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RFMC 모델 기반의 카 셰어링 지속 사용에 관한 연구

An Investigation on the Continuous Use of Carsharing: Evidence from RFMC Model

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요 약

정보 기술의 발전으로, 공유 경제 서비스는 새로운 형태의 소비 방식으로 자리 잡았다. 특별히 차량을 소유하지 않고 빌려 쓰는 형태인 카 셰어링은 개인들의 이동 수단의 범위를 확장하는 새로운 서비스이다. 차량 소유로 발생하는 비효율성을 줄이고, 교통 문제를 완화하는 등 카 셰어링은 다양한 사회적 이점을 제공하지만, 이를 구현하기 위해서는 개인의 카 셰어링 서비스 이용 패턴을 이해하고 이용자의 서비스 재사용을 유도해야 한다. 본 연구는 개인의 카 셰어링 서비스 재사용 행동을 이해하기 위해 RFMC (Recency, Frequency, Monetary, and Clumpiness) 모델을 활용하였다. 국내 카 셰어링 서비스 업체의 데이터를 분석한 결과, 카 셰어링 서비스 재사용에 Recency, Monetary 는 부의 영향을, Frequency는 정의 영향을 끼치는 것으로 나타났다. 더욱이 Clumpiness가 높은 집단의 경우, Recency와 Monetary의 효과는 두드러지는 반면, Frequency의 영향은 미미해졌다. 이러한 연구 결과를 바탕으로, 이론적, 실무적 함의를 도출하였다.

키워드 : 카 셰어링, 공유경제, 지속 사용, RFMC, 재사용 행동

Ⅰ. Introduction

As Rifkin (2001) pointed out, owning is not the only mode of consumption, and consumers started to recognize that they do not need to own products to obtain benefits from them. In fact, only few are able to fully utilize their belongings, and consumers pay costs of inefficiencies when they do not use them. This is why consumers started to borrow or share products as they need (i.e. pay-as-you-use). Under the name of sharing economy, the very mode of consumption can be observed in the context of transportation. As a means of personal transportation, owning a vehicle seemed to offer the only answer; however, thanks to the advancement in information technologies (IT), a new type of transportation service, carsharing, has emerged. Carsharing is a type of sharing economy service allowing users to access and drive a car on a minute-by-minute basis using mobile applications (Burkhardt and Millard-Ball, 2006). This business mod-

el is motivated by the fact that a great amount of utility of owning a car has been deserted when it is parked in a parking lot, and consumers do not need to own cars and pay an extra charge of idleness with carsharing service (Schaefers, 2013). In addition to solving the inefficiencies of the major means of transportation, carsharing can relieve problems that most cities suffer from: lack of parking spaces, severe traffic congestion, and car accidents (Grischkat *et al.*, 2014; Martin and Shaheen, 2011). Carsharing offers a win-win business model for service providers and their users since it can achieve maximum resource utilization for both, and thus enhances overall environmental sustainability by improving the efficiency of existing resources and reducing greenhouse gas emissions (Goldman and Gorham, 2006).

Although carsharing seems to be an attractive option for personal transportation, the mere attractiveness does not guarantee changes in the transportational modes of individuals. Even cost-sensitive individuals, such as college students, may not consider car-sharing services as their main mode of transportation (Rotaris *et al.*, 2019). In fact, only through repetitive uses of carsharing services can carsharing take on the role of a transportational mode (Asgari and Jin, 2020). Taking the individuals' mode of transportation is particularly important for realizing the benefits of carsharing since positive effects become insignificant when people do not continuously use carsharing services. In that sense, investigating the reuse behavior of carsharing can reveal factors that can reinforce the positive effects of carsharing. Several scholars have therefore attempted to find factors influencing the continuous use of carsharing services (Cheng *et al.*, 2016; Mensah *et al.*, 2019). But results of these studies mainly focused on the attitude or intention of carsharing users, not the patterns of service usages, which calls for the investigation on the actual usage pattern with the empirical analysis.

To reveal factors triggering the continuous use of car sharing, we investigated the usage pattern of carsharing users. Especially, we posit that patterns of repetitive use behavior can be a significant factor. For that purpose, we applied RFMC (recency, frequency, monetary, and clumpiness) model in investigating the factors of carsharing service continuous usage which introduced clumpiness to deal with the variance of usage pattern (Zhang *et al.*, 2015). Using a dataset from a leading carsharing service provider in South Korea, we empirically analyze the effect of RFMC on carsharing reuse behavior. Our results suggest that recency, frequency, and monetary value all have significant impacts on carsharing reuse; recency and monetary value are negatively related to reuse whereas frequency is positively associated with carsharing service reuse. When considering the customer's clumpiness, the difference in overall tendency was not significant. Yet, comparing the impact size of RFM measures between clumpy and non-clumpy users, the impact of recency and monetary value are higher among clumpy users whereas that of frequency is higher among non-clumpy users.

This study offers several contributions to the literature. First, by employing field data directly retrieved from one of the major carsharing operating firms in South Korea, this study fills the research gap revealing how the reuse behaviors of carsharing users are affected. Second, by investigating the usage pattern which is necessary for the effectiveness of a service's benefits, this study provides insights to the literature on the societal role of sharing economy. Finally, by applying RFMC model to the case for carsharing service usage, our study better contributes to the service reuse literature as clumpiness measure explains more detailed usage pattern of individuals, which may not be captured through recency and frequency. In addition, regarding the result for monetary value, our study adds to literature by showing that while monetary value is shown to

have positive association with repurchase or reuse other types of product or services (Liao *et al.*, 2017; Theodorakis *et al.*, 2009), monetary value and reuse likelihood are negatively related in case of carsharing usage. The result implies how price expectation affects consumer's usage pattern.

Our study also provides meaningful implications to managers and policymakers. First, the findings of our study show how each factor in RFMC model affects service reuse. Leveraging the knowledge for the factors, managers interested in enhancing users' reuse behavior can design strategies for promoting regular and constant use of their services such as targeting coupons differently based on RFMC value of users. Second, this study provides insights to policymakers in terms of refining transportation systems. Analyzing users' RFMC values for each carsharing station, it is possible to capture the stations where reuse behavior likelihood is high. Using the analysis results, policymakers can design strategies for relieving traffic congestion and solving resource allocation problems.

Ⅱ. Literature Review

2.1 Carsharing

With the trend of urbanization, the number of cars has skyrocketed for the last few decades, and with increased mobility, a driver can enjoy a more convenient and comfortable life in a wider zone of life. However, the rapid increase causes side effects such as insufficient parking lots, extreme traffic jams, and a large amount of greenhouse gas emissions. What is worse, most cars are not fully utilized by the owners and are usually idled in parking lots. The average driving time of a car is only one hour or less during the day (Shaheen *et al.*, 1998). To reduce the negative effects and operate transportational resources more efficiently, carsharing emerged as an alternative mode of transportation. Carsharing is defined as "open-accessed shared vehicle programs, intended for occasional trips where a car is needed; station cars for commuters to drive to work from the transit station and systems …" (Millard-Ball, 2005, p. 2-1).

The benefits of carsharing can be summarized into two categories. First, carsharing offers financial incentives for the participants of carsharing platforms. The fixed costs of car purchase include the price of a car, car insurance, and various taxes. Combined with additional costs for fuel, consumables, and parking spaces, carsharing can be a financially attractive option for people who think of car ownership as an unbearable cost for what they get. Accordingly, people can use on-demand carsharing services offering equivalent transportation experience for a given time. The attractiveness increases especially for people with low demand in using a car (Litman, 2000). Similarly, carsharing enables college students and low-income households to use a car in short-term without paying the full costs of car ownership (Duncan, 2011).

Second, carsharing can solve urban sustainability issues. Large cities have suffered from severe traffic jams and a deficiency of parking spaces. These problems become insolvable because cities cannot physically grow exponentially. Researchers suggest that encouraging the use of carsharing may reduce private vehicle ownership (Martin and Shaheen, 2011; Zhou *et al.*, 2020) and relieve the urban problem of securing parking space (Jian *et al.*, 2020). Furthermore, carsharing can encourage the use of public transportation and the reduction of carbon emissions (Luna *et al.*, 2020; Nijland and van Meerkerk, 2017). Combined with other elements of transportation, the effect of carsharing is expected to be even greater. For instance, the environmental benefits of carsharing can be enhanced when the electric or zero-emission vehicle is

introduced to carsharing (Shaheen *et al.*, 2020).

The pattern of carsharing usage have a close relationship with the mode of urban transportation of an individual. For some citizens that move from place to place on a daily basis, frequent and continuous use of carsharing indicates that individuals recognize carsharing as an ordinary means of transportation, not a special treat. For them, there is no barrier to carsharing as much as taking a taxi or bus. On contrary, an individual may try a carsharing service occasionally. These infrequent users may think carsharing as a fancy way of mobility that is different from other urban transportation methods. The difference in the attitude and perception toward carsharing has critical effect on usage of carsharing (Rotaris *et al.*, 2019; Zhou *et al.*, 2020). However, researchers pay little attention to empirically analyze customer retention and continuous usage of carsharing services, and the majority of literature have focused on identifying the factors influencing intention to adopt or use carsharing service (Cheng *et al.*, 2016; Prieto *et al.*, 2017; Zhang and Li, 2020). Since the analysis of continuous use of carsharing has close relationship with the sustainability of the service and hints to solve the problems of urban transportation, investigation on the reuse behavior of carsharing users can shed light on the carsharing and transportation literature. This study seeks insights into usage behaviors of carsharing services.

2.2 Continuous Usage and Reuse Behavior

Empowered by the trend of customer-centric and increased availability of customer data (Kumar and Shah, 2009), managers and researchers have tried to extract meanings and patterns from transactions by analyzing the past behavior of customers (Fader *et al.*, 2005). By utilizing customer data, managers can estimate customer lifetime values (Heldt *et al.*, 2019), prepare long-term marketing strategies with identified customer categories (Sun and Shibo, 2011), and improve overall profitability (Haenlein and Libai, 2013).

Among various purposes that managers want to achieve with customer data, customer retention has a high priority. Retention of existing customers can be more effective than the acquisition of new ones in increasing sales and profits at lower costs (Ming-liang, 2003) because of the cost reduction for service education for existing customers (Hennig-Thurau and Thurau, 2003). For example, the cost for the acquisition of new customers is six to nine times higher than that of retention of existing ones (Peppers and Rogers, 1993), and a five percent increase in the rate of customer retention leads to double the rate of firm's return (Reichheld and Sasser, 1990). To achieve customer retention, managers should reveal factors triggering subsequent purchases based on transactional data. Identified factors can help managers prepare marketing programs to find out potential customers who are likely to reuse their services. The issue is important for sharing economy service providers since accurate predictions of customer behavior can help operational tasks such as vehicle dispatch management and dynamic pricing (Wagner *et al.*, 2016) and strategies planning based on users' usage patterns (Boldrini *et al.*, 2016). With this regard, prior studies investigated factors affecting sharing economy consumers' reuse behavior. Table 1 summarizes prior studies on the determinants of sharing economy service reuse.

According to <Table 1>, although several attempts have been paid to find determining factors of reusing sharing economy service, such studies are limited in finding the relationship between trust and service usage and understanding continuous use intention rather than behavior. In addition, it is also important for carsharing service managers to examine the ways to attract con-

〈Table 1〉 Literature Review on Sharing Economy and Continuous use Behavior

Author (year)	Research context	Factors of reuse behavior	methodology
Ter Huurne *et al.* (2017)	General sharing economy	Antecedents of trust (e.g. reputation, trust in the platform, interaction experience) related to multiple entities (i.e. seller, buyer, platform, interpersonal and transaction)	Literature review
Joo (2017)	Carsharing	Convenience, Time savings, Cost savings, Social value	Survey
Lu *et al.* (2021)	General sharing economy	Perceived effectiveness of feedback mechanisms, escrow services, provider certification, urgent rescue, Institutional trust	Survey
Sun *et al.* (2022)	General sharing economy	Trust propensity, Organizational legitimacy, Perceived social impact	Survey

tinuous use of customers. However, in related studies, only the general sharing economy context is dealt with, and user behavior in carsharing context is overlooked. Although the total number of users can grow only when existing users remain, previous studies have focused on how to create an inflow of new users (Cheng *et al.*, 2016; Prieto *et al.*, 2017; Zhang and Li, 2020). Well-recognized availability of carsharing can create regular and frequent users which become a basis of economic efficiency of carsharing, and such enhanced efficiencies are only archived when frequent users are secured (Schaefers, 2013; Silvestri *et al.*, 2021). Furthermore, it can be helpful to investigate the usage pattern of carsharing users to extract insights for encouraging citizens to use a carsharing service. Therefore, it is important to understand what drives the continuous usage and re-use of carsharing services.

2.3 RFMC

To understand the behavior of continuous use and customer lifetime value, recency, frequency, and monetary values (RFM) model has been utilized as a convenient tool (Gupta *et al.*, 2006). Recency is defined as the time elapsed after the last purchase meaning that the more recently the customer used the service, the more likely the customer will reuse the service. Additionally, frequency indicates the number of purchases in a given time window. Accordingly, the higher the frequency, the more chance to reuse the service. Lastly, monetary refers to the amount spent within a specific period. RFM has been utilized for diverse contexts whenever repetitive use of service is possible. To name a few, contexts of online game item purchase (Lee *et al.*, 2015), stock trading (Kim *et al.*, 2020), and outpatients of a hospital (Li *et al.*, 2020) are studied with the lens of RFM.

Although RFM has been widely adopted by managers and researchers due to its computational convenience and structural intuitiveness (Chiang and Yang, 2018), the limitations of the approach have been criticized consistently. Especially, the method is vulnerable to reflecting clustered or clumpy data which is frequently observed in behavioral data (Zhang *et al.*, 2013). For the basic RFM model, the density of contacts with customers is neglected within a certain time window. However, we argue that the regularity of carsharing use can be a proxy of one's perception of the value of carsharing. That is, those who use carsharing to commute can be different from occasional carsharing users. By considering time regularity, the performance of individual-level predictions and under-

〈Table 2〉 Literature Review on RFMC

Author (year)	Research context	Use of Clumpiness
Zhang *et al.* (2015)	Customer lifetime value	As a classifier used to segment customers
LaTour and Noel (2021)	Online learning	As a classifier that divides students into different categories
Reutterer *et al.* (2021)	Predicting customer behavior	As a factor for modeling the purchase pattern of customer behavior in various contexts

standing of the customer base can be increased (Platzer and Reutterer, 2016). Provided the necessity of expansion, researchers have taken clumpiness, defined as the degree of irregular time spacing, into consideration and suggested RFMC (Zhang *et al.*, 2015). By investigating relationships between clumpiness and RFM measures, Zhang *et al.* (2015) show that a measure for clumpiness (C) can improve predictive power regarding customer lifetime value (CLV) by categorizing customers according to clumpiness. Furthermore, they insist that not capturing clumpiness may result in significant prediction errors. After the introduction, researchers have applied the concept of clumpiness to diverse contexts. Reutterer *et al.* (2021) utilized the clumpiness of datasets to describe the regularity of customer patterns. Additionally, LaTour and Noel (2021) verified the usefulness of clumpiness for analyzing online self-learning behaviors. <Table 2> shows the existing studies investigating RFMC.

We take the lens of RFMC in order to investigate repurchasing behavior of carsharing users for considering not only regular but also clumpy usage patterns of carsharing service. Given that some can regularly commute by sharing a car, but others can occasionally for their leisure time, carsharing service usage patterns can be differentiated. While RFM can offer valuable insights using transactions of a carsharing service, C, a clumpiness measure, can add an extra dimension that captures irregular spacing between carsharing service usage. This study investigates the analytical power of RFMC and draws strategic implications for carsharing service providers.

Ⅲ. Data and Methods

We used a rich dataset collected from one of the major carsharing companies in South Korea. This company had diverse service platforms and around 1,000 cars to provide a carsharing service and such service is operated through mobile applications. Users can locate and rent a car using mobile application. Each vehicle can be leased ten-minute unit basis with a minimum of 30 minutes. As the company operates 5 different carsharing applications (i.e. channels), our dataset includes various customer groups and purposes of use. The data consists of 25,291 purchase – carsharing usage – information between January 2014 and December 2016. As the car-sharing service was in the beginning stage in Korea and actively expanded in the data collection period, our dataset is appropriate to understand the continuous usage of carsharing services. Purchase information included purchase date, purchase period, type of car purchased (reserved), type of website channel used to purchase (reserve) a carsharing service, purchased price, and personal information of users. Personal information included each user's gender and age.

3.1 Dependent Variables

The goal of this study is to examine the factors

of customer reuse behavior. Thus, the dependent variable is $Reuse_i$, a binary variable indicating user whether the user i used carsharing service in the first period and reused the service in the next period. The purchase period was set to one month based on Lee *et al.* (2015). If the user i used the carsharing service in the first month and reused the service in the second month, reuse variable was set to "1", and "0" otherwise.

3.2 Independent Variables

Independent variables employed here are based on RFMC (Recency, Frequency, Monetary value, and Clumpiness) model. We measured each variable following Zhang *et al.* (2015)'s approach. In the analysis, recency ($Recency_i$) was defined as the periodic distance, the interval between the first date of reuse in the reuse month and the latest purchase date of the first purchase month. The smaller the value of distance the more recent a purchase was made. Frequency ($Frequency_i$) was defined by the total number of purchases of user *i* during the first purchase period. Monetary value ($Monetary_i$) is measured by the total expenditure of user *i* for using a car during a month, which is denoted as ln ($Monetary_i$). In the analysis, due to the high skewness of $Monetary_i$, we employed a natural log for this variable. Clumpiness ($Clumpiness_i$) is denoted as a binary variable that if the user i's behavior was found to be clumpy, the value is set to "1". Clumpiness was calculated using the equation employed by Zhang *et al.* (2015). We first generated H_p like the equation (1), where n is the number of purchases within a month and N denotes the length of the observation period, here, the number of days in a month, and x_i is the i_{th} occurrence of inter-visit times.

$$H_p = 1 + \frac{\sum_{i=1}^{n+1} \log\left(\frac{x_i}{N+1}\right) \cdot \frac{x_i}{N+1}}{\log(n+1)} \quad (1)$$

Then we created Z-table using Zhang *et al.* (2015)'s method. Then, if H_p exceeds the corresponding critical z value, $Clumpiness_i$ was set to "1" and "0" otherwise.

3.3 Control Variables

According to previous studies on purchase intention or product usage, user characteristics are always considered important aspects (Akhter, 2003; Punj, 2011). We thus controlled for user characteristics including user's gender, age, and the number of types of cars rented by a user (e.g. if a user *i* has only rented a car of model 'A' from 'B Motors' several times during data period, the number of type of cars rented by *i* is 1).

〈Table 3〉 Descriptive Statistics of Variables

Variable	Observations	Mean	Std. Dev.	Min	Max
$Recency_i$	25,291	12.9644	8.9627	1	31
$Frequency_i$	25,291	2.1423	2.4214	1	47
ln ($Monetary_i$)	25,291	10.3521	1.1036	6.7223	14.2913
$Gender_i$	25,291	0.7617	0.4261	0	1
Age_i	25,291	29.8384	6.1521	22	75
$Cars_i$	25,291	1.1258	0.3701	1	5

〈Table 4〉 Correlation Matrix

	1	2	3	4	5	6
1. $Recency_i$	1.000					
2. $Frequency_i$	-0.332*	1.000				
3. ln ($Monetary_i$)	-0.142*	0.333*	1.000			
4. $Gender_i$	-0.021*	0.061*	-0.065*	1.000		
5. Age_i	0.011	0.006	0.236*	-0.069*	1.000	
6. $Cars_i$	-0.209*	0.447*	0.236*	0.049*	0.012	1.000

<Table 3> shows descriptive statistics of the variables, and <Table 4> shows the correlation matrix. As none of the variables have correlation of over 0.8 in 5% level, it is ensured that multi-collinearity does not cause a significant effect on our analysis (Farrar and Glauber, 1967).

3.4 Logit Model

We employed a logit model, in which the reuse likelihood is a logit function of the randomized conditions. The equation (2) describes our logit model.

$$\mathrm{Reuse}_i = \frac{\mathrm{Exp}(U_i)}{\mathrm{Exp}(U_i)+1} \quad (2)$$

$$U_i = \alpha + \alpha_1 \times Recency_i + \alpha_2 \times Frequency_i + \alpha_3 \times \ln(Monetary_i) + \Gamma Controls_i + \theta_i + \epsilon_i \quad (3)$$

where U_i is the latent utility of reuse decision. $Reuse_i$ is the dependent variable indicating reuse likelihood of user *i*. The key independent variables are RFMC measures when user *i* uses carsharing service. $Controls_i$ is a vector of control variables indicating the user characteristics. In addition, our data providers operate an integrated platform of carsharing. Reservation can be made through one of five websites. We thus controlled for website fixed-effects, denoted as θ_i in equation (1) in order to avoid endogeneity issues arising from website characteristics.

Ⅳ. Results

<Table 5> summarizes our main results. Model (1) and (2) describe the impact of RFM measures on reuse behavior among customers with a high level of clumpiness whereas Model (3) and (4) depict the phenomenon among customers with a low level of clumpiness. The results suggest that all of the independent variables, $Recency_i$, $Frequency_i$, $Monetary_i$, have significant effects on the reuse likelihood of carsharing user regardless of the level of clumpiness. According to all 4 models, first, $Recency_i$ is negatively related to reuse likelihood of user *i*. As recency is measured by the distance between the date of last use and reuse date, $Recency_i$ is negatively related to reuse likelihood of user *i*, meaning that the more recent the user has used carsharing service, the more likely that the user will reuse the service. This result indicates that if usage experience is closer to the present, the memory of using product or service is more accessible, which leads to an enhanced likelihood of users repeat purchase or usage (Chandon *et al.*, 2004). Second, the result shows that $Frequency_i$ is positively associated with reuse likelihood. This suggests that the user who uses carsharing service more often has a higher possibility for using the service again. It is consistent with previous findings on RFM (Lee *et al.*, 2015).

〈Table 5〉 Logit Model Result

Dependent Variable:				
Independent Variables	High clumpiness Model (1)	High clumpiness Model (2)	Low clumpiness Model (3)	Low clumpiness Model (4)
$Recency_i$	-0.041*** (0.003)	-0.041*** (0.003)	-0.037*** (0.002)	-0.037*** (0.002)
$Frequency_i$	0.382*** (0.031)	0.384*** (0.033)	0.521*** (0.021)	0.506*** (0.021)
ln ($Monetary_i$)	-0.244*** (0.047)	-0.252*** (0.047)	-0.196*** (0.019)	-0.208*** (0.020)
$Gender_i$	-	0.019 (0.090)	-	0.167*** (0.036)
Age_i	-	0.011 (0.007)	-	0.015*** (0.003)
$Cars_i$	-	0.002 (0.114)	-	0.150** (0.055)
Constant	1.578** (0.561)	1.305 (0.597)	0.847*** (0.232)	0.201 (0.246)
Channel-fixed effect	Included	Included	Included	Included
N	3,570	3,570	21,721	21,721
Log likelihood	-2,038.929	-2,037.668	-12,433.958	-12,404.233
(Pseudo) R^2	0.169	0.170	0.161	0.163

Note. ***p<0.001, **p<0.01, *p<0.05 Standard errors in parentheses.

Third and interestingly, $Monetary_i$ is shown to have a negative relationship with carsharing reuse, meaning that a user who paid a larger amount of money is less likely to reuse the carsharing service. Although it is in contrast with previous findings that a user may repurchase using product or service again once he/she has spent a large amount of money (Lee *et al.*, 2015; Stangl *et al.*, 2017), it is plausible from the characteristics of carsharing as a means of transportation. The carsharing literature has noted that unrepetitive users use carsharing longer trips than repetitive users because owning a car is probably more cost-saving for repetitive users when they would make many long trips (Duncan, 2011). In this way, users who use a carsharing service unrepetitively are more likely to spend a large amount of money. This might show the negative relationship between the monetary aspect and the continuous usage of carsharing service. Last, by comparing the coefficients of independent variables between high and low clumpiness groups, it is shown that recency and monetary value has higher impact on reuse behavior among clumpy users whereas the impact of frequency is higher among non-clumpy users. This implies that users who use the service in relatively irregular manner are more cost-sensitive and more likely to reuse the service when having recent usage experience whereas the impact of frequency is smaller.

Ⅴ. Discussion

As an example of sharing economy services that leads to the change in consumption pattern from owning to accessing, carsharing service can reduce resource

allocation inefficiencies and alleviate transportation systems problems. To maintain the positive effects of carsharing service, it is essential to understand individuals' service usage pattern and identify the determinant of users' reuse behavior. By applying RFMC-recency, frequency, monetary, and clumpiness-model and empirically analyzing more than 25,000 usage records from one of the leading carsharing service vendors in South Korea, this study identifies the factors that affect the continuous use of carsharing by employing logit regression. The results show that users who use the service more recently and frequently are more likely to reuse while users who spent a large amount of money are less likely to carsharing service reuse. Moreover, such impacts are consistent regardless of clumpiness of usage pattern, however, users with a high level of clumpiness are more likely to be affected by recency and monetary factor, whereas less affected by frequency in terms of continuous use.

5.1 Implications

This study has several contributions to the literature. First, to maximize the benefit of carsharing service, the service should be used continuously rather than an occasional basis. However, previous studies revolve around exploring the factors affect service adoption and even such studies are based on user intention or attitude (Cheng *et al.*, 2016; Prieto *et al.*, 2017; Zhang and Li, 2020), not the actual behaviors. By empirically investigating the factors that affect the continuous use of carsharing with field data from a carsharing service provider, our findings enrich the understanding of the usage pattern of carsharing service. In particular, carsharing service is regarded as sustainable way of consuming the asset. In this vein, the role of the explored factors such as recency and clumpiness can be investigated in other types of sustainable services.

Second, carsharing can be an aid to solve urban problems such as transportation system issues including inefficiencies in public transportation utilization or lack of parking lots. Carsharing can thus play an important societal role as other sharing economy services do. Despite its prevalence and importance, carsharing has received relatively limited attention in academia compared to other sharing economy services. Recent studies on sharing economy services such as accommodation sharing or ride sharing services are dealing with the societal impact of those services such as changes in mortality rate (Greenwood and Wattal, 2017), effects on the labor market (Li *et al.*, 2018) and related industry (Zervas *et al.*, 2017). Taken account of these societal roles, it is necessary to understand the usage behaviors and think of ways to lead to continuous use of those services. In this respect, this study can be aligned with the studies on the societal impacts of sharing economy.

Third, the contribution of this study lies on its scrutiny of the value of clumpiness in capturing reuse likelihood. While RFM is widely used in identifying customer lifetime value of service usage (Chiang and Yang, 2018), only a few studies investigated the role of clumpiness (Zhang *et al.*, 2015). However, as carsharing is a means of transportation, whose usage cycle may vary depending on the purpose of use unlike general service usage, more detailed consideration on service usage pattern not only the aggregated usage pattern – frequency – is needed. Thus, we employed RFMC model rather than RFM, to reflect the contextual characteristics as a means of transportation. By comparing the impact of clumpiness on the relationship between RFM and service reuse, our findings imply the effect of usage patterns to understand the continuous usage of service. Furthermore, in terms of the result on the effect of monetary value, our study also contributes by adding opposite findings regarding the relationship

between monetary value and purchase behavior. In contrast to previous findings that monetary value and customer purchase likelihood are positively related (Lee *et al.*, 2015; Stangl *et al.*, 2017), monetary value is shown to have a negative impact on carsharing reuse. These results may attribute to the contextual characteristics of car usage as a car is a means used regularly for commuting and periodic movement in daily life resulting in the necessity for both accessibility and cost efficiency. Taken together, this study extends the RFMC model to carsharing context and identifies their consistent effects as well as context-specific effects.

The findings of this study also provide managerial insights to carsharing service providers who are interested in promoting users' continuous use of the service and policymakers concerned with enhancing the quality of transportation systems. First, for carsharing service providers, strategic approaches are required for promoting regular and constant use of their services. For example, they can design services for encouraging regular use by offering coupons or discounts which can be used in a certain time interval. Also, service providers can arrange carsharing stations to the appropriate places. Using RFMC approach, they can predict future heavy users so that they can strategically arrange carsharing stations to the place where many of those users can easily access. For one, among RFMC measures, as the days elapsed since a user last used the service is shorter (i.e. Recency), the more likely the user will be using carsharing service again. Thus, managers should consider the promotion related to that kind of users. Providing a coupon or vouchers to users whose last purchase data is more than two weeks can be such a strategy that service providers can implement by leveraging the findings.

Second, from the perspective of policymakers, this study can provide implications for refining transportation systems. Leveraging the findings of our study, it is possible to figure out the usage pattern of each carsharing station. That is, the RFMC measures of each carsharing station can show the stations where re-usage occurs a lot. This may help identify carsharing stations attaining heavy users, which is closely related to traffic conditions such as traffic congestion or parking lot shortage issues in areas around such carsharing stations. Leveraging the usage information of such carsharing stations, policymakers can design strategies to resolve such issues. For instance, they can balance carsharing stations and public transportation routes, which can relieve traffic congestion and solve resource allocation problems together.

5.3 Future Research Opportunities

Our study provides several avenues for future research. First, although we controlled for consumer characteristics such as age and gender, other personal characteristics may affect consumer's reuse pattern. For example, a consumer's occupation may have influence on the relationship between monetary value and reuse likelihood. That is, due to the nature of the customer's job, he/she frequently works outside the office for a long distance that the amount of car-sharing usage fee is high, but the probability of reuse may be high. In such case, our findings might not be applied. We thus expect future researchers by considering personal data to provide a better interpretation. Second, although our dataset was collected in 2014 and 2016, these years are the beginning stage of carsharing services in Korea. At that time, the concept of carsharing was popularized and had received attentions from scholars and practitioners, and relating services were actively expanded (e.g., Chang, 2016; Hwang and Jeon, 2014). As our findings were based on the sample in the period of expansion of carsharing, we think that our discussion is still meaningful in the present that people have used

various carsharing services more generally. Nonetheless, as there is a still time difference, we call for future research with recent dataset to reconfirm our findings and provide the deeper understanding of continuous usage of carsharing services. Relatedly, in our analysis, we focused on one of the carsharing vendors in South Korea. Although the company runs diverse platforms to consider multi-channels, data from several other service providers are not included in the analysis. It is required for future studies to consider other service vendors for the enhanced robustness of our findings.

References

[1] Akhter, S. H., "Digital divide and purchase intention: Why demographic psychology matters", *Journal of Economic Psychology*, Vol.24, No.3, 2003, pp. 321-327.

[2] Asgari, H. and X. Jin, "Incorporating habitual behavior into mode choice modeling in light of emerging mobility services", *Sustainable Cities and Society*, Vol.52, 2020, p. 101735.

[3] Boldrini, C., R. Bruno, and M. Conti, "Characterising demand and usage patterns in a large station-based car sharing system", *2016 IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), IEEE*, 2016, pp. 572-577.

[4] Burkhardt, J. E. and A. Millard-Ball, "Who is attracted to carsharing?", *Transportation Research Record*, Vol.1986, No.1, 2006, pp. 98-105.

[5] Chandon, P., V. G. Morwitz, and W. J. Reinartz, "The short-and long-term effects of measuring intent to repurchase", *Journal of Consumer Research*, Vol.31, No.3, 2004, pp. 566-572.

[6] Chang, D., *[2016 Look Back ③] 5 Keywords for Hot Talk in the Automobile Industry*, in: Sisa Today, 2016.

[7] Cheng, X., S. Fu, and G. Yin, "Does subsidy work? An investigation of post-adoption switching on car-hailing apps", *Journal of Electronic Commerce Research*, Forthcoming, 2016.

[8] Chiang, L. L. L., and C. S. Yang, "Does country-of-origin brand personality generate retail customer lifetime value? A big data analytics approach", *Technological Forecasting and Social Change*, Vol.130, 2018, pp. 177-187.

[9] Duncan, M., "The cost saving potential of carsharing in a us context", *Transportation*, Vol.38, No.2, 2011, pp. 363-382.

[10] Fader, P. S., B. G. Hardie, and K. L. Lee, "Rfm and Clv: Using iso-value curves for customer base analysis", *Journal of Marketing Research*, Vol.42, No.4, 2005, pp. 415-430.

[11] Farrar, D. E. and R. R. Glauber, "Multicollinearity in regression analysis: The problem revisited", *The Review of Economic and Statistics*, 1967, pp. 92-107.

[12] Goldman, T. and R. Gorham, "Sustainable urban transport: Four innovative directions", *Technology in Society*, Vol.28, No.1-2, 2006, pp. 261-273.

[13] Greenwood, B. N. and S. Wattal, "Show me the way to go home: An empirical investigation of ride-sharing and alcohol related motor vehicle fatalities", *MIS Quarterly*, Vol.41, No.1, 2017, pp. 163-187.

[14] Grischkat, S., M. Hunecke, S. Böhler, and S. Haustein, "Potential for the reduction of greenhouse gas emissions through the use of mobility services", *Transport Policy*, Vol.35, 2014, pp. 295-303.

[15] Gupta, S., D. Hanssens, B.Hardie, W. Kahn, V. Kumar, N. Lin, N. Ravishanker, and S. Sriram, "Modeling customer lifetime value", *Journal of Service Research*, Vol.9, No.2, 2006, pp. 139-155.

[16] Haenlein, M. and B. Libai, "Targeting revenue

leaders for a new product", *Journal of Marketing*, Vol.77, No.3, 2013, pp. 65-80.

[17] Heldt, R., C. S. Silveira, and F. B. Luce, "Predicting customer value per product: From RFM to RFM/P", *Journal of Business Research*, Vol.127, 2021, pp. 444-453.

[18] Hennig-Thurau, T. and C. Thurau, "Customer orientation of service employees－toward a conceptual framework of a key relationship marketing construct", *Journal of Relationship Marketing*, Vol.2, No.1-2, 2003, pp. 23-41.

[19] Hwang, K.-Y. and H.-J. Jeon, "Applying sharing economy principle on transport with focus on car sharing practice and research", *Journal of Transport Research*, Vol.21, No.1, 2014, pp. 35-49.

[20] Jian, S., W. Liu, X. Wang, H. Yang, and S. T. Waller, "On integrating carsharing and parking sharing services", *Transportation Research Part B: Methodological*, Vol.142, 2020, pp. 19-44.

[21] Joo, J.-H., "Motives for participating in sharing economy: Intentions to use car sharing services", *Journal of Distribution Science*, Vol.15, No.2, 2017, pp. 21-26.

[22] Kim, D., K. Park, D.-J. Lee, and Y. Ahn, "Predicting mobile trading system discontinuance: The role of attention", *Electronic Commerce Research and Applications*, Vol.44, 2020, p. 101008.

[23] Kumar, V. and D. Shah, "Expanding the role of marketing: From customer equity to market capitalization", *Journal of Marketing*, Vol.73, No.6, 2009, pp. 119-136.

[24] LaTour, K. A. and H. N. Noel, "Self-directed learning online: An opportunity to binge", *Journal of Marketing Education*, Vol.43, No.2, 2021, pp. 174-188.

[25] Lee, J., J. Lee, H. Lee, and J. Lee, "An exploratory study of factors influencing repurchase behaviors toward game items: A field study", *Computers in Human Behavior*, Vol.53, 2015, pp. 13-23.

[26] Li, M., Q. Wang, Y. Shen, and T. Zhu, "Customer relationship management analysis of outpatients in a Chinese infectious disease hospital using drug-proportion recency-frequency-monetary model", *International Journal of Medical Informatics*, 2020, p. 104373.

[27] Li, Z., Y. K. Hong, and Z. Zhang, "Empowerment or substitution? Entry of platform-based sharing economy on the local labor markets", *39th International Conference on Information Systems, ICIS 2018. Association for Information Systems*, 2018.

[28] Liao, C., H.-N. Lin, M. M. Luo, and S. Chea, "Factors influencing online shoppers' repurchase intentions: The roles of satisfaction and regret", *Information & Management*, Vol.54, No.5, 2017, pp. 651-668.

[29] Litman, T., "Evaluating carsharing benefits", *Transportation Research Record*, Vol.1702, No.1, 2000, pp. 31-35.

[30] Lu, B., Z. Wang, and S. Zhang, "Platform-based mechanisms, institutional trust, and continuous use intention: The moderating role of perceived effectiveness of sharing economy institutional mechanisms", *Information & Management*, Vol.58, No.7, 2021, p. 103504.

[31] Luna, T. F., M. Uriona-Maldonado, M. E. Silva, and C. R. Vaz, "The influence of e-carsharing schemes on electric vehicle adoption and carbon emissions: An emerging economy study", *Transportation Research Part D: Transport and Environment*, Vol.79, 2020, p. 102226.

[32] Martin, E. and S. Shaheen, "The impact of carsharing on public transit and non-motorized travel: An exploration of north american carsharing survey data", *Energies*, Vol.4, No.11, 2011, pp.

2094-2114.

[33] Mensah, I. K., Z. Tianyu, G. Zeng, and L. Chuanyong, “Determinants of the continued intention of college students in China to use didi mobile car-sharing services”, *SAGE Open*, Vol.9, No.4, 2019, p. 2158244019893697.

[34] Millard-Ball, A., *Car-Sharing: Where and How It Succeeds*, Transportation Research Board, 2005.

[35] Ming-liang, C., “A experimental research on the determinants of customer repurchase intention”, *Science Research Management*, Vol.1, 2003, p. 019.

[36] Nijland, H. and J. van Meerkerk, “Mobility and environmental impacts of car sharing in the Netherlands”, *Environmental Innovation and Societal Transitions*, Vol.23, 2017, pp. 84-91.

[37] Peppers, D. and M. Rogers, *The One to One Future: Building Relationship One Customer at a Time*, New York: Doubleday, 1993.

[38] Platzer, M. and T. Reutterer, “Ticking away the moments: Timing regularity helps to better predict customer activity”, *Marketing Science*, Vol.35, No.5, 2016, pp. 779-799.

[39] Prieto, M., G. Baltas, and V. Stan, “Car sharing adoption intention in urban areas: What are the key sociodemographic drivers?”, *Transportation Research Part A: Policy and Practice*, Vol.101, 2017, pp. 218-227.

[40] Punj, G., “Effect of consumer beliefs on online purchase behavior: The influence of demographic characteristics and consumption values”, *Journal of Interactive Marketing*, Vol.25, No.3, 2011, pp. 134-144.

[41] Reichheld, F. and J. Sasser, “Zero defections: Quality come to services”, *Harvard Bussines Review*, Vol.68, No.5, 1990, pp. 105-111.

[42] Reutterer, T., M. Platzer, and N. Schröder, “Leveraging purchase regularity for predicting customer behavior the easy way”, *International Journal of Research in Marketing*, Vol.38, No.1, 2021, pp. 194-215.

[43] Rifkin, J., *The Age of Access: The New Culture of Hypercapitalism*, Penguin, 2001.

[44] Rotaris, L., R. Danielis, and I. Maltese, “Carsharing use by college students: The case of milan and rome”, *Transportation Research Part A: Policy and Practice*, Vol.120, 2019, pp. 239-251.

[45] Schaefers, T., “Exploring carsharing usage motives: A hierarchical means-end chain analysis”, *Transportation Research Part A: Policy and Practice*, Vol.47, 2013, pp. 69-77.

[46] Shaheen, S., E. Martin, and H. Totte, “Zero-emission vehicle exposure within us carsharing fleets and impacts on sentiment toward electric-drive vehicles”, *Transport Policy*, Vol.85, 2020, pp. A23-A32.

[47] Shaheen, S., D. Sperling, and C. Wagner, “Carsharing in Europe and North America: Past, present, and future”, *Transportation Quarterly*, Vol.52, No.3, 1998, pp. 1-18.

[48] Silvestri, A., S. Foudi, I. Galarraga, and A. Ansuategi, “The contribution of carsharing to low carbon mobility: Complementarity and substitution with other modes”, *Research in Transportation Economics*, Vol.85, 2021, p. 100968.

[49] Stangl, B., M. Kastner, and G. Prayag, “Pay-what-you-want for high-value priced services: Differences between potential, new, and repeat customers”, *Journal of Business Research*, Vol.74, 2017, pp. 168-174.

[50] Sun, B. and L. Shibo, “Learning and acting on customer information: A simulation-based demonstration on service allocations with offshore centers”, *Journal of Marketing Research*, Vol.48, No.1, 2011, pp. 72-86.

[51] Sun, G., R. Sun, J. Li, W. Wang, and L. Johnson, “Consumers’ trust propensity and continuous use intention toward the sharing economy: A moderated mediation model”, *Journal of Consumer Behaviour*, 2022, Vol.21, No.4, pp. 871-879.

[52] Ter Huurne, M., A. Ronteltap, R. Corten, and V. Buskens, “Antecedents of trust in the sharing economy: A systematic review”, *Journal of Consumer Behaviour*, Vol.16, No.6, 2017, pp. 485-498.

[53] Theodorakis, N. D., A. Koustelios, L. Robinson, and A. Barlas, “Moderating role of team identification on the relationship between service quality and repurchase intentions among spectators of professional sports”, *Managing Service Quality: An International Journal*, Vol.19, No.4, 2009, pp. 456-473.

[54] Wagner, S., T. Brandt, and D. Neumann, “In free float: Developing business analytics support for carsharing providers”, *Omega*, Vol.59, 2016, pp. 4-14.

[55] Zervas, G., D. Proserpio, and J. W. Byers, “The rise of the sharing economy: Estimating the impact of airbnb on the hotel industry”, *Journal of Marketing Research*, Vol.54, No.5, 2017, pp. 687-705.

[56] Zhang, Y., E. T. Bradlow, and D. S. Small, “New measures of clumpiness for incidence data”, *Journal of Applied Statistics*, Vol.40, No.11, 2013, pp. 2533-2548.

[57] Zhang, Y., E. T. Bradlow, and D. S. Small, “Predicting customer value using clumpiness: From RFM to RFMC”, Marketing Science, Vol.34, No.2, 2015, pp. 195-208.

[58] Zhang, Y. and L. Li, “Intention of Chinese college students to use carsharing: An application of the theory of planned behavior”, *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol.75, 2020, pp. 106-119.

[59] Zhou, F., Z. Zheng, J. Whitehead, R. K. Perrons, S. Washington, and L. Page, “Examining the impact of car-sharing on private vehicle ownership”, *Transportation Research Part A: Policy and Practice*, Vol.138, 2020, pp. 322-341.

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An Investigation on the Continuous Use of Carsharing: Evidence from RFMC Model

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Abstract

Thanks to information technologies, sharing economy services offer a new way of consumption. Carsharing appeared as a novel type of service that transformed the conventional way of personal transportation, from owning a vehicle to using an on-demand service. Allowing users to use a vehicle without owning a car, carsharing provides various social benefits such as the reduction of resource allocation inefficiencies and the alleviation of transportation problems. To strengthen such positive aspects of carsharing service, it is essential to understand an individual's service usage pattern and reveal factors that affect users' reuse behavior. This study investigates the factors that have an influence on carsharing reuse of users applying RFMC (Recency, Frequency, Monetary, and Clumpiness) model, the popular model for understanding the reuse likelihood of customers. Using data from a leading carsharing service provider in South Korea, we empirically analyze the effect of RFMC on carsharing reuse behavior. The findings show that recency and monetary values are negatively related to reuse while frequency is positively related to carsharing service reuse. Moreover, the impact of recency and monetary value are more salient whereas the impact of frequency is smaller among users with higher clumpiness. Based on these findings, this study elaborates on theoretical and practical implications.

Keywords: Carsharing, Sharing Economy, Sustainable Use, RFMC, Reuse Behavior

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충북대학교 경영정보학과 부교수로 재직 중이다. KAIST 경영대학에서 박사학위 취득 후 중국과학기술대학(USTC) 및 한국기술교육대학교 조교수를 역임하였다. 주요 관심분야는 collective dynamics and human behavior in IS이다. Journal of Management Information Systems, Journal of the Association for Information Systems, Journal of Business Ethics, International Journal of Information Management, International Journal of Electronic Commerce, Communications of the ACM 등의 학술지에 논문을 발표하였다.

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