Dynamic Ride Sharing as an Alternative Transportation Mode for Commuting Among METU Campus and Eryaman

Mehmet Erdi Özgürlük and Ismail Yavuz Paksoy

Abstract Dynamic ride sharing is an alternative way of commuting to individual car use with the utilization of improving available seat capacity for new riders through which more sustainable trips are ensured among drivers and riders who have similar itineraries in closer time slots. This paper describes a study in which dynamic ride sharing practice among METU (Middle East Technical University) Campus and Eryaman (district of Ankara) via both Facebook group and TAG (let's ride in a single car) app has been investigated with the participation of 12 users. The main objective of the study was to acquire in depth knowledge about the phases of dynamic ride sharing practices, experiences of individuals commuting via ride sharing, their concerns and acquisitions from ride sharing, and to determine potential solutions for improving the overall ride sharing practice which would make it an effective and preferable way of alternative transportation in a sustainable manner. The study revealed user's underlying motivations towards ride sharing, their concerns, needs and desires which would help generate better approaches to performing ride sharing practice, in terms of both optimized and secured ways for better experiences in the light of fresh insights gathered in specific themes.

Keywords Dynamic ride sharing · Sustainability · Behaviour change · Sustainable transportation · Campus commuting

1 Introduction

"Nowadays we are experiencing a shift of paradigm from ownership of goods to sharing goods and experiences" [1, p. 777]. Developments in technology have influenced the way people behave towards their actions through daily practices, including

M. E. Özgürlük (✉) · I. Y. Paksoy
Middle East Technical University, Ankara, Turkey
e-mail: ozgurluk@metu.edu.tr

I. Y. Paksoy
e-mail: ypaksoy@metu.edu.tr

sharing experiences and shifted them to another level. Uber, Lyft, Airbnb, Blablacar and similar services have given a direction to daily routine activities of people and sharing practices enabled the acquisition of a new meaning. In this respect, for ride sharing, Fogel and Nehmad [2] illustrate that people having profiles on social networking websites tend to take greater risks through their attitudes. Therefore, sharing a ride with people they have never met is not a big trust issue affecting their decisions. Inspired by those sharing practices of the era, this research explores ride sharing experiences of METU (Middle East Technical University) students commuting between Eryaman (district of Ankara) and METU Campus.

1.1 Dynamic Ride Sharing

All presence of mobile internet technology has provided, for those having similar itineraries and time schedules, new opportunities to share their rides on short notice [3]. According to Saranow [4] the demand for ride sharing services which meets the needs of people of common transport in similar routes and time slots has increased clearly in recent years. Specially, the spread of using Internet-enabled smartphones "allow people to offer and request trips whenever they want wherever they are, enabling dynamic, on-demand ride-sharing" [5, p.4]. In that sense, dynamic ride sharing differs from traditional car sharing or carpooling and vanpooling with its two distinct features [6]. In traditional ride sharing, the origin and destination points are fixed, yet through dynamic ride sharing one can simply match with random points and random times regarding the trip purpose. Another distinct feature of dynamic ride sharing is that trip arrangements are made very close to the trip time when a user needs immediate travel rather than arranging it from weeks ago.

There are several economic, environmental and social benefits of dynamic ride sharing. In general terms, as current transportation models are not both environmentally and socially sustainable, road transportation is one of the most challenging issues of the new world [7]. In one respect, car pollution directly causes global climate change as being one of the major sources of greenhouse emissions [8]. In another respect, traffic congestions have a great influence on the reduction of people's quality of life worldwide [9]. Considering that on average cars carry 1.6 passengers, only 25% of predicted amount of emissions are caused by people travelling and the rest is caused by empty seats [10]. In this respect, many researchers from diverse disciplines such as transportation [11], economics [12], and behavioural, social and environmental psychology [13] have described dynamic ride sharing as an effective solution to the inefficiency of current transportation models. Moreover, circumstances such as finite oil reserves, rising gas prices, traffic congestions and related environmental concerns have given a direction to people to use their personal automobiles more wisely with an increased interest in services such as dynamic ride sharing [14]. Further-more, Agatz [14] states that at an individual level, ride sharing allows participants having automobiles to share travel expenses while offering those without cars an enhanced mobility. In overall ride sharing, in other terms the joint

travel of two or more persons in a single car has initiated a common way of sharing also the costs and benefits together of a shared private car [15].

1.2 Problem Statement

University campuses have high human concentration where many trips are being made daily. Travel to and from campuses is associated with diverse mode choices such as public transit, individual car use, ride sharing, walking, cycling, subway if available, and so on. Affecting the behaviour of commuters and guiding them to use more environmental-friendly modes is crucial for the improvement of sustainable transportation of the campus area and surrounding neighbourhoods. Limanond, Butsingkorn and Chermkhunthod [16] state that recently, the rising awareness on the issues of climate change and gasoline price crises have caused university planners to focus much more attention on the encouragement of alternative modes that are environmentally friendlier and less gasoline-dependent on campus. Transport planning needs to encourage using these alternative modes, while discouraging individual car use [17]. Mode choice decisions for travelling depend on many different issues such as convenience, comfort, safety, time considerations, accessibility and cost, yet these decisions tend to be affected by social, economic and environmental impacts of commuters' acts and behaviours. Fu et al. [18] state that there has been substantial interest in promoting sustainable transportation alternatives due to climate change, aging infrastructure, and raising *green* culture. Population-based changes in individuals' behaviours, attitudes and knowledge are important to accomplish wide-spread adoption of alternative transportation modes. Moreover, for the improvement in the quality of life of campus residents, some measurements should be implemented through sustainable transportation which will return in many social, economic and environmental benefits. In this respect, dynamic ride sharing could be one of the most prominent solutions for METU Campus where hitchhiking culture is truly favoured among all its members. Deciding on how to commute by either using the Facebook group or via TAG app can be another major means of transportation in campus level after some conflicts are resolved and the experience is made better with further improvements.

1.3 Aim of the Study

This paper presents a study conducted with the participation of both drivers and passengers to a specific diary study with the aim of gathering their concerns, needs, desires and acquisitions through dynamic ride sharing experiences. Commute experiences of different types of users, via ride sharing among METU Campus and Eryaman, are utilized to set a number of applicable criteria for better ride sharing

experiences under diverse-themed positive and negative insights. This paper introduces the study which is constituted of pursuit of users' ride sharing experiences throughout a week and complementary stages for obtaining feedback on their acquisitions with their experiences. After gathering this feedback, the study finally discusses how the findings can turn into insights to be used for the further development of ride sharing experiences, under different themes, using affinity diagramming.

2 The Study

The study consists of three main phases. At the start of the study, mass data logs of the TAG app, an app used by commuters who are mostly university students to arrange ride sharing, are collected to determine the participants of the study. Furthermore, an experience chart is prepared, to reflect the experiences of participants regarding ride sharing. The second phase incorporates initial interviews with the participants, which also employs the participants to build an experience timeline using the chart created in the preparation phase. The third phase includes the conducting of the diary study. At the same time of the diary study, behaviours of participants are also monitored using the real-time device logs. Furthermore, post interviews are conducted to fill in the knowledge gaps in the prior part of the study.

2.1 Phase 1: Preparation

The first phase of preparation aimed to gather cumulative data regarding the ride sharing Facebook group titled "ODTÜ-Eryaman Araç Paylaşımı" (METU-Eryaman Ride Sharing) and TAG (Tek Araba Gidelim-*let's ride in a single car*) app to determine the profile of participants to conduct the study with. In addition, an experience chart was prepared in this phase to be employed during the first face-to-face encounter with participants, in the second phase. At the end of the preparation phase, 12 participants were determined to conduct the study with.

Collection of Mass Data Logs. Mass data logs from the developers of the TAG app were acquired in order to determine the sampling strategy for the study. The harvested data included general demographic data regarding the participants' gender, age, role (driver or rider), number of journeys with TAG app and frequency of application use. Sensitive data that may distinguish individual users were not included in these mass data logs.

Sampling. Quota sampling is a method of acquiring representative data from a group. Unlike random sampling, quota sampling requires each representative participant to be chosen out of a specific subgroup [19]. This study uses quota sampling technique to determine participants. The factors that are taken into consideration to achieve the quota sampling were demographic data such as gender and age, role of the user as the user can be either driver or passenger, frequency of application use and

number of journeys made with TAG. Contemplating on the data harvested, which includes 340 users in total, 214 were passengers and 126 were drivers. Number of males and females were very close to each other. Considering that the study was conducted for a graduate course with limited time to complete the study, it was decided to conduct the study with 12 participants. As a result, the sampling was distributed as two female drivers, two male drivers, four female passengers and four male passengers.

Preparation of the Experience Chart. An experience chart was prepared for the participants of the field study to fill in their ride sharing timeline experience rating. With the tool, the aim was for participants to declare the steps of a general ride-sharing practice. For this reason, the A4 landscape formatted tool employs a timeline, where participants can add the significant steps of ride sharing. Along with a timeline, the tool also accommodates an area for participants where they can note the positive, neutral and negative experiences as they talk, corresponding to the steps declared. The positive, neutral and negative aspects of experiences are represented with emoji-like bullet points. There are also fields for distinctive characteristics of participants in addition to duration information of the interview.

2.2 Phase 2: Initial Interviews and Experience Timeline

The aim of the second phase was to get to know the participants and make them talk about how they plan their daily commutes, and how they make choices regarding their mode of transportation. Furthermore, they were encouraged to express their typical commute experiences explaining the positive and negative aspects of their experiences and problems they face during the commute. The interviews also aimed at extracting knowledge regarding the ethics, advantages and disadvantages of the ride sharing activity. TAG app, which accommodates ride sharing for both drivers and passengers, was also the topic of discussion, as one of the aims of the research was to understand how TAG works and how it could be improved.

To achieve all this, semi-structured interviews were conducted with each participant, considering the factors presented in Table 1. During the interviews, participants were asked to fill in the ride sharing timeline and experience rating tool (Fig. 1), as the tool clarifies the significant steps of the commuting and ride sharing experiences to sensitize participants to see their journeys from start to the end and talk about how they felt about a certain step or behaviour. An example of a ride sharing timeline & experience rating tool is presented in Fig. 2.

Table 1 Considerations for semi-structured interviews

Passenger	Driver
Planning the ride/method Deciding on method by available options	Deciding on the route Deciding on whether there should be additional passengers or not
Leaving home/campus	Heading to the car
Heading to bus stop/waiting point	Heading to gathering point/etc
Waiting for bus/car/etc	Waiting for the passenger/if available
Identifying bus/car Getting into the car	Identifying passengers who wants to join Letting passenger to get in
Social contact	Social contact
Quality of comfort/accompany	Quality of accompany/comfort
Timing	Timing
Traffic	Traffic
Driving (safe/sound)	Company (distracting/helping)
Reaching to the campus/home	Reaching destination
Drop off point	Drop off point
Final social contact for the ride comments on driving, declaring gratitude	Final social contact for the ride comments on accompany, declaring gratitude
Money transaction	Money transaction
Rating driver	Rating passenger

2.3 Phase 3: Diary, Device Logs and Post Interview

The third phase of the study employed a diary study to acquire knowledge regarding fresh commuting experiences of participants, device logs for the duration of diaries and a post interview to fill the missing gaps in the researchers' minds.

Diary. In the diary studies, reports on the events and experiences of participants' daily lives are journaled frequently by the participants themselves. The method allows participants to examine reported events and experiences in their natural, spontaneous context, providing information complementary to that obtainable by more traditional designs [20]. Diary study designs require careful consideration of the question(s), to increase effectiveness. With the assistance of technology, different media types (including photographs, videos, audio recordings, and location data) can be obtained as a response from the participants. Three types of diary studies are [20]: Signal contingent, event contingent, and interval contingent. The diary study was conducted with the 12 participants. When all interviews with the 12 participants were completed, they were asked to initiate their journaling on the app. The journaling process started at the same time for all participants, which took place for a week. Participants were asked to complete a short survey after each commute was completed. Questions mainly covered two areas: How their commute experience was, and how the usability

Fig. 1 Ride-sharing timeline and experience rating tool

Fig. 2 Example of a filled ride-sharing timeline & experience rating tool

of the application could be improved. The study provided longitudinal data, which shows changes over time (commute to commute) for an individual and how the experience differs from person to person. Passengers were rewarded with free trips to METU or Eryaman for their participation, while drivers acquired their money as usual during the study.

Device Logs. Device logs were aimed at gathering relevant information regarding the TAG mobile application use. With the consents obtained from participants of the study, TAG app developers were asked to share real-time application screen recordings and quantitative application use data that revealed information such as application use time and duration, number of messages sent between participants, contents of the messages, location data with commute start and end time, UI action data that reveals information about number of taps and swipes on screen. The device logs were employed as a way to discover the usability of the mobile application. Furthermore, the logs also helped researchers to discover participants' motivations and behaviours regarding the factors that affect experiences independent from the app.

Post Interviews. Follow-up interviews was the last stage of the data collection procedure. According to the significant points based on the results of previous studies, this interview included refined, to the point questions for users, to extract more specific data for the study. All 12 participants were interviewed to learn more about the reasons behind their ratings in the diaries. As questions depended on participants' individual experiences, each interview progressed differently. This step also allowed researchers to gain more in-depth data regarding the better solutions to current experiences, as participants were more sensitized, enabling them to give suggestions for future ride sharing solutions.

3   Analysis and Findings

The collected data allocated significant amount of information since there were multiple steps of data collection including mass data logs, initial interviews, diaries, device logs and follow-up interviews. To translate all the data into meaningful insights, affinity diagramming with content analysis is employed. Furthermore, insights are presented in experience timeline of ride sharing, which are colour coded with their specific themes, source of information and number of mentions. Findings are presented in this paper under each specific theme and shared with the Facebook group members and TAG App developers.

3.1   Affinity Diagram

An affinity diagram is an analytical tool employed for managing numerous ideas into subgroups which builds up themes [21]. In the study, researchers first extracted

Fig. 3 Affinity diagramming with themes

insights from all the data collected, and wrote it down on post-it notes for classification. As the insights collected on the table, ride sharing related statements surfaced as TAG-positive, TAG-negative, General Experience-positive, General Experience-negative. Elicited insights were then grouped together based on their natural relationships, which created the themes. Analysing data via affinity diagramming produced six themes: social contact; trust, safety and comfort; timing; meeting and route; cost of ride and payment; TAG app-specific insights. Based on the content, negative insights were also marked with a sign, to signify them as a drawback/negative inference. Some of the insights were related to the phases of the ride sharing experience. Therefore, the insights were represented in a temporal fashion in the experience timeline (Fig. 3).

These insight themes (Fig. 4) were presented on a two-axis graph, in which the horizontal axis represented the experiences of ride sharing as a timeline of phases, and the vertical axis represented Facebook group-specific themes at the top, and TAG app-specific themes at the bottom. At the left end of the horizontal axis, themes independent of the phases of ride sharing were presented (Fig. 5).

3.2 Themes

Social Contact. Under the theme of social contact, it is discovered that sharing commute allows both drivers and passengers to gain new friendships. On the contrary,

Fig. 4 Distribution of mentions under related themes

Total 83 insights; positive 41% (34), negative 59% (49)		
social contact	%21,7 (18) over total	%50 (9) are positive	%50 (9) are negative
safety/trust/ comfort	%15,7 (13) over total	%46,2 (6) are positive	%53,8 (7) are negative
timing	%21,7 (18) over total	%44,4 (8) are positive	%55,6 (10) are negative
meeting/ route	%7,2 (6) over total	%33,3 (2) are positive	%66,7 (4) are negative
cost of ride/ payment	%12 (10) over total	%50 (5) are positive	%50 (5) are negative
TAG App specific	%21,7 (18) over total	%22,2 (4) are positive	%77.7 (14) are negative

unnecessary and overwhelming social contact via Facebook group or TAG App, or on the road, disturbs both parties. In addition, there still are trust issues among the members of the commute, since a significant number of encounters happen for the first time. Meeting for the first time also make it hard to identify passengers to pick up, as mentioned by the drivers. It is also expressed by the drivers that they may not recognize some passengers although they met more than once with them. Furthermore, people who are coming from different backgrounds have instrumental idea sharing in the phase of journey, which is one of the topics of chit-chat during the journey. Moreover, popular culture is one of the topics of conversation, which makes long commutes more satisfactory. On the other hand, silence makes people nervous during the journeys. Lastly, drivers stated that they do not like to be treated as a taxi driver, as some passengers prefer to do other activities rather than having a conversation with the driver.

Trust, Safety and Comfort. As members of the METU have similar demographic background and have certain level of characteristic values, people tend to trust each other when they realize that they belong to the same community. Based on this reasoning, people also feel nervous when they encounter non-METU members. A few participants of the study also expressed that they make quick background checks for people they will meet for the first time. A significant number of riders feel that their home address should be kept private. On the side of drivers, it is expressed that riders should not leave trash on board. In addition, complying with traffic rules is important for both safety and comfort, however, most of the journeys did not have issues related to that, although a few riders reported that they feel uncomfortable when the car is driven in a hurry. Drivers also feel more responsible when they carry passengers.

Timing. In terms of duration of journeys, car sharing is more effective regarding time compared to mass transportation. In addition, door-to-door transportation is ensured via ride sharing. Thanks to ride sharing, passengers have more time to sleep due to the fact that journeys take half the time of mass transportation. In addition, being able to pass through security checks of the university gates and arriving at

Fig. 5 Insights presented on experience timeline

a closer point of their destination, not only lessens the travel time significantly but also makes the journey much more comfortable. Furthermore, being able to share rides at late nights, when there are rare bus rounds, makes ride sharing a significant contribution to the riders. In the negative side, when mutual responsibilities among riders and drivers are not met, inconveniences that take time occur for all members, which causes the journey to start later than expected.

Meeting and Route. When it comes to the meeting point and route to be followed, the proximity of driver's origin and pick-up points of riders is a significant factor for optimum journey planning. Thanks to the application and conventions developed in the Facebook group, members try their best to adapt to the journey plan. A few participants reported that drivers change their route to best serve passengers when they have time, which happens mostly coming back from the campus. However, especially when going to the campus, the app does not offer driver's route of daily commute to passengers. On the Facebook group, drivers must write down their routes manually so that passengers can know the nearest point to join the commute.

Cost of Ride and Payment. Most of the riders believe that ride sharing should be free or priced reasonably. For this reason, the Facebook group has much more activity due to being free and being established much earlier than the app. However, those who want to pay or get paid via the app suggested that there should be option to change the amount and type of payments, since the TAG app does not offer custom pricing for the commutes. In addition, the cost for the travel can be adjusted depending on the number of passengers, as the amount of cost per rider is fixed and independent from the number of passengers. Furthermore, as payment by credit card is the only option, participants expressed their complaints regarding not being able to pay in cash. Interestingly, as a few drivers stated that they do not want to get any profit from carrying students, riders want to make favours for drivers such as giving a gift, bringing coffee or hand-made pastry.

TAG App. As the app offers a promising starting point for a more sustainable transportation, there were still a lot to consider for satisfying members' expectations. Significant number of participants reported that they were not aware of the TAG app before the study. In addition to bringing solutions to the pain points mentioned under the other themes, the app can improve itself in terms of its user experience. Reportedly, transitions in the app is slow in addition to being hard to understand, which drops the motivations of users to continue using the app. Moreover, the app is not that favourable when compared to Facebook group, as the group has its own dynamics and is more informal by nature which makes users more comfortable. Furthermore, both drivers and passengers could be evaluated based on a rating system where there are different categories such as driving skills, friendliness, punctuality, respect to personal space, etc.

4 Conclusions

In this paper, we have presented a case study for ride sharing where it took place in Ankara for the commutes between METU and Eryaman. Facebook group was the main means of communication to arrange ride sharing practices at the time. In addition, TAG App was a newly emerged mobile application which specializes on the ride sharing practice with a payment support. We discussed users' concerns, needs, desires and motivations through their ride sharing experiences for further analysis of the acquisitions. With a three staged methodological approach, we revealed diverse insights under six specific themes regarding the ride sharing practice itself and tools to arrange and maintain it. The study showed that further improvements should be considered to develop better ride sharing experiences both for Facebook group and TAG App.

In order to achieve a broad grasp of the research aim, a variety of methods have been utilized throughout the data collection and analysis procedure. Empirical methods including experience chart, device logs and diary study is employed for data collection procedure. Initial and post interviews were conducted to gain knowledge about ride-sharing practices of students, in the context of Eryaman and METU. Device logs study provided valuable amount of data throughout the study. Thanks to the developers of TAG, which is a specialized tool for ride sharing, researchers were able to generate meaningful distribution of users, according to the provided data logs. Affinity diagram is the tool for analysis of the collected data, which gave a birth to the Experience Timeline chart above, that sums up the initial evaluation of the data. Themes, which were created with the help of affinity diagram, are formed to represent groups of issues/contributions.

The most significant limitation of the study was time, as the research was conducted under a graduate level course which was limited to 14 weeks. If there was adequate time for further research, the data would show more generalizable insights with in-depth characteristics with the participation of more commuters.

References

1. Gargiulo E, Giannantonio R, Guercio E et al (2015) Dynamic ride sharing service: are users ready to adopt it ? Procedia Manuf 3:777–784
2. Fogel J, Nehmad E (2009) Computers in human behavior internet social network communities: risk taking, trust, and privacy concerns. Comput Human Behav 25:153–160. https://doi.org/10.1016/j.chb.2008.08.006

3. Agatz N, Erera AL, Savelsbergh MWP, Wang X (2011) Dynamic ride-sharing: a simulation study in metro Atlanta. Procedia—Soc Behav Sci 17:532–550. https://doi.org/10.1016/j.sbspro.2011.04.530

4. Saranow J (2019) Carpooling for grown-Ups—high gas prices, new services give ride-sharing a boost, Rating Your Fellow Rider

5. Agatz N, Erera A, Savelsbergh M, Wang X (2010) Sustainable passenger transportation: dynamic ride-sharing

6. Casey RF, Labell LN, Moniz L, Royal JW, Sheehan M, Sheehan T, Marks B et al. (2000) Advanced public transportation systems: the state of the art update 2000 (No. FTA-MA-26–7007–00–1). United States. Federal Transit Administration

7. Kleiner A, Nebel B, Ziparo VA (2011) A mechanism for dynamic ride sharing based on parallel auctions. In Twenty-second international joint conference on artificial intelligence

8. European Commission (2010) Energy European commission. Statistical pocketbook 2010, EU energy and transport in figures. Publications Office of the European Union

9. European Conference of Ministers of Transport (1999) European conference of ministers of transport. Traffic congestion in Europe. ECMT Round Tables. OECD Publishing

10. Jeanes P (2010) Can total car emissions be reduced enough by 2020?. Traffic engineering and control 51(1)

11. Morency C (2007) The ambivalence of ridesharing. Transportation (Amst) 34:239–253. https://doi.org/10.1007/s11116-006-9101-9

12. Brownstone D, Golob TF (1992) The effectiveness of ridesharing incentives. Discrete-choice models of commuting in Southern California. Reg Sci Urban Econ 22:5–24. https://doi.org/10.1016/0166-0462(92)90023-T

13. Nordlund AM, Garvill J (2003) Effects of values, problem awareness, and personal norm on willingness to reduce personal car use. J Environ Psychol 23:339–347. https://doi.org/10.1016/S0272-4944(03)00037-9

14. Agatz N, Erera A, Savelsbergh M, Wang X (2012) Optimization for dynamic ride-sharing: a review. Eur J Oper Res 223:295–303

15. Furuhata M, Dessouky M, Ordóñez F et al (2013) Ridesharing: the state-of-the-art and future directions. Transp Res Part B: Methodol 57:28–46

16. Limanond T, Butsingkorn T, Chermkhunthod C (2011) Travel behavior of university students who live on campus: a case study of a rural university in Asia. Transp Policy 18:163–171. https://doi.org/10.1016/j.tranpol.2010.07.006

17. Norzalwi N, Ismail A (2011) Public approach towards sustainable transportation in UKM's campus. Australian J Basic Appl Sci 5:1332–1337. https://doi.org/10.1007/s10640-009-9274-8

18. Fu TS, Mundorf N, Redding CA et al (2012) Promoting behavior change among campus commuters. 53rd Annual Transportation Research Forum, TRF 2012 2:994–1025

19. Moser CA (1952) Quota sampling. J Royal Statist Soc. Series A (General) A 115:411. https://doi.org/10.2307/2980740

20. Bolger N, Davis A, Rafaeli E (2003) Diary methods: capturing life as it is lived. Ann Rev Psychol 54:579–616

21. Plain C (2007) Build an affinity for KJ method. Qual Prog 40:88