	0.1376	0.1376
AVER	0.0612	0.0628	0.0614	0.0569	0.0614	0.0526	0.0605	0.0911
FLEX	0.0714	0.0712	0.0694	0.0662	0.0842	0.0722	0.0729	0.0955
STATUS	0.0742	0.0861	0.0858	0.0818	0.0855	0.0832	0.0841	0.1013
REL	0.0561	0.0516	0.0550	0.0463	0.0322	0.0360	0.0396	0.0477

Table 5. Final weights and preference ranking of barriers.

Barriers	Weight	Rank
SECUR	0.1406	3
SPACE	0.2229	2
CONT	0.2298	1
CONV	0.1370	4
AVER	0.0635	7
FLEX	0.0754	6
STATUS	0.0852	5
REL	0.0456	8

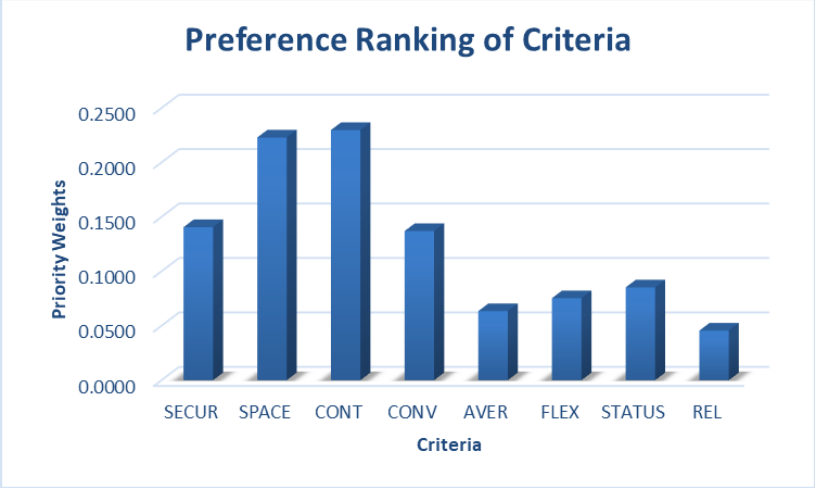

Figure 2. Preference ranking of barriers.

The analysis reveals some interesting findings. The results of Table 5 reveal that commuters attribute the 'safety from contagion' as the most significant and strong factor for not choosing carpooling services during COVID-19. Further, the desire for personal space and personal security were the next two most important inhibitors for availing ridesharing services. Socio-economic status and the lack of reliability of service were not given much importance by the respondents.

5. Implications and Discussions

The findings of the study offer some implications for practice. Businesses need to withstand all challenges and become agile and resilient in these dynamically changing business environments.

Working on recovery and resilience strategies requires knowledge of the possibilities (Sigala, 2020). A possible way for the mobility businesses might be to take insights from all the stakeholders, their coping mechanisms, and experiences. Before making strategic decisions regarding designing safer cab services during and post-COVID-19 times, it would be vital to develop an understanding of the changed target market in the changing environment. Social distancing is expected to lead to a lower frequency of essential traveling and close to zero instances of non-essential traveling along with the least preference for public transport services (De Vos, 2020). Ensuring the safety of the passengers should be the prime and the most significant strategy for the firms. As safety is preferred over monetary cost (Jabbari & MacKenzie, 2020), a proper mechanism should be devised to instill a sense of assurance in the minds of potential commuters who are already in a state of fear and anxiety. All the cab drivers should be properly diagnosed before being deemed fit to take up a ride. Routine medical check-ups such as temperature measurement and symptom identification should be carried out regularly.

Furthermore, to ensure the safety of the drivers too, the temperature measurement of passengers should also be recorded by the drivers for their safety. Hand sanitizers should be installed in all the vehicles, and the use of masks and gloves be made available to the drivers as well as the commuters. This would ensure a lesser risk of fomite transmission. The app for the cab service may also be linked with the health safety App, 'Aarogya Setu' recommended by the Government of India. The app keeps a track of symptomatic and active COVID-19 cases through the geo-positioning system. Businesses should also invest in temporary sanitization units for cars and other fleets. Further, a sanitization certificate for vehicles, as well as a fitness certificate for the drivers should be issued by the firms to instill a sense of security and trust in the minds of customers since the strengthening of the structural assurance positively impacts customers' revisit intentions, which is vital for sustainable business (Malhotra et al., 2017). Since social distancing measures are effective to slow down the spread of diseases that are transmitted by respiratory droplets, a suggested measure was to create a glass or fiber partition between driver and passenger to further enhance the safety of both. A more ventilated space was suggested for a lesser risk of virus spread by the government agencies and the use of air conditioning was prohibited. A similar suggestion was made in a study conducted by Hetherington et al. (2021) where the firms in the mobility business can make the use of air conditioners as an option for passengers. Another safety measure could be limiting the number of passengers on a ride at a time and displaying this information on the app while booking a ride. This information can also be useful in increasing the perceived security of the potential customers during panic and fear. Such a currency of information and its easy accessibility affect consumers' decision-making (Trivedi & Trivedi, 2018). According to the institutional trust theory, such institutional structures and technical aspects of mechanisms ensure the development of trust between the two unknown parties transacting in uncertain online environments (Malhotra et al., 2017; Shapiro, 1987; Zucker, 1986). Similarly, another study has established that reducing the number of rides/trips per day has been opted by drivers in China (Jabbari & MacKenzie, 2020). Overall, the findings of our study are in alignment with other studies that also focused on exploring firm and consumer concerns regarding commuting during and after COVID-19. Studies largely indicate safety and hygiene as major concerns of passengers in various contexts by exploring as many ways as possible to avoid contagion in transportation such as ride-sharing motorbike taxis, other ride-hailing options including buses and rikshaw (Choi & Shi, 2022; Hetherington et al., 2021; Jamal et al., 2022; Loa et al., 2022). In these unprecedented times when paranoia and fear reside in everyone's mind, these technical assurances will help to reduce the side effects of uncertainties on consumer minds as well as on businesses that need prompt recovery (Hendrickson & Rilett,

2020; Rothengatter et al., 2021). These businesses not only favor economic benefits but also sustainable environment goals by encouraging fuel-efficient practices such as ride-sharing (Dai et al., 2022). Ridesharing business supports the idea of sustainable development goals by making responsible consumption and production through lesser consumption of fuel (Dai et al., 2022; Jamal et al., 2022; SDGs, 2020). Hence, the perpetuity of ridesharing cab service firms is important for sustainability goals and the present research would contribute toward meeting this goal. Additionally, this study explores MCDM applicability in post-COVID behavioral analysis and helps in prioritizing the issues at hand.

6. Concluding Remarks and Future Research Recommendations

COVID-19 pandemic has immensely impacted the wellbeing of the people, thereby leading to changes in behavior and preference at the community level. It is not the first time when a viral outbreak has paused the routine lives of people but such a drastic disruption in the transportation business was unusual. The human aspect of the pandemic was manifested in the behavioral changes related to travel and commutation patterns. This paper aimed to explore and analyze the factors that inhibit commuters from using App-based carpooling and ridesharing services in Indian contexts. The authors explored various factors reported in the literature and analyzed them using the multi-criteria decision support approach based on *AHP*. It was found that safety from contagion was given the most weightage. Further, to avoid contracting the virus by sharing surfaces, the need for personal space captured the second most important position in the hierarchy followed by personal security as the third-most preferred aspect while deciding on the ride-sharing service options. Overall, the hierarchy would help ridesharing firms in working on strategies aimed at leveraging commuters' preferences to reduce their fear and risk perception for sustained business operations post-COVID. Based on these findings, the authors also pinpointed the various possible strategic options that these businesses may consider, to make them more resilient and adaptive to this disruptive environment.

The contribution of the study is threefold. First, it delineates the factors prohibiting commuters to use app-based ridesharing services and then establishes a priority scheme for them. Second, it also proposes several policy recommendations for mobility businesses to make them more resilient and agile in their operations in the present and future. This piece of study provides some key policy recommendations to all the mobility businesses operating in India. Third, our study would help firms to bring a sense of normalcy in the minds of consumers during these uncertain and fearful times, resulting in the recovery of ridesharing businesses. Overall, the hierarchy would help ride-sharing firms in conforming with commuters' choices and to work on commuters' preferences to bring down their fear and risk perceptions. Our research demonstrates how these private ride-sharing services can thrive by offering perceived safety and risk-free rides to their passengers even during the possible third wave of COVID-19. For example, a recent initiative by UBER India offered free rides for supporting the vaccination (IndiaSA Comms Team, 2021). With the dawn of the third wave of COVID-19 (Rothengatter et al., 2021) and the introduction of new variants, it becomes imperative for businesses as well as consumers groups to find ways to make life easier by implementing the learned lessons from previous waves. In other words, as a result of coping and recovery mechanism (Rothengatter et al., 2021), society as a whole would be required to make efforts toward regaining the routine ways of life as well as dying businesses. Revival of ridesharing business would help in responsible consumption and production practices and meeting sustainable development goal by promoting the concept of shared economy.

The context of our study i.e., COVID-19 itself poses few limitations in terms of access to a large number of consumer data as well as the availability of the literature. The findings are based on responses from only sixty commuters, as during the beginning of the COVID-19, very limited commuters were using shared riding options. For better representation and heterogeneity, large consumer data can also be worked upon later by the time population develops a better understanding of the new normal. The study offers several research opportunities for future works. Based on the criteria analyzed in the study, future works can also evaluate various app-based ride-sharing service providers. Since the analyses reported in this study are based on responses received from commuters in the age group of 25-35 years only, other age groups may have varied and different decision preferences and, thus, the same can be addressed in future works. Further, the findings of the present work may be validated using statistical models. The underlying psychological mechanisms governing the evolved behavioral changes can be studied by using experimental designs. Scholars can also analyze the contextual relationships among the factors identified in the present study. With time, populations are expected to co-exist with the continuously mutating novel Coronavirus, which is expected to give rise to new patterns of traveling, commutation, and ride-sharing practices. Since the pandemic changed the needs and preferences of commuters, these are expected to remain dynamic in near future. Hence the future behavioral patterns are likely to evolve. The present work would serve as a comparative benchmark for future research on situations then and now.

Conflict of Interest
No potential conflict of interest was reported by the author(s).

Acknowledgements
Authors are thankful to all the anonymous reviewers for their suggestions toward improving the manuscript.

References

Aguarón, J., & Moreno-Jiménez, J. M. (2003). The geometric consistency index: Approximated thresholds. *European Journal of Operational Research*, *147*(*1*), pp. 137–145. https://doi.org/10.1016/S0377-2217(02)00255-2

Alemi, F., Circella, G., Handy, S., & Mokhtarian, P. (2018). What influences travelers to use uber? exploring the factors affecting the adoption of on-demand ride services in California. *Travel Behaviour and Society*, *13*, pp. 88–104. https://doi.org/10.1016/j.tbs.2018.06.002

Alkharabsheh, A., Moslem, S., Oubahman, L., & Duleba, S. (2021). An integrated approach of multi-criteria decision-making and grey theory for evaluating urban public transportation systems. *Sustainability*, *13*(*5*), p. 2740. https://doi.org/10.3390/su13052740

Atalan, A. (2020). Is the lockdown important to prevent the COVID-19 pandemic? Effects on psychology, environment and economy-perspective. *Annals of Medicine and Surgery*, *56*, pp. 38–42. https://doi.org/10.1016/j.amsu.2020.06.010

Bajec, P., Tuljak-Suban, D., & Zalokar, E. (2021). A distance-based AHP-DEA super-efficiency approach for selecting an electric bike sharing system provider: One step closer to sustainability and a win–win effect for all target groups. *Sustainability*, *13*(*2*), p. 549. https://doi.org/10.3390/su13020549

Berlingerio, M., Ghaddar, B., Guidotti, R., Pascale, A., & Sassi, A. (2017). The GRAAL of carpooling: GReen And sociAL optimization from crowd-sourced data. *Transportation Research Part C: Emerging Technologies*, *80*, pp. 20–36. https://doi.org/10.1016/j.trc.2017.02.025

Beynon, M. J. (2005). A method of aggregation in DS/AHP for group decision-making with the non-equivalent importance of individuals in the group. *Computers & Operations Research*, *32*(*7*), pp. 1881–1896. https://doi.org/10.1016/j.cor.2003.12.004

Bian, Z., Zuo, F., Gao, J., Chen, Y., Pavuluri Venkata, S. S. C., Duran Bernardes, S., Ozbay, K., Ban, X. (Jeff), & Wang, J. (2021). Time lag effects of COVID-19 policies on transportation systems: A comparative study of New York City and Seattle. *Transportation Research Part A: Policy and Practice*, *145*, pp. 269–283. https://doi.org/10.1016/j.tra.2021.01.019

Bignami, E., Manca, D., & Bellini, V. (2021). Riding the waves of COVID-19 pandemics – A call for a multiobjective compromise. *Trends in Anaesthesia and Critical Care*, *38*, pp. 13–15. https://doi.org/10.1016/j.tacc.2021.04.004

Bolloju, N. (2001). Aggregation of analytic hierarchy process models based on similarities in decision makers' preferences. *European Journal of Operational Research*, *128*(*3*), pp. 499–508. https://doi.org/10.1016/S0377-2217(99)00369-0

Bonsall, P. W., Spencer, A. H., & Tang, W.-S. (1984). What makes a car-sharer? *Transportation*, *12*(*2*), pp. 117–145. https://doi.org/10.1007/BF00167372

Budd, L., & Ison, S. (2020). Responsible transport: A post-COVID agenda for transport policy and practice. *Transportation Research Interdisciplinary Perspectives*, *6*, p. 100151. https://doi.org/10.1016/j.trip.2020.100151

Chakraborty, I., & Maity, P. (2020). COVID-19 outbreak: Migration, effects on society, global environment and prevention. *Science of The Total Environment*, *728*, p. 138882. https://doi.org/10.1016/j.scitotenv.2020.138882

Chan, N. D., & Shaheen, S. A. (2012). Ridesharing in North America: Past, present, and future. *Transport Reviews*, *32*(1), pp. 93–112. https://doi.org/10.1080/01441647.2011.621557

Chen, L., & Deng, X. (2018). A modified method for evaluating sustainable transport solutions based on AHP and dempster–shafer evidence theory. *Applied Sciences*, *8*(*4*), p. 563. https://doi.org/10.3390/app8040563

Cheng, M., & Wei, W. (2020). An AHP-DEA approach of the bike-sharing spots selection problem in the free-floating bike-sharing system. *Discrete Dynamics in Nature and Society*, *2020*, pp. 1–15. https://doi.org/10.1155/2020/7823971

Cherchi, E., Cirillo, C., & Ortúzar, J. de D. (2017). Modelling correlation patterns in mode choice models estimated on multiday travel data. *Transportation Research Part A: Policy and Practice*, *96*, pp. 146–153. https://doi.org/10.1016/j.tra.2016.11.021

Choi, T.-M., & Shi, X. (2022). On-demand ride-hailing service platforms with hired drivers during coronavirus (COVID-19) outbreak: Can blockchain help? *IEEE Transactions on Engineering Management*, pp. 1–16. https://doi.org/10.1109/TEM.2021.3131044

Dai, R., Ding, C., Gao, J., Wu, X., & Yu, B. (2022). Optimization and evaluation for autonomous taxi ride-sharing schedule and depot location from the perspective of energy consumption. *Applied Energy*, *308*, p. 118388. https://doi.org/10.1016/j.apenergy.2021.118388

de Haas, M., Faber, R., & Hamersma, M. (2020). How COVID-19 and the Dutch 'intelligent lockdown' change activities, work and travel behaviour: Evidence from longitudinal data in the Netherlands. *Transportation Research Interdisciplinary Perspectives*, *6*, p. 100150. https://doi.org/10.1016/j.trip.2020.100150

De Vos, J. (2020). The effect of COVID-19 and subsequent social distancing on travel behavior. *Transportation Research Interdisciplinary Perspectives*, *5*, p. 100121. https://doi.org/10.1016/j.trip.2020.100121

Delhomme, P., & Gheorghiu, A. (2016). Comparing French carpoolers and non-carpoolers: Which factors contribute the most to carpooling? *Transportation Research Part D: Transport and Environment*, *42*, pp. 1–15. https://doi.org/10.1016/j.trd.2015.10.014

Dewan, K., & Ahmad, I. (2007). Carpooling: A step to reduce congestion (A case study of Delhi). *Engineering Letters*, *14*(*1*), pp. 61–66.

Dueker, J., & Levin, I. (1976). *Arpooling: Attitudes and Participation*.

Glover, R. E., van Schalkwyk, M. C., Akl, E. A., Kristjannson, E., Lotfi, T., Petkovic, J., Petticrew, M. P., Pottie, K., Tugwell, P., & Welch, V. (2020). A framework for identifying and mitigating the equity harms of COVID-19 policy interventions. *Journal of Clinical Epidemiology*. https://doi.org/10.1016/j.jclinepi.2020.06.004

Golden, B. L. (1989). *The Analytic Hierarchy Process: Applications and Studies.* Springer-Verlag.

Gompf, K., Traverso, M., & Hetterich, J. (2021). Using analytical hierarchy process (AHP) to introduce weights to social life cycle assessment of mobility services. *Sustainability*, *13*(3), p. 1258. https://doi.org/10.3390/su13031258

Goscé, L., & Johansson, A. (2018). Analysing the link between public transport use and airborne transmission: mobility and contagion in the London underground. *Environmental Health*, *17*(*1*), p. 84. https://doi.org/10.1186/s12940-018-0427-5

Hendrickson, C., & Rilett, L. R. (2020). The COVID-19 pandemic and transportation engineering. *Journal of Transportation Engineering, Part A: Systems*, *146*(*7*), p. 01820001. https://doi.org/ 10.1061/JTEPBS.0000418

Hetherington, R., Toufique Hasan, A. B. M., Khan, A., Roy, D., Salehin, M., & Wadud, Z. (2021). Exposure risk analysis of COVID-19 for a ride-sharing motorbike taxi. *Physics of Fluids*, *33*(*11*), p. 113319. https://doi.org/10.1063/5.0069454

Indian Express. (2020). COVID-19 impact: After Ola, Uber to lay off 600 employees in India. *Indian Express*. https://indianexpress.com/article/business/companies/uber-india-lay-off-600-employees-due-to-covid-19-6427689/

IndiaSA Comms Team. (2021). Uber pledges free rides worth INR 10 Cr to support vaccination of vulnerable citizens. *Uber Newsroom*. https://www.uber.com/en-IN/newsroom/uber-pledges-free-rides-worth-inr-10-cr-to-support-vaccination-of-vulnerable-citizens/

Jabbari, P., & MacKenzie, D. (2020). Ride sharing attitudes before and during the COVID-19 pandemic in the United States. *Findings*. https://doi.org/10.32866/001c.17991

Jamal, S., Chowdhury, S., & Newbold, B. (2022). Transport preferences and dilemmas in the post-lockdown (COVID-19) period: Findings from a qualitative study of young commuters in Dhaka, Bangladesh. *Case Studies on Transport Policy*. https://doi.org/10.1016/j.cstp.2022.01.001

Karpen, I. O., & Conduit, J. (2020). Engaging in times of COVID-19 and beyond: theorizing customer engagement through different paradigmatic lenses. *Journal of Service Management*, *31*(*6*), pp. 1163–1174. https://doi.org/10.1108/JOSM-05-2020-0156

Kotoula, K. M., Sialdas, A., Botzoris, G., Chaniotakis, E., & Salanova Grau, J. M. (2018). Exploring the effects of university campus decentralization to students' mode choice. *Periodica Polytechnica Transportation Engineering*. p. 11641. https://doi.org/10.3311/PPtr.

Kunhikrishnan, P., & Srinivasan, K. K. (2018). Investigating behavioral differences in the choice of distinct Intermediate Public Transport (IPT) modes for work trips in Chennai city. *Transport Policy*, *61*, pp. 111–122. https://doi.org/10.1016/j.tranpol.2017.10.006

Li, H., Hou, J., Liu, X., Li, R., Zhu, H., & Wu, L. (2011). Combined determination of specific surface area and surface charge properties of charged particles from a single experiment. *Soil Science Society of America Journal*, *75*(*6*), pp. 2128–2135. https://doi.org/10.2136/sssaj2010.0301

Li, Z., Hong, Y., & Zhang, Z. (2016). Do ride-sharing services affect traffic congestion? An empirical study of uber entry. *SSRN Electronic Journal*. p. 2838043. https://doi.org/10.2139/ssrn.

Liakopoulou, S., Kakana, M. M., Avtji, P., Genitsaris, E., & Naniopoulos, A. (2017). Investigating the preferences of students towards the creation of a carpooling system serving the academic bodies of Thessaloniki city. *Transportation Research Procedia*, *24*, pp. 425–432. https://doi.org/10.1016/j.trpro.2017.05.091

Loa, P., Hossain, S., Liu, Y., & Nurul Habib, K. (2022). How has the COVID-19 pandemic affected the use of ride-sourcing services? An empirical evidence-based investigation for the Greater Toronto Area. *Transportation Research Part A: Policy and Practice*, *155*, pp. 46–62. https://doi.org/10.1016/j.tra.2021.11.013

Malhotra, N., Sahadev, S., & Purani, K. (2017). Psychological contract violation and customer intention to reuse online retailers : Exploring mediating and moderating mechanisms. *Journal of Business Research*, *75*, pp. 17–28. https://doi.org/10.1016/j.jbusres.2017.01.013

Mäntymäki, M., Baiyere, A., & Islam, A. K. . N. (2019). Digital platforms and the changing nature of physical work: Insights from ride-hailing. *International Journal of Information Management*, *49*, pp. 452–460. https://doi.org/10.1016/j.ijinfomgt.2019.08.007

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., Agha, M., & Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *International Journal of Surgery*, *78*(March), pp. 185–193. https://doi.org/10.1016/j.ijsu.2020.04.018

Patel, S. J., & Patel, C. R. (2020). Prioritizing facilitators for successful implementation of PBSS in Indian urban areas using BWM method. *International Journal of Mathematical, Engineering and Management Sciences*, *5*(*6*), pp. 1108–1117. https://doi.org/10.33889/IJMEMS.2020.5.6.084

Punniyamoorthy, M., & Prasanna Mohan Raj, M. (2007). An empirical model for brand loyalty measurement. *Journal of Targeting, Measurement and Analysis for Marketing*, *15*(4), pp. 222–233. https://doi.org/10.1057/palgrave.jt.5750044

Rasheed Gaber, H., & Elsamadicy, A. M. (2021). What drives customers to continue using ride-sharing apps during the COVID-19 pandemic? The case of uber in Egypt. *Cogent Business & Management*, *8*(*1*). p. 1944009. https://doi.org/10.1080/23311975.2021.

Reeves, M., Carlsson-Szlezak, P., Whitaker, K., & Abraham, M. (2020). Sensing and shaping the post-COVID era. *Bcg*, pp. 1–9. https://bcghendersoninstitute.com/sensing-and-shaping-the-post-covid-era-c282cd227a4f

Rothengatter, W., Zhang, J., Hayashi, Y., Nosach, A., Wang, K., & Oum, T. H. (2021). Pandemic waves and the time after Covid-19 – Consequences for the transport sector. *Transport Policy*, *110*, pp. 225–237. https://doi.org/10.1016/j.tranpol.2021.06.003

Roy, D., Tripathy, S., Kar, S. K., Sharma, N., Verma, S. K., & Kaushal, V. (2020). Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic. *Asian Journal of Psychiatry*, *51*, p. 102083. https://doi.org/10.1016/j.ajp.2020.102083

Saaty, T. L. (1980). *The Analytic Hierarchy Process*. McGraw hill international.

SDGs. (2020). *Ensure sustainable consumption and production patterns*. United Nations. https://sdgs.un.org/goals/goal12

Shah, P., Varghese, V., Jana, A., & Mathew, T. (2020). Analysing the ride sharing behaviour in ICT based cab services: A case of Mumbai, India. *Transportation Research Procedia*, *48*, pp. 233–246. https://doi.org/10.1016/j.trpro.2020.08.018

Shaheen, Susan, Cohen, A., & Zohdy, I. (2016). *Shared Mobility: Current Practices and Guiding Principles.*

Shalini Umachandran. (2020). *Blame it on the virus, it's the largest lockdown in history*. Livemint. https://www.livemint.com/news/india/blame-it-on-the-virus-it-s-the-largest-lockdown-in-history-11585159348758.html

Shapiro, S. P. (1987). The social control of impersonal trust. *American Journal of Sociology*, *93*(3), pp. 623–658. http:/www.jstor.org/stable/2780293

Sigala, M. (2020). Tourism and COVID-19: Impacts and implications for advancing and resetting industry and research. *Journal of Business Research*, *117*, pp. 312–321. https://doi.org/10.1016/j.jbusres.2020.06.015

Srivastava, A. (2020). Uber lays off 600 staff as Covid-19 hits ride-hailing business. *Economictimes Bureau*. https://economictimes.indiatimes.com/small-biz/startups/newsbuzz/uber-lays-off-600-staff-as-covid-19-hits-ride-hailing-business/articleshow/75991117.cms

Tam, M. C. Y., & Tummala, V. M. R. (2001). An application of the AHP in vendor selection of a telecommunications system. *Omega*, *29*(*2*), pp. 171–182. https://doi.org/10.1016/S0305-0483(00)00039-6

Trivedi, A., & Singh, A. (2017a). Prioritizing emergency shelter areas using hybrid multi-criteria decision approach: A case study. *Journal of Multi-Criteria Decision Analysis*, *24*(3–4), pp. 133–145. https://doi.org/10.1002/mcda.1611

Trivedi, A., & Singh, A. (2017b). A hybrid multi-objective decision model for emergency shelter location-relocation projects using fuzzy analytic hierarchy process and goal programming approach. *International Journal of Project Management*, *35*(*5*), pp. 827–840. https://doi.org/10.1016/j.ijproman.2016.12.004

Trivedi, V., Chauhan, A., & Trivedi, A. (2021). Analysing consumers' smartphone adoption decisions using qualitative dimensions: a multi-criteria decision approach. *International Journal of Technology Marketing*, *15*(*1*), p. 48. https://doi.org/10.1504/IJTMKT.2021.116893

Trivedi, V., & Trivedi, A. (2018). Interpretive structural modelling of website quality factors for repurchase intention in online context. *International Journal of Electronic Business*, *14*(*4*), pp. 309–325. https://doi.org/10.1504/ijeb.2018.10019533

Troko, J., Myles, P., Gibson, J., Hashim, A., Enstone, J., Kingdon, S., Packham, C., Amin, S., Hayward, A., & Van-Tam, J. N. (2011). Is public transport a risk factor for acute respiratory infection? *BMC Infectious Diseases*, *11*(*1*), p. 16. https://doi.org/10.1186/1471-2334-11-16

Wang, W., Miao, W., Liu, Y., Deng, Y., & Cao, Y. (2022). The impact of COVID-19 on the ride-sharing industry and its recovery: Causal evidence from China. *Transportation Research Part A: Policy and Practice*, *155*, pp. 128–141. https://doi.org/10.1016/j.tra.2021.10.005

WHO. (2020a). *Archived: WHO Timeline - COVID-19*. WHO. https://www.who.int/news-room/detail/27-04-2020-who-timeline---covid-19

WHO. (2020b). *COVID Cases*.

WHO. (2020c). Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations. WHO. https://www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations

Yaliniz, P., Ustun, O., Bilgiç, S., & Vitosoglu, Y. (2016). Evaluation of park and ride scenarios for eskisehir with AHP. *IOP Conference Series: Earth and Environmental Science*, *44*, p. 052061. https://doi.org/10.1088/1755-1315/44/5/052061

Zucker, L. G. (1986). Production of trust: Institutional source of economic structure 1840–1920. *Research in Organizational Behavior*, *8*, pp. 53–111.

Zwanka, R. J., & Buff, C. (2021). COVID-19 generation: A conceptual framework of the consumer behavioral shifts to be caused by the COVID-19 Pandemic. *Journal of International Consumer Marketing*, *33*(*1*), pp. 58–67. https://doi.org/10.1080/08961530.2020.1771646