ИНФОРМАЦИОННЫЕ ТЕХНОЛОГИИ

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RESEARCH AND ANALYSIS OF CARSHARING SERVICE

The article is devoted to the research and analysis of the car-sharing service. Great attention is paid to the literature review, and different business models suitable for building a car-sharing service are examined. Based on existing business models for different types of car sharing, the authors have justified and presented a new business model canvas. Another focus of the article is the study of the legal aspects for the establishment of a carsharing service in Kazakhstan, as well as the analysis of potential risks and methods for their management.

Key words: *Carsharing, business model, transport infrastructure, micromobility, sustainability, carsharing literature review*

Introduction. Nowadays, one of the tasks in improving transport infrastructure is to develop a shared consumption economy, including carsharing and micromobility services. Carsharing is considered as a potential lever to reduce car dependency and traffic congestion, improve the ecological environment, develop transport infrastructure and contribute to the promotion of sustainable urban development [1]. For example, a decrease in greenhouse gas emissions, as well as a reduction in vehicle ownership and mileage, are often associated with the development of micromobility services, especially car sharing [2-5]. Articles [6-9] also point out that the use of car sharing supports a shift towards the use of multimodal, environmentally friendly transport modes that complement public and active transport modes (cycling, walking). Following the results of the study [8], a summary report of the social and environmental impacts of car sharing was produced (Table 1).

Table 1 – Report on the social and environmental impact of car sharing

Impact	Europe	North America	Australia
1	2	3	4
Reducing carbon dioxide emissions	from 39 to 54%	from 27% to 56%	–

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1	2	3	4
The number of personal cars that can be replaced by car sharing	from 4 to 10 cars	from 9 to 13 cars	from 7 to 10 cars
The car was sold because of car sharing	15.6% до 34%	25%	21.3%
Cancellation of a car reservation due to car sharing	–	25%	28.1%

Literature review. The research conducted towards car sharing and the number of articles published in the last four years are more than double the number of all previous years combined [10]. Looking at the published articles, they can be conditionally divided into two groups: Articles dealing with the technical aspects and modeling [11, 12], and articles dealing with the business aspects of carsharing [13]. In the article [14], the developed taxonomy was used to review 137 articles in two categories: Journals (94 articles) and Newsletters (43 articles). Most of the articles were from the journal Transportation Research Record and Transportation Research Part A-F. The article [14] describes general tendencies, trends and research perspectives towards car sharing. Specifically, it addresses issues of user behavior and a factor influencing the choice of carsharing over traditional transportation; demand analysis as a description of methods for determining supply and demand; optimization of carsharing services - designing service, infrastructure, and fleet management for optimization; and business models, business development, and the economics of carsharing.

Research methodology. Before direct development of the information system, it is necessary to conduct a review of existing solutions, a literature review, a review of existing business models of various car-sharing services, a study of the legal aspects regulating this activity in Kazakhstan, and a risk analysis using the example of foreign car-sharing services. These sections are the result of the application of various research methods: the method of analysis, the systematic approach, the method of deduction, and classification. In particular, quantitative and numerical methods are used to evaluate the degree of risk to identify the risks associated with the introduction of the service. For example, each risk is described by the following factors: Frequency, cost of risk occurrence, source of risk, scenarios in which the risk occurs. In this aspect, we do not address the solution issues as this is beyond the scope of our article.

The project plans to use a modular approach to the development of an information system, as this approach allows flexibility, consistency between modules, and ease of testing. The developed models, such as the data transfer between the car and the server, the determination of the driver's portrait and driving behavior, and the payment system, will be integrated into the developed system as separate modules (microservices) and tested on a real car.

Carsharing business models. Free-Float-Carsharing model. In this type of carsharing customers can rent a car at a location where a car is available and park it at any location within the service's permitted coverage area. Car rental is done through a mobile application and users gain access to the car through keyless entry (via Bluetooth). The billing system for rented cars works per minute.

One of the disadvantages of this type of car sharing is that the service must have a large enough fleet of vehicles to meet demand. These vehicles must also be equipped with special technical means (GPS, keyless access, GSM communication).

Examples of companies operating under the free-floating business model are Zipcar (USA), Enterprise Carshare (USA), Car2Go (USA), BelkaCar (Russia), Anytime (Russia, also available in Kazakhstan). DosCar (Kazakhstan) is an excellent example of car-sharing operating on this model. The article [15] gives an overview of the business model of the Car2Go service.

Stationary carsharing model. In this type of car sharing, customers rent a car at a fixed location and return to it as well. Cars are charged by the hour, and sometimes there is a flat annual fee. Examples of companies working on the model of stationary car-sharing: Car City Club (Italy) [16], DosCar (Kazakhstan).

Peer-to-peer carsharing model. This type of carsharing requires renting and returning a car at a fixed location. Unlike stationary carsharing in the business model, the peer-to-peer carsharing model allows individuals and legal entities to offer their cars for carsharing. The car is rented for several hours, usually for a day. Turo (USA) [17], GetAround (USA).

While investigating the business models of the different services, we concluded that when developing a car-sharing service, a peer-to-peer car-sharing model is the best option. Taking into account the advantages and disadvantages of the different models described in [18], the advantages of the peer-to-peer model include the relatively low cost of 'entry', the provision of different options for cars, and the fact that there is no need to maintain staff or premises for the maintenance and parking of cars. A new business model was developed based on the Turo business model (Table 2).

Table 2 – Canvas of the business model of our service. Version 1

Key partners Car owners Payment systems Insurance companies Akimat of Nur-Sultan Astana Innovations	Key activities Platform development IT system support Users support Marketing and promotion Attracting car owners and users Legal Aspects	Key values Customers have a safe and secure way to travel Possibility of additional income for car owners when the car is idle	Relationship with customers Peer-to-peer car sharing market-place Checking car owners and users using Know your customer (KYC) system -> security, reduce fraud The car owner selects the available car time in the calendar The user chooses the free time of the car, makes reservations and makes payments	Customer segments Car owners Travelers Corporate clients
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	Key Resources IT system Qualified team Akimat support		Channels Mobile application iOS, Android Direct channels through car rental companies	
Cost structure Car damage coverage by insurance, Salary of workers IT infrastructure support, Product development Marketing, Users support, Security Service			Sources of income Car owners can set their own price Service charge 20%	

Regulatory Authorization. After deciding on a business model, it is necessary to study the existing legal framework in the city where the car-sharing service will be used, especially the rules for parking on public roads, car rental rules, and insurance. In most countries, parking is controlled and managed by local municipal authorities [19]. Fluctuo has developed a report, the European Shared Mobility Index, which paints a quarterly picture of the shared mobility market in 16 European cities, selected to highlight diversity in terms of size, geography, and market characteristics [20].

The main set of rules regulating the legal framework and general conditions for the functioning of road transport and ensuring its safety in the Republic of Kazakhstan is the Law on Road Transport (Law of the Republic of Kazakhstan of April 17, 2014, No. 194-V ZRK). The law contains 14 chapters, one of which is directly related to car-sharing: Rights and Obligations of Road Users (Chapter 8), Admission to Participate in Road Traffic (Chapter 10), Admission of Persons to Drive Vehicles (Chapter 11), Mandatory Roadworthiness Testing (Chapter 13), Management of Activities to Ensure Road Safety and Eliminate the Consequences of Road Accidents (Chapter 5). Thus, Chapter 5 contains Article 30 on sustainable transport. According to this article, sustainable transport means vehicles (cars, bicycles, ecological vehicles) that reduce the negative impact of road transport on the environment.

Risk management. A variety of risks can arise when implementing a peer-to-peer car-sharing system. Common causes are shown in the table below. It shows the risks, the frequency of the risks, the cost of the risks, the source of the risks, the scenarios that usually lead to the risks, and the corresponding solutions.

Table 3 – Description and cost of widely faced risks

Risks	Risks probability	Risks effect	Source of risk	Scenario	Risk Management
1	2	3	4	5	6
Car theft	Low	Extremely high	Customer	The person took the stolen ID and driving license and used them as KYC. Once a person has penetrated the system, he can easily dis	Selfie compliance with KYC. Before using the vehicle, the person must take a selfie and that selfie must match the KYC images. However, if

1	2	3	4	5	6
				connect use it for other purposes (selling it in parts, etc.).	the person has a selfie photo, we need to add an aliveness detection feature that determines whether the person is a living person or not (by pretending to perform certain actions and tracking whether the person performs those actions)
Theft of car auto parts	High	Average	Customer	The person took the stolen ID and driving license and used them as KYC. Once a person has entered the system, he can easily steal parts, as well as through ID and the driver's license after using the car.	1) Frequent vehicle inspection (before and after posting). 2) Add ML a solution that can prevent such use cases in advance. 3) Selfie matching with KYC. 4) Determination of liveness for KYC.
Replacement of car auto parts	Average	Low	Customer	The person took the stolen ID and driving license and used them as KYC. Once a person gets into the system, he can easily replace the parts, as well as through ID and the driver's license after using the car.	1) Frequent vehicle inspection (before and after posting). 2) Add ML a solution that can prevent such use cases in advance. 3) Selfie matching with KYC. 4) Determination of liveness for KYC.
Vandalism	Average	Low	Customer	The person took the stolen ID and driving license and used them as KYC. Once a person has entered the system, he can easily vandalize with ID and a driving license after using the vehicle.	1) Take a photo of the vehicle before and after posting (from 8 sides). 2) Frequent vehicle inspection (before and after the booking). 3) Add an ML solution that can prevent such use cases in advance 4) Selfie matching with KYC 5) Determination of liveness for KYC.
Car accident	Average	High	Customer	Any road user can have an accident while driving a car.	1) Take a photo of the vehicle before and after booking (from 8 sides). 2) Frequent vehicle inspection (before and after the booking). 3) Add a machine learning solution that can prevent such use cases in advance (understanding driver behavior and

1	2	3	4	5	6
					informing bad driver behavior in advance). 4) Use of insurance
Fraud (use of someone else's cards, documents)	Average	Average	Customer	A person may be successfully registered but use stolen cards (e.g. from the black market) and drive vehicles with them. This will lead to a bad reputation for the company.	1) Add a function that determines if a payment method is used for other customers. 2) Check if the customer has a large number of payment methods that might raise suspicion. 3) Add a machine learning model that notifies you in advance if a subscriber's behavior is suspicious.
Transfer of vehicle control to unauthorized persons	High	Low	Unregistered customer	The person can be successfully registered, but other people (relatives and friends) can use this vehicle in the name of the registered person. This situation can lead to various scenarios such as accidents, improper driving, etc.	Selfie matching, when the customer needs to take a selfie and this selfie needs to be matched with the KYC images. If the faces belong to the same person, allow him/her to drive, otherwise block the member.
Aggressive driving	Extremely high	High	Customer	A person may be successfully registered, but he may damage the car by bad driving. This leads to various types of damage to vehicles.	Using a machine learning model that can inform participants about bad behavior. The functions can be done by GPS, gyroscope, etc.
Violation of traffic rules	Extremely high	Average	Customer	A person may successfully register but commit an offense while driving or parking the vehicle. This will result in additional fines for cars and some types of accidents.	Check before and after booking to see if the vehicle is breaking any rules (third parties may be involved). If this is the case, please inform the buyer.
Vandalism from 3 persons	Average	Average	Strangers	While the car is parked in the lot, third parties can damage the car and commit various types of vandalism with it.	Add only those cars that have a DVR. If third parties commit vandalism, we can fix it with the help of video recorders and solve the problem.
Driving while drunk or under the influence of drugs	Average	High	Customer	A person may be successfully connected to the system, but while driving, the driver may be intoxicated or using drugs. This leads to a variety of random events.	Use the expanded definition of survivability before driving. People who are intoxicated and under the influence of drugs cannot easily perform the actions required by the

1	2	3	4	5	6
					system. Consequently, intoxicated clients (including drug users) cannot drive.
Improper behavior on the part of the owner	Average	Low	Car owner	While adding the vehicle to the system, the vehicle documents may not be correct, the photos of the vehicle may not match the real vehicle or the vehicle may be stolen, etc. This leads to customer dissatisfaction and poor results of the company.	While adding the host, it is necessary to check and confirm whether the host is verified or not. Required also add a "Verified" tag next to the hosts if there is no suspicious behavior/documents.
Fake hosts	Low	Low	Car owner	While the vehicle is added to the system, a situation may arise where there is actually no vehicle. This leads to customer dissatisfaction and a bad reputation for the company.	While the host is being added, we need to double-check and confirm whether the host has been verified or not (if the machine actually exists). We can also add a "Verified" tag next to the hosts if there are no suspicious behaviors/documents.

Conclusion. Car sharing as a form of the sharing economy is becoming increasingly popular and is one of the most important links in the transport infrastructure of smart cities. The development offers great opportunities for car manufacturers, suppliers, and other players in the field of mobility. As practice shows, the use of car-sharing not only reduces the "ecological footprint" (damage caused by activities) but also contributes to the development of other modes of transport - public transport, bicycles, scooters.

The article examined the business models of the different types of car sharing and also provides links to the business models of the most popular services. For example, part of the operating costs of the car-sharing service Car City Club (Italy) [16] is subsidized by the Italian Ministry of Environment, which in turn shows the need for active involvement of the state and local authorities in supporting such initiatives. From the legislative side, the activities of sharing services require the development of new laws, and those that open opportunities for such services are regulated.

In the future, it is necessary to conduct interviews with potential customers, conduct a survey to validate hypotheses. As a result of the analysis, a technical specification and a minimum viable product will be created, which will implement the main functions of the product.

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АВТОКӨЛІКТІ БӨЛІСУ ҚЫЗМЕТІН ЗЕРТТЕУ ЖӘНЕ ТАЛДАУ

Мақала автокөлікті бөлісу қызметін зерттеу мен талдауға арналған. Мақалада әдебиеттерді шолуға көп көңіл бөлінеді, сондай-ақ көлікті бөлісу қызметін құруға қолданылатын әртүрлі бизнес үлгілері зерттеледі. Автокөлікті бөлісу түрлері бойынша қолданыстағы бизнес-модельдер негізінде авторлар жаңа бизнес-модель канвасын әзірледі. Сондай-ақ, мақалада Қазақстанда сервисті енгізудің құқықтық аспектілерін зерделеуге маңызды көңіл бөлінген, сонымен қатар ықтимал тәуекелдер мен оларды басқару әдістері талданған.

Түйін сөздер: Автокөлікті бөлісу, бизнес-модель, көлік инфрақұрылымы, микромобильділік, тұрақтылық, автокөлікті бөлісу туралы әдебиеттерге шолу

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ИССЛЕДОВАНИЕ И АНАЛИЗ СЕРВИСА КАРШЕРИНГА

Статья посвящена исследованию и анализу сервиса каршеринга. Значительное внимание в статье уделяется литературному обзору, а также исследуются различные бизнес-модели, применимые для построения сервиса каршеринга. На основе существующих бизнес-моделей по типам каршеринга, авторы обосновали и представили новый канвас бизнес-модели. Также, немаловажное внимание в статье уделено изучению правовых аспектов для развертывания сервиса в Казахстане, а также проанализированы потенциальные риски и методы управления ими.

Ключевые слова: Каршеринг, бизнес-модель, транспортная инфраструктура, микромобильность, устойчивость, обзор литературы по каршерингу