Periodicals of Engineering and Natural Sciences ISSN 2303-4521
Vol. 9, No. 1, February 2021, pp.301-307

Using the smartphone in carpooling for new mobility services

Samera Ibrahim Kadum Al-Addal
Faculty of Physical Planning, University of Kufa, Iraq

ABSTRACT

The principle of dynamic carpooling is in local real-time to send the "user-carpooler." If we choose to travel with standard vehicles, we can contact the service a few minutes before departure. The service then searches for the best driver to give the desired car-sharing service on the chosen route. In recent years, there has been growing creation of modern information and communication technology, particularly with the growth of the Internet and mobile telephones. New knowledge and networking systems are therefore closely linked with the changing area of mobility. Policies and processes introduced for sustainable mobility in this field. New forms of transportation aim to find a space for them and promote emerging mobility technologies such as shared cars. It has been shown that these programs utilize modern knowledge and communication technology, particularly recently, to evolve via telephone. The aim of this project is, in this sense, to decide how often smartphone car sharing access can be utilized. This tool seems important in specific typical vehicle use encounters and seems a significant factor in growing its scope by simplifying access and use. The method is versatile and provides a high standard of operation with a reasonable number of participants: the probability of having a shared vehicle is reasonable. This scheme complements mass transit – on-demand and daily – and complementary options such as bicycle terminals.

Keywords: Sustainable mobility, New Mobility Services, Carpooling, Dynamic Carpooling, NTIC, Smartphone

Corresponding Author:

Samera Ibrahim Kadum Al-Addal
Department of Regional Planning
University of Kufa, Kufa, Iraq
Email: samerai.al-addal@uokufa.edu.iq

1. Introduction

The problem of transport is at the core of numerous environmental, social, and regional issues. Dominated for decades as a single-car method, mobility systems aim to adapt after difficulties [1]. The automobile is still commonly used, mostly because of the lack of acceptable and desirable substitutes. That is why lawmakers seek to rely on emerging models of transportation that highlight new solutions to existing private vehicle use. The purpose is to think differently about the new mobility structure such that mobility takes care of everyone, without neglecting each other's interests: sustainable mobility. Technological development and its efficiency are continuously enhancing the resources. Technology is an essential aspect of our culture and has gone into numerous sectors, including travel. ICT and transport are strongly intertwined due to their similarity in forming networks and the transfer of knowledge and vehicles. Transport networks were designed to expand facilities based on technologies of their period [2, 3]. Therefore, the emergence of modern transport systems, entirely or partially based on emerging information and communication technology, is not unexpected. Carpooling is one of these facilities. Car sharing is an alternative option for automated transport, which improves automobile occupancy and thus combat congestion. Car usage plays a role in reducing greenhouse gas emissions and polluting emissions in terms of environmental impacts. Financially, by sharing the expenses of driving the vehicle, and economically, establishing a reciprocal link with people using shared vehicles[4, 5]. A new kind of car usage, focused primarily on new information and communication technology, is trying to show its utility in this sense. Dynamic car sharing has strong growth potential and seeks to allow standard vehicles to be more appealing and versatile. Relevant resources are necessary to maintain operation on the move, based on the real-time concept. This form of car sharing can be reached by using a mobile. Therefore, we must grasp more precisely how convenient it is to use a mobile

to access car-sharing. This study helps one to evaluate what this technology adds to the activities of mobility. To this end, Carpooling: a changing accessibility service, the theoretical contributions of the mobile to carpooling experience, and eventually the usage of the smartphone for carpooling tests.

2. Carpooling: A changing mobility service

2.1. Carpool practice

To arrange a carpool ride, the driver and one or more passengers must settle on a trip conducted in the same vehicle together. These two parties may interact informally, in which case they will engage immediately in the vehicle. Moreover, precarious tenants often establish coach escorts called mutual assistance so that they may travel about. In reality, in some cases, the solidarity-based collective usage is a requirement for mobility for the most vulnerable individuals and enables them to work. This informal process of car usage does not use technology [6, 7]. It relies instead on the relations between family members, neighbors, or colleagues. In the case of an unfortunate event, car-sharing usage may be considered to fix future malfunctions or unpredictable incidents at the last minute. The ties between people are significant since this car usage depends mainly on confidence [3, 8] We are talking about the coordinated motor exchange if the meeting needs coordination. In reality, some mechanisms allow car users to interact. These systems promote variations by relying on car share deals and demands. Such external organizations can be mobility centers, unions, people, businesses, or even agencies. Car-sharing is not a viable process but can be supplementary to other potential options to a private vehicle such as public transport. It is also a distinct approach for versatility that can be paired with other modes. Besides that having a shared vehicle will minimize the expense of transport by sharing the ride with other citizens; it can also be used to meet the desired destination. There is no need to know how to operate the card or navigate the Internet anymore. Mobility issues are also minimized [9].

2.2. Significant emergence of carpooling

Since car-sharing is a sincere solution to reducing the (weight) importance of a private car, particularly by growing the occupancy rate of the traveling cars, local councils have been interested in improving it after 2000. Results are inherent because public transportation usage prefers to restrict the flow of vehicles; the emissions they emit are thus minimized. In reality, fewer road vehicles lead to greenhouse gas emissions mitigation as it is calculated that a car driver stops 1 ton of carbon dioxide each year on average [10]. The usage of standard vehicles is an effective means of lowering emissions of greenhouse gas into the atmosphere. There is also minimal environmental harm incurred by overload engines. Car sharing often can minimize future pressure on the road network since drivers are in the same car rather than in the car. Around the same period, parking demands for the destination area are often minimized. In some instances, the usage of standard vehicles is becoming more and more common. Indeed, the first websites devoted to shared car use in the 1990s, demonstrating the trend in shared car use, continued to expand. However, it remains challenging to ascertain the precise number of car participants, as participants will participate on many websites without being active. In comparison, unofficial car sharing would not make counting simpler [11].

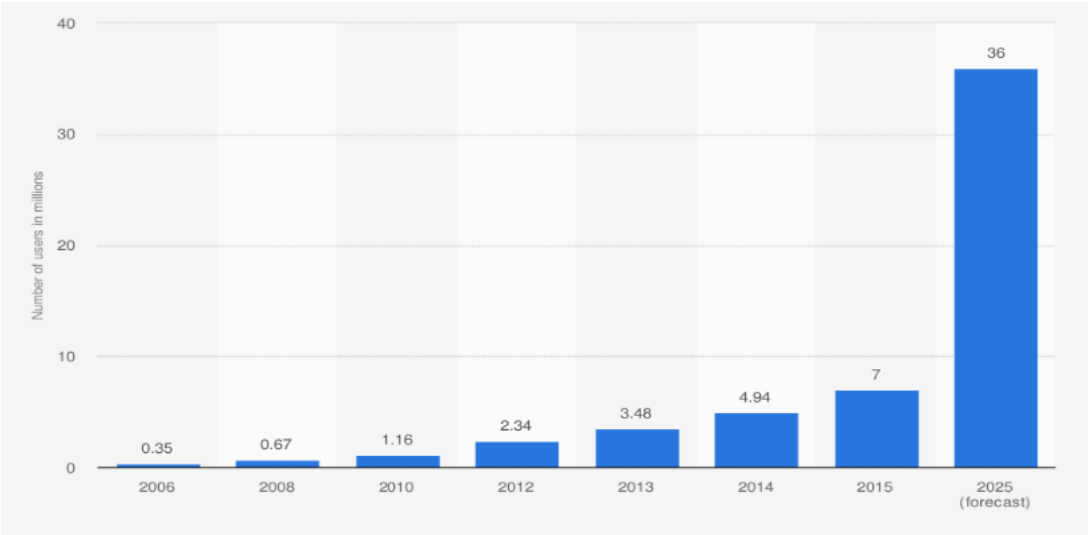

Figure 1. The number of carpooling users worldwide from 2006 to 2025 (in millions)[12]

Since car-sharing is a sincere solution to reducing the (weight) importance of a private car, particularly by growing the occupancy rate of the traveling cars, local councils have been interested in improving it after 2000. Results are inherent because public transportation usage prefers to restrict the flow of vehicles; the emissions they emit are thus minimized. In reality, fewer road vehicles lead to greenhouse gas emissions mitigation as it is calculated that a car driver stops 1 ton of carbon dioxide each year on average [13]. The usage of standard vehicles is an effective means of lowering emissions of greenhouse gas into the atmosphere. There is also minimal environmental harm incurred by overload engines. Car sharing often can minimize future pressure on the road network since drivers are in the same car rather than in the car. Around the same period, parking demands for the destination area are often minimized. In some instances, the usage of standard vehicles is becoming more and more common. Indeed, the first websites devoted to shared car use in the 1990s, demonstrating the trend in shared car use, continued to expand. However, it remains challenging to ascertain the precise number of car participants, as participants will participate on many websites without being active. In comparison, unofficial car sharing would not make counting simpler [11].

2.3. The appearance of dynamic carpooling

The practice of classic cars has diversified in recent years, and a modern model for ordinary cars has arisen. It is a modern generation of car sharing that can be named dynamic. This car category has the feature that it is not pre-regulated like conventional car sharing. This ride-sharing system allows such technical constraints due to traditional car usage to be minimized. The meetings are agreed upon not long before the trip, which makes the structure very versatile. Therefore, motorists could already be in their car or on their way from work [14].Dynamic Ride Sharing is defined as a service to provide a car share customer with an almost real-time view who wishes to utilize the car-sharing route and call a few minutes before leaving. The service would then look for the right driver to provide the required mass transit on the desired path. The activity of car sharing will also no longer have to be arranged in advance since even after the trip, a person may decide to find car sharing [15]. The core basis of this car-sharing is, therefore, real-time. It relies primarily on cell telephone and geolocation in operation. The method incorporates modern technology in information and connectivity, so it requires full versatility. After registering with the registry based on carpool participation deals and queries, the device handles pairing in real-time. The driver should then be warned of a passenger who intends to depart near his car in the same direction. In the face of affordability, this form of automobile usage may also become a lever to encourage greater social equality, considering the mobility issues certain citizens with lower incomes may experience. Besides, spontaneous car usage is already occurring in some slums, particularly for economic reasons. These families are also less mobile and are required to find other options for transport. Last-minute attendance is then organized because of logistical difficulties related to an aging influx of cars that can also crash [16]. The demands for car sharing will then be volatile and coordinated at the last minute. However, this is the same as utilizing competitive car sharing, mainly through emerging innovations are not involved. Furthermore, poor communities are typically compact metropolitan districts, which raise the risk of shared autos. The use of car sharing, mainly when a variable with dynamic car use arises, appears to be at the heart of the real-time reactive mobility problem. To better explain the potential relation between modern ICTs and new mobility structures and, in particular, the car-sharing, the extent of new knowledge and communication technology was highlighted. Technology is demonstrating this freedom gradually in the context of human mobility [17].

3. Theoretical contributions of the smartphone to the practice of carpooling

3.1. The Smartphone: A tool for mobility

Mobile is a telephone that helps us to communicate on the go to the Internet. A smartphone offers several features a cell phone would use: GPS, check routes, time, etc. Therefore, it was possible to access the Internet through a mobile telephone in recent years, but it has only lately become an important activity, mainly due to the spread of the smartphone. Internet links are typically short-lived but still prevalent during the day. It has the drawback that it can be finished at all hours, which helps you have more spare time. In reality, people still have their smartphones with them to use them whenever they want [18, 19]. Moreover, almost half of the consumers of smartphones never switch it off. It is necessary to remember that one in four people has a smartphone. The handset is a multi-tasking system that substitutes the machine more and more. The mobile Internet is not often easy, though, so machines are favored for such tasks. Web pages for smartphones are not necessarily optimized to prevent users from remaining on these sites for an extended period. On the other hand, user knowledge is an essential factor because certain users access the Internet on a device more effectively than with a mobile. The telephone is the means for the bulk of mobile conversations and thus an essential instrument for this study. In reality, going online is becoming

increasingly popular. As we can see from the chart below, smartphones' share rises rapidly, and almost half of the world owns a smartphone.

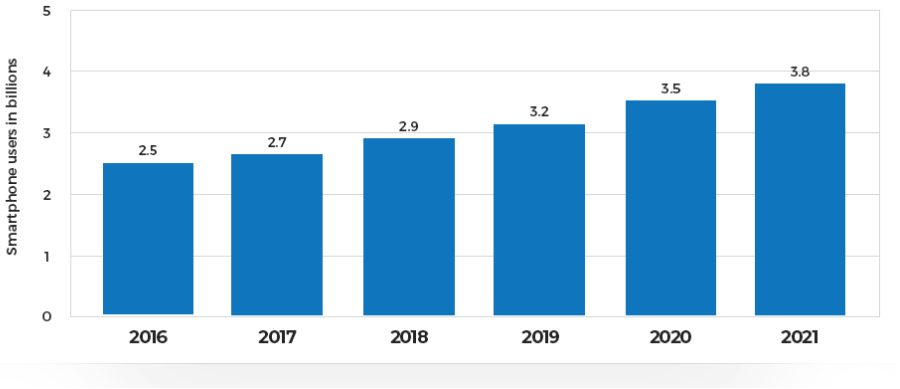

Figure 2. The number of Smartphone users in the world [20]

Simple access to details helps a person to optimize the path they are expected to follow in compliance with the transport methods accessible in the region and to be used. Apps for car sharing, such as the BlaBlaCar app or iDVROOM, are accessible on smartphones. There are update and run programs on the phone. This form of the program has multiple mobile internet connections. The request will take several forms. It may be built explicitly as an interface or an adaptation of an established website. Furthermore, the program's flexibility is gradually growing, whether for a realistic knowledge task, an administrative role, Etc. This program helps the software meet any requirement, either for mobility or for free, or for a fee. Due to necessary equipment and payment rates, free apps are typically more common than paid apps. Specific software is sometimes released because of the constructive reviews it gets. Connectivity is necessary in order to provide one application over another. The mobile has a good feature in terms of versatility. In reality, the smartphone will cause the fitted individuals to be geolocated. This service is often expected to use some emerging transportation systems, such as dynamic car sharing. This function somehow is a concern for the usage of personal details, but people are prepared to use it. In reality, for functional purposes, over half of the people fitted with smartphones use geolocation. Geolocation helps them monitor their paths, access road traffic details, and find local facilities [21].

3.2. Smartphones: A potential asset for carpooling

The mobile provides several features that can be interfered with from the legislative level to its execution throughout the practice of car sharing. It is crucial to select the mode of transport for the expected trip before traveling. However, the range of accessible deals is not often noticeable in the case of navigation. Therefore, it is not always necessary to use one transport mode above another without understanding all the choices available. In shared cars, it is not always apparent if shared cars practice in a specific area and, more specifically, on the preferred route is successful. Therefore, pooled car use is a possible option provided there is knowledge regarding it. Car sharing features can be viewed on the chart for mobile apps. The mobile then becomes a relay for modal knowledge exchange. For this purpose, prospective passengers are aware of the robust car-sharing scheme in a given room, making it easier to combine users [22]. The scheme generally performs well because of the vast number of future customers choosing to use standard vehicles. Passengers with a smartphone will then quickly react to the availability of the car. The offer of entry to public cars encourages vehicles to check and pick up passengers on their way. The driver provides frequent input to see whether customers wish to share the vehicle with him on his ride. It is no longer appropriate to be at home or work on a stationary machine. Car sharing may be an intuitive nomadic approach for versatility. Many smartphone apps or websites provide last-minute car-sharing capabilities. The sharing of cars could then no longer be prepared in advance and seem like the most common forms of transport. mMoreover, thanks to the cancelation function, the mobile makes for unpredictable events at the last minute. Car comrades get real-time updates that encourage them to adjust their circumstances. In comparison, comments are also a cause of consumer resistance. However, there is a transition assurance via the framework in case of an unlikely event. If the driver cancels at the last minute, the application's service can locate the remedy for transfer and transfer them to the passenger instantly[18]. In certain situations, you might also pay a cab if there are no other options. Therefore riders in car-sharing are likely to return. A mobile will reduce any user's worries about utilizing public cars by accompanying them. Any mobile applications carry on

the responsibility for the scheduled car sharing. Once car sharing is planned, accessibility is required, which can be directly carried out with a smartphone. Vehicle escorts are then told in real-time when car sharing can be planned. Applications that specify the path to reach the meeting point [23] allow the meeting of the different participants easy to reach. Any pause on the part of the recipient is therefore notified to the parties concerned. In reality, some vehicles use smartphone apps to decide users wait or pause. The target vehicle's position on the path can also be seen on the chart in real-time, thanks to the geographical location change. The passenger will also foresee the approach of the car. On the move, car sharing was optimized using smartphone apps, which can decide the most appropriate route to a destination taking real-time traffic conditions into account. Any loss of time is avoided by utilizing the technology offered by a smartphone. Regarding the feeling of fear that arises when utilizing car sharing, it is essential to remember that the trip is registered and that users of shared cars are recognized with mobile apps that will comfort users. Any mobile apps accept the cost estimation, and a virtual wallet device might be available. There is now no need to measure travel expenses anymore. You might also picture a mobile payment system. This ticketing device then depends on the contactless chipset NFC (Near Field Communication). However, this function allows some more software to be downloaded. Finally, certain apps may measure the carbon dioxide amounts saved as you opt to share the vehicle instead of borrowing a private car alone, enabling the driver to drive around more easily [24].

4. Usage of the smartphone as part of a carpooling experiment

4.1. The Project of €COPOLL

The goal of this project, developed by One Plus One Technologies[25], was to demonstrate the viability of the idea 'carpooling lings through a service experience' (The service theory is to enable passengers with a car-sharing service to approach through text. The proposed pilot is based in the Inovallée Technopole Job District in Meylan and Montbonnot St Martin, France's Isère Region. The PDIE Purpose Led Innovation Ecosystem has been introduced by the first technical park and has demonstrated the boundaries of the existing structures that form the current state of the art in car sharing. Inovallée Technopole, situated 8 kilometers north-east of central Grenoble, has 300 businesses and 9,000 staff on 110 hectares. Technopol is on the northern edge of the Grenoble Chambéry highway (A 41). Three public transit lines serve it:

• V-axes north of the agglomeration of Grenoble is served by Voiron-Crolles express;

• the Inovallée shuttle from the A and B tram stations "Les Grands Sablons"

• Line 6070, which links the French train station and the bus station to the National Community.

The new transport survey on Technopol found that a median share of public transport is 15%. A database of 6,200 non-nominal addresses was generated for workers of 120 technology firms, excluding those whose personnel operate more offsite. The data suggest that:

• 14% of workers reside outside the Isère department.

• 73% of workers remain outside of Grenoble and mostly along the roads (Chambéry, Valence, Lyon) in the province of Isère;

• 13% of workers reside in Grenoble. Less than 30 km take place 64 percent of journeys.

To measure the possibility of utilizing shared cars, a possible passenger car driver was measured to decide if at least 1 driver was on the car-sharing route. According to the convention, this partnership leads to the verification of two spatial criteria:

• The employee walks from door to door fewer than 500; on the path from home to the driver, then the business at the drop-off point;

• The driver lives fewer than 2 kilometers from journeys of 10 km or less than 20 percent, or less, of the overall duration of his travel on journeys of more than 10 km.

After production, the number of possible travelers and drivers is 80 percent of 6,200 workers. In reality, though, it is not possible that car sharing is used by more than 5% of the workforce, although it has an online matching program and an advertising campaign on the web. Among the needs that conventional car sharing does not fulfill and may justify the 5% to 80% gap, the goal is to maintain passengers' individuality and driver freedom by utilizing the dynamic typical tour planning program. Therefore, the service's relative value is explicitly connected to the number

of drivers on each trip accessible to the same customer. This parameter underlines the number of drivers per passenger and underlines the classification of drivers according to three separate potential practices:

A: "participatory stop": this section is that the gap to drivers is limited (<10 km), but the driver supply is blocked (>30 drivers/passenger); A:

B: one direction (> 5 cond./passes) between 10 and 30 km of "carpooling lines;"

C: "Classical" carpooling and the savings by carpoolers is the key consideration in this chapter.

This Section B of 2,000 future riders focuses on the € COPOLL initiative. They travel on a one-way stretch of 13.4 km and are willing to save € 100 a month by car sharing, thus growing their pollution by 3,100 tons of CO2 equivalent per year.

4.2. The project of covoidurable

Savoie Technolac creates the SMS Collaboration Experience for Car Sharing (Purpose Guided Innovation Ecosystem) PDIE. This project, established by PENTILA and Savoy University, offers a complex communication framework for smartphone and Internet users. Furthermore, the project is focused on [1]:

- Geolocation to minimize service encounters and increase the efficiency of response to demand.
- To strengthen partnerships and increase service trust by leveraging social networks.

In the project, car drivers disclose offers to share cars and collect SMS from registered passengers to complete the crew (2, 3 people). Motorists receive SMS proposals from travelers. If the plan for the usage of shared cars is approved, confirmation of location, period, automobile form, etc., shall be provided to the customer. You must first register on the web to benefit from the service. You should be a citizen of, or travel via, Chambéry, Aix-les-Bains, or La Motte-Servolex to enter or exit Savoie Technol. The returned promise is valid: bus fares, bicycle entry, corresponding contact number [26].

5. Conclusion

This study has demonstrated that innovations will be at the core of Modern Mobility Services, but not inherently revolutionize everything. In the sense of automobile sharing, the smartphone promotes classic shared automobiles and the implementation of a modern framework. Indeed, in organizing car sharing, mobile usage enables participants to improve in specific their reaction and, therefore, the procedures to be more versatile. Thanks to the functionality that it requires, it also encourages the introduction of immersive vehicle experiences. Launching is a crucial step towards requesting a quality operation. Difficult as this is, diverse encounters have demonstrated the rising involvement of neighborhoods, businesses, and individuals in carpooling. In some instances, device connectivity, coupled with the right technologies, seems to be a path to performance. It should not be ignored, though, that travel planning must be considered part of the whole mobility scheme. Car sharing, however, cannot be viewed separately but must form part of the navigation offer available.

References

[1] G. Bosworth, L. Price, M. Collison, and C.J.L.E. Fox, "Unequal futures of rural mobility: Challenges for a “Smart Countryside”," vol. 35, no. 6, pp. 586-608, 2020.

[2] H. Ma, X. Li, and Y.J.S.C. Liu, "Multi-period multi-scenario optimal design for closed-loop supply chain network of hazardous products with consideration of facility expansion," vol. 24, no. 4, pp. 2769-2780, 2020.

[3] A. Alaidi, I. Aljazaery, I. Mahmood, and F. Abed, "Design and Implementation of a Smart Traffic Light Management System Controlled Wirelessly by Arduino," *International Journal of Interactive Mobile Technologies*, vol. 14, no. 7, pp. 32-40, 2020.

[4] R.B. Stewart, M. Oppenheimer, and B.J.S.E.L. Rudyk, "Building blocks for global climate protection," vol. 32, p. 341, 2013.

[5] R.M. Al_airaji, I.A. Aljazaery, S.K. Al_dulaimi, and H.T.S, "Generation of high dynamic range for enhancing the panorama environment," *Bulletin of Electrical Engineering and Informatics*, Article vol. 10, no. 1, pp. 138-147, 2021.

[6] M. Smith and J. Mac, *Revolting prostitutes: The fight for sex workers' rights*. Verso Trade, 2018.

[7] N.A.H. Hala A. Naman, Mohand Lokman Al-dabag, "Encryption System for Hiding Information Based on Internet of Things," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 15, no. 2, 2021.
[8] P.A. Hancock, T. Kajaks, J.K. Caird, M.H. Chignell, S. Mizobuchi, P.C. Burns, J. Feng, G.R. Fernie, M. Lavallière, and I.Y.J.H.f. Noy, "Challenges to human drivers in increasingly automated vehicles," vol. 62, no. 2, pp. 310-328, 2020.
9] E.J.N.R. Castex, communication et territoires, "Organisation des pratiques de covoiturage entre inconnus dans les territoires. L'exemple de l'aire métropolitaine lilloise," no. 29-1/2, pp. 153-176, 2015.
[10] L.A. Guzman, F. Escobar, J. Peña, and R.J.L.u.p. Cardona, "A cellular automata-based land-use model as an integrated spatial decision support system for urban planning in developing cities: The case of the Bogotá region," vol. 92, p. 104445, 2020.
[11] T. Delaunay, "L'intégration du covoiturage dans le système de mobilité francilien: hybrider le transport collectif et individuel pour asseoir l'hégémonie de l'automobile?," 2018.
[12] S. Telang, A. Chel, A. Nemade, and G. Kaushik, "Intelligent Transport System for a Smart City," in *Security and Privacy Applications for Smart City Development*: Springer, 2021, pp. 171-187.
[13] R. Johansson, S. Meyer, J. Whistance, W. Thompson, D.J.R. Debnath, and S.E. Reviews, "Greenhouse gas emission reduction and cost from the United States biofuels mandate," vol. 119, p. 109513, 2020.
[14] E. Brynjolfsson and A. McAfee, *Race against the machine: How the digital revolution is accelerating innovation, driving productivity, and irreversibly transforming employment and the economy*. Brynjolfsson and McAfee, 2011.
[15] S.B. Cheikh, "Optimisation avancée au service du covoiturage dynamique," 2016.
[16] C. Jana, S. Mahapatra, and R. Chattopadhyay, "A MULTI OBJECTIVE FUZZY LINEAR PROGRAMMING APPROAa-t TO ENERGY RESOURCE ALLOCATION FOR DOMESTIC LIGHTING."
[17] R. Clavel and P. Legrand, "Le covoiturage dynamique: étude préalable avant expérimentation," 2009.
[18] S.T. Poon, "Designing for Urban Mobility: The Role of Digital Media Applications in Increasing Efficiency of Intelligent Transportation Management System," in *Smart Cities: A Data Analytics Perspective*: Springer, 2021, pp. 181-195.
[19] H.T.S. AlRikabi, A.H.M. Alaidi, A.S. Abdalrada, and F.T. Abed, "Analysis of the efficient energy prediction for 5G wireless communication technologies," *International Journal of Emerging Technologies in Learning*, Article vol. 14, no. 8, pp. 23-37, 2019.
[20] K. Apicharttrisorn, X. Ran, J. Chen, S.V. Krishnamurthy, and A.K. Roy-Chowdhury, "Frugal following: Power thrifty object detection and tracking for mobile augmented reality," in *Proceedings of the 17th Conference on Embedded Networked Sensor Systems*, 2019, pp. 96-109.
[21] P. Raj and A.C. Raman, *The Internet of Things: Enabling technologies, platforms, and use cases*. CRC Press, 2017.
[22] B. Toader, F. Sprumont, S. Faye, M. Popescu, and F.J.I.I.J.o.G.-I. Viti, "Usage of smartphone data to derive an indicator for collaborative mobility between individuals," vol. 6, no. 3, p. 62, 2017.
[23] C. Caballero-Gil, P. Caballero-Gil, J. Molina-Gil, F. Martín-Fernández, and V.J.S. Loia, "Trust-based cooperative social system applied to a carpooling platform for smartphones," vol. 17, no. 2, p. 245, 2017.
[24] N. Bounie, F. Adoue, M. Koning, A.J.T.R.P.A.P. L'hostis, and Practice, "What value do travelers put on connectivity to mobile phone and Internet networks in public transport? Empirical evidence from the Paris region," vol. 130, pp. 158-177, 2019.
[25] I. Karlsson, D. Mukhtar-Landgren, G. Smith, T. Koglin, A. Kronsell, E. Lund, S. Sarasini, J.J.T.R.P.A.P. Sochor, and Practice, "Development and implementation of Mobility-as-a-Service–A qualitative study of barriers and enabling factors," vol. 131, pp. 283-295, 2020.
[26] R.J. Lee, I.N. Sener, and J.A.J.T.L. Mullins III, "An evaluation of emerging data collection technologies for travel demand modeling: from research to practice," vol. 8, no. 4, pp. 181-193, 2016.