

## Consumer Choice Modelling in Sharing Economy

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### Abstract

*Development of sharing economy creates new challenges and opens unprecedented business opportunities. In this economic environment, industrial enterprises can expand their direct selling strategies with the new business model “product as a service”. This option is the result of a shift in consumer preferences among clients of industrial enterprises. The development of the consumer choice model applied to sharing economy is a topical agenda, perhaps now more than ever. Such a model, if available, would help predict multiple scenarios of consumer behaviour and prepare the manufacturing companies for better interaction with their target market. This article makes an attempt to offer a consumer choice model in sharing economy, based on 4 types of possible consumer behaviour. The results of the article serve as a foundation of multi-agent modelling and quantitative assessment of abstract situations in the business-to-consumer market.*

**Key-words:** Sharing Economy, Consumer Choice Model, Product as a Service, Sharing Services.

### 1. Introduction

“Global growth of material well-being and innovations brought in the new forms of product consumption. Nowadays the priority is given to the use of goods over possession. This principle is the cornerstone of sharing economy (SEC), which emerged as we know it now in early 2010s” [22]. In 2019 the amount of SEC transactions in Russia reached 769.5 billion roubles, with annual growth at 50% [23]. At the same time in Russia the consumer choice models will continue to change both in B2C and B2B markets [5]. Due to the coronavirus (COVID-19) pandemics the C2C sharing economy is predicted to go down [16], nevertheless, the impact of COVID-19 on B2B segment is not so obvious. Large number of companies lost profit, so sharing assets can become a solution to this

economic crisis and a way to minimize damages. Taking into account the number of free unutilized assets and digitalization of modern business, we believe there is still much potential for sharing assets in Russia [14].

SEC creates bigger opportunities for business with proper use of B2B platforms for sharing economy [1]. In order to minimize its expenses it would be advisable for a business to utilize car-sharing, carpooling services (sharing trucks, sharing deliveries); open assets for barter; make use of services with freelance contractors (thus minimizing personnel expenses); share production facilities or rent them from P2P actors; employ data sharing with other market players, including contractors; take advantage of logistics and purchase sharing [2]. It would be wise for a business enterprise to bring into play the technologies of crowdsourcing (project management shared with product consumers, etc.) [7]; crowdfunding (searching investors and testing market hypothesis); lend unoccupied company spaces for coworking, use other services for sharing work [2].

Another aspect of SEC influence on business is a shift in the product consumption model, which in its turn leads to the transformation of business models of industrial companies into “product as a service” model [19]. Manufacturers face the dilemma of choice between production strategies: produce for direct sales, and/or make products for P2P market. The goal of this article is to suggest a description of the consumer choice model in SEC, which could help senior management of industrial companies understand P2P markets and adapt appropriate strategies. In addition, the model proposed in this article can be utilized for multi-agent modelling and further research in market strategies for industrial companies in sharing economy.

## **2. Modelling in Sharing Economy**

Currently there are several global publications dealing with the topic of modelling in sharing economy (SEC). Mostly their authors suggest models for cooperation of industrial companies with sharing services [9, 13, 15, 18, 19], models for price formation in SEC [17, 21], models for SEC platforms functioning [10, 20], models for optimization of sharing services [11, 12], and models for consumer behaviour in SEC [12]. In Russia similar research projects have not been developed enough so far, their authors study the preconditions for developing models in SEC [4,8]. Comparison of different approaches to economic processes modelling in SEC is presented below in the overview of research studies of economic models in SEC (see Table 1).

Table 1- Overview of Research Studies of Economic Models in SEC

No	Author, title, year	Research goal	Results
1	2016. Weber T.A. Product Pricing in a Peer-to-Peer Economy [21]	Analysis of goods prices and consumer choice w/ SEC and w/o SEC.	Comparison of optimal retail prices and profit w/ SEC and w/o SEC shows that sharing economy markets are more favorable for retail companies with expensive products.
2	2017. Nishino N., Takenaka T., Takahashia H. Manufacturer's strategy in a sharing economy // CIRP Annals - Manufacturing Technology [19]	Make predictions based on the model of long-term sharing services, where manufacturers and consumers interact with each other, predict several abstract cases of consumer and manufacturer behaviour on the market in order to adjust manufacturers' strategies.	Strategies recommendations for each of the predicted case.
3	2018. Parker G., Alstyne M. Innovation, Openness, and Platform Control [20]	Describe optimal degree of transparency and models of intellectual property management in the ecosystem platform.	Optimal contract system developed for innovation ecosystems and industry regulators to increase competitive potential and social security.
4	2018. Popov E.V., Hercegovca K., Semyachkov K.A. Innovations in Institutional Modeling of the Shared Economy [8]	Develop economic principles of SEC modelling.	Defined principles of institutional modelling for collaborative economy from the point of view of its efficiency, suggested classification of institutions for sharing economy based on the model of economic agents interaction.
5	2019. Abhishek V., Guajardo J.A., Zhang Z. Business Models in the Sharing Economy: Manufacturing Durable Goods in the Presence of Peer-to-Peer Rental Markets [9]	Analyze sharing service influence on the use of original equipment.	Sharing services create an effect of balance (willingness to pay reaches almost the same level with high- and low-level consumption customers), which causes consumers with lower buying power purchase products.
6	2019. Choi T., He Y. Peer-to-peer collaborative consumption for fashion products in the sharing economy: Platform operations [12]	Create models of a specific type and analyze SEC benefits for clothing shops and consumers.	Analysis conclusions confirmed that operations w/ SEC in comparison with their counterpart w/o SEC always benefit both the clothing brand (i.e. company), and consumers who buy the product.
7	2019. Choi T., Taleizadeh A.A., Yue X. Game theory applications in production research in the sharing and circular economy era [13]	Form an idea of strategic behaviour of people who make decisions with the help of game theory.	Studied the influence of SEC on supply chains in industrial manufacture.
8	2019. Grondys K. Implementation of the Sharing Economy in the B2B Sector [15]	Identify factors, which motivate companies to utilize sharing resources with each other.	Research results show significant potential for sharing assets in B2B segment.
9	2019. Li Y., Bai X., Xue K. Business modes in the sharing economy: How does the OEM cooperate with third-party sharing platforms? [18]	Based on price values of shared goods as perceived by a consumer and maintenance expenses (which depend on the prime cost) of product owners, the task is to identify means of manufacturer's profit maximization in P2P and B2C platforms.	A manufacturer should not cooperate with any sharing economy platform, if perception factor is too low, and the marginal cost is too high. If perception factor is too high or marginal expenditure is low, then a manufacturer should choose the B2C platform. Finally, a manufacturer should prefer P2P platform, if perception factor is somewhere in the middle and marginal cost is high.
10	2020. Benjaafar S., Hu M. Operations Management in the Age of the Sharing Economy: What Is Old and What Is New? [10]	Perform comparative analysis of classical models of business management and new models based on sharing economy principles.	Analysis shows 4 directions for further research of sharing economy.

Source: table compiled by the author of this article

One thing common to all of the above research works is the idea of a consumer's willingness to pay (WTP) for "durability" of goods [9]. Normally, goods (product) model includes durability, letter 'd' is used to denote this concept in formulas. Once a period of time (t) is over, durability is reduced by one. If  $d = 0$ , it means the end of product service life. Consumers can use a product for as long as  $d > 0$ , if they want. In other words, durability influences and determines the value of consumer utility.

In addition, sharing service platforms have a number of constant special features, which are taken into account by all authors from the list above, when they model economic processes applied to sharing economy [10]:

1. There are multiple buyers and sellers. The sharing platform takes the role of an intermediary, reducing market tension, such as searching time expenses, transaction expenses and moral risks, making space for players both from selling and buying teams;
2. The offer side does not differ from the demand side. Larger number of people who choose to be owners means less renters, and vice versa;
3. Offer stimulates demand, and the other way round. Larger number of owners increases chances for renters, whereas more renters give opportunity for owners to provide their product/service;
4. One unit of available resources may meet the needs of more than one consumer. Since available resources are not depleted to the full, they can be used by multiple consumers.

There is a notable diversity of SEC business models inside the C2C segment [3], which is not so characteristic of the B2B segment, with its limited set of interaction patterns between an industrial company and sharing services [18]. Besides, there is a certain restriction for businesses on utilization of existing SEC platforms: companies employ SEC platforms with respect to available assets and recorded incurred costs [15].

Summing up previous paragraphs, there is a significant theoretical base for SEC modelling. Nevertheless, modelling consumer choice in sharing economy has a number of features that allow us to specify the existing models.

### 3. Consumer Choice Modelling in Sharing Economy

We suggest a new modified model of consumer choice in SEC, based on research papers of Thomas Weber from the Swiss Federal Institute of Technology of Lausanne [21] and Japanese scholars from the University of Tokyo and National Institute of Advanced Industrial Science and Technology (AIST) in Tokyo [19].

The model of consumer choice we propose suggests that sharing services allow the consumers who possess their own products to lend them to other consumers, instead of selling them. In order to simplify understanding of the model, we assume that the consumer-owned product can be rented in sharing service no more than ‘k’ number of times during a fixed period of time. The payment for the shared use ‘p<sub>s</sub>’ is a constant value. Consumers who provide their products earn directly via sharing service, and the latter gets its profit too ‘r<sub>ss</sub>’.

Each consumer chooses one of 4 options: buy a new product, continue to use an old product in possession, employ a sharing service or provide the product in possession for use in a sharing service. Consumer utility ‘i’, derived from the use of product, is calculated with the formula:  $\alpha\beta^{\bar{t}-1}d_{j,t}$ , where ‘α’ stands for the willingness-to-pay (WTP) parameter. Besides,  $\beta^{\bar{t}-1}$  represents the effect that shows a decrease in utility, when a number of  $\bar{t}$  periods pass from the moment of purchase. If the level of ‘β’ is high, this describes the consumer as a long-term user, while low level of ‘β’ shows a short-term user. In this case consumer utility ‘i’ during the ‘t’ period is defined as:

$$\pi_{i,t}^c = \begin{cases} \alpha d_{j,t} - p_{j,t} & (\text{product purchase}) \\ \alpha\beta^{\bar{t}-1}d_{j,t} & (\text{continue to use}) \\ \alpha\hat{d}_t - p_s - r_{ss} & (\text{use of sharing service}) \\ p_s\hat{Q}_{i,t} - r_{ss} & (\text{provide access to product}) \end{cases}$$

Here ‘ $\hat{Q}_{i,t}$ ’ stands for the quantity of product provided by consumer ‘i’ to a sharing service for the duration of period ‘t’. ‘d<sub>t</sub>’ stands for durability of the product in sharing service during period ‘t’. In case of “product purchase” discounting effect is zero, because  $\beta^{\bar{t}-1} = 1$ . Consumers can choose any of the four options given above to maximize utility. In addition, for each consumer product necessity is determined as ‘θε’ (values 0 and 1). This means that if  $\theta = 0$ , then consumer has no need for the product. If  $\theta = 1$ , then consumer needs this product. That being so, consumer ‘i’ in possession of a product, with  $\theta = 0$ , will provide the product to a sharing service. We believe that at every period for every consumer the value of ‘θ’ is stochastically determined as  $\theta = 1$ , with probability  $\Theta$ .

This consumer choice model in sharing economy can be integrated into a larger multi-agent model with ‘n’ periods, ‘m’ manufacturers of same product, and ‘l’ consumers who decide to buy that type of product. It is assumed that consumers can use sharing services instead of buying products, while durability of a product in this model is determined by the amount of money the manufacturers are eager to invest in their research and development (R&D) programs. A manufacturer ‘j’ makes one type of product with a certain prime cost ‘ $c_{j,t}$ ’ for the time period ‘t’. Then this manufacturer makes a decision to increase R&D expenses to improve durability of the product. This decision would change the prime cost value. In this context, every manufacturer has to choose the amount of R&D expenditure and the product price for each time period in order to maximize the total revenue in all periods. Manufacturer’s revenue in time period ‘t’ is expressed with the formula:

$$\pi_{j,t}^M = p_{j,t}Q_{j,t} - c_{j,t},$$

where ‘ $p_{j,t}$ ’ and ‘ $Q_{j,t}$ ’ stand for the product price and quantity respectively, purchased by the consumer in time period ‘t’. Production prime cost ‘ $c_{j,t}$ ’ is determined with respect to R&D expenditure value (‘ $c_{\text{low}} < c_{\text{mid}} < c_{\text{high}}$ ’). There are supposedly three levels of R&D expenditures: low, medium, and high. Decision to change current R&D expenditures might directly affect the value of durability ‘d’:

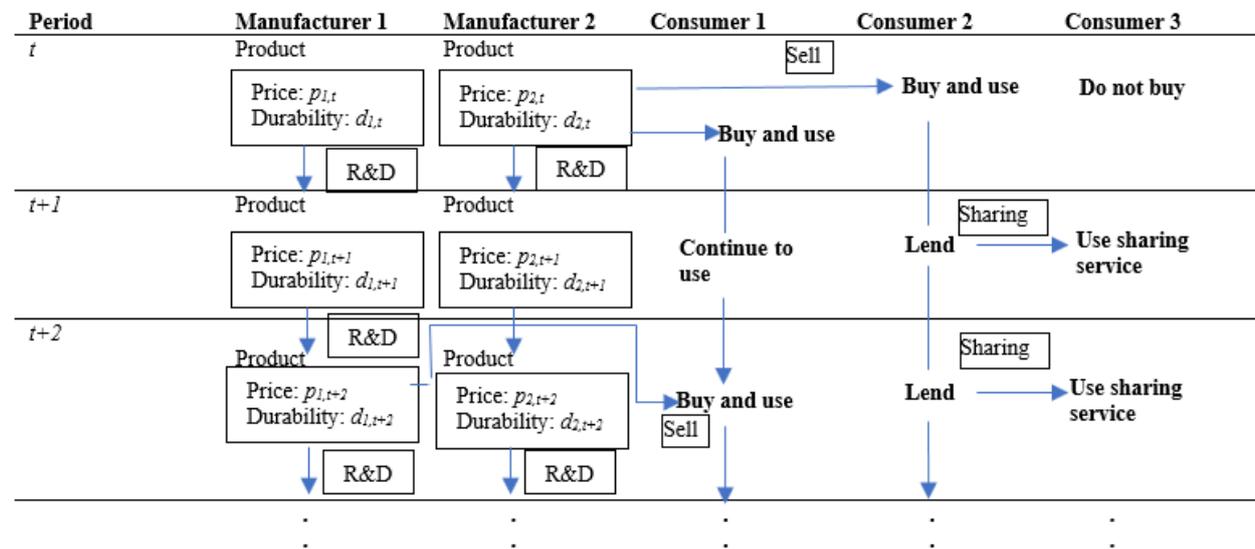
$$d_{j,t+1} = \begin{cases} d_{j,t} - \tilde{d} & (\text{if R\&D expenditure is low}) \\ d_{j,t} & (\text{if R\&D expenditure is medium}) \\ d_{j,t} + \tilde{d} & (\text{if R\&D expenditure is high}) \end{cases}$$

In this equation ‘ $d_{j,t}$ ’ stands for durability set by the manufacturer ‘j’ in the time period ‘t’, and ‘ $\tilde{d}$ ’ is the unit of durability alteration. The abovementioned system of equations shows that R&D expenditures are mandatory to the extent that is needed to increase product durability. If the product service life is too short, then the R&D cost goes down too. If, on the contrary, durability increases, then R&D cost will be high.

Since the model we propose implies that products have a certain level of durability, then it also means that products can in be in possession only for a limited respective number of time periods. Illustration 1. explicates the decision-making process of a consumer during several consecutive time periods. Product durability is determined by the manufacturer’s R&D investments. Additionally, decision making can be affected by the number of sharing service users. If the number of users goes up, then product sales will go down. So, if some consumers do not own their products, then the sharing service cannot be stable in its operation. That is why development of sharing services might

have the unexpected consequences for manufacturers, which proves the practical topicality of our model application.

Illustration 1- Decision-making Process in Our Model



#### 4. Conclusion

In the article we studied the model of consumer choice in sharing economy, which predicts consumer utility based on 4 possible market options: buying a new product, using own product already in possession, using a sharing service, or providing products to be used in a sharing service. What makes this model stand out among others is the described dependency between consumer utility and sharing service revenue. In addition, the article illustrates connection between product “durability” and R&D investment values.

Digital economy suggests development of new management methods [6], which inevitably leads to new models of product consumption. This is a topical issue for study by industrial manufacturers. Suggested model will be of use for business community as well – it gives understanding of the changing paradigms in consumption and production strategies. Scholars can use the model as a starting point for further research and study, specifically, in multi-agent modelling. State government institution can apply this model for P2P markets regulation.

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