Application of Prospect Theory on Car Sharing Product Service System

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Abstract

To date, majority of current studies of product service system are approached from manufacturer’s perspectives, while relatively few efforts have been devoted to investigate customer’s decision making in between product and service. According to the Prospect Theory, there exist a variety of factors that will lead people to make irrational decisions. That being said, a clear understanding of the reason why and under what conditions people tend to behave irrationally is useful in improving existing services and designing new services. This paper presents some preliminary discussions of applicability of the Prospect Theory on a use-oriented product service system - car sharing service.

1. Introduction

The importance of effectively integrating products and services becomes increasingly recognized by today’s society that aims to achieve a sustainable development [1]. As a result of this trend, many efforts have been devoted to the study of product service system (i.e., PSS) [2-4]. The core value proposition behind the PSS is to provide the same or better functionality with more services and less products, under the assumption that the exclusive ownership of physical products results in more unnecessary wastes of natural resources than the shared usage of intangible services. From the theoretical perspective, many theories, frameworks, and classification of PSS have been developed [5-8]. From the application perspective, many viable strategies and business models have been developed for specific product categories [9-11]. The benefits of PSS have been indicated by a number of past studies. For example, the manufacture will create additional values to its existing products [2]. Customers will receive cheaper cost of the same functionality (e.g., international phone call via Skype). Government will benefit from a boost of employment opportunities because of the labor-intensive nature of services [2]. To date, the vast majority of previous studies of PSS are framed from the manufacturer’s perspective as opposed to from the customer’s angles. Relatively fewer efforts have been devoted to investigate the same coin from both sides – production and consumption, in particular, how these two fundamental economic activities are linked together by customer’s decision making between product and service as well as among different service alternatives.

One fundamental assumption of the classic economics is that humans are rational, and they make decisions rationally. According to the rational choice theory [12], a rational decision making is completely determined by the absolute value of multiplying an outcome with its probability of occurrence. However, in the real world, there exist a variety of factors that will affect people to sometimes make irrational decisions. This is particular true in the context of PSS, which often requires the customer to transfer ownership of tangible products back to the manufacture or the third-party service providers in the interest of sustainability. That being said, a clear understanding of the reason why and under what
conditions people tend to make irrational decisions will be useful in improving existing services and designing future services. The theory that we rely on to obtain such an understanding is the Prospect Theory [13-14], which is a well-established theory in behavior economics. The Prospect Theory is often used to explain people’s irrational behaviors over alternatives that involve uncertainty. Our hypothesis is that the Prospect Theory in economics also applies in customer’s decision making in between product and service, and over different service alternatives. In the past, the Prospect Theory was mostly used to explain individual’s economic decision over tangible products, whereas few efforts have been devoted to investigate the theory’s applications on services, particularly from the product service system perspective.

The rest of this paper is organized as following. Section 2 introduces some basics of the Prospect Theory and summarizes multiple typical irrational human behaviors that can be explained using the theory. Section 3 explains how we employ the Prospect Theory to explain customer’s decision making over the emerging car sharing service, which is a particular type of use-oriented PSS. Section 4 draws conclusions and outlooks future works.

2. Introduction of Prospect Theory

This section presents a brief introduction of the Prospect Theory, which describes a decision making process as two stages: edition stage and evaluation stage. During the edition stage, the decision maker uses his/her heuristics to determine a reference point, and considers outcomes below this reference point as losses and outcomes above this reference point as gains. Next, during the evaluation stage, the decision maker calculates a value for every alternative based on potential outcomes and their respective probability, then they select the alternative that has the highest utility. It should be noted that the Prospect Theory is a descriptive (as opposed to prescriptive) theory, meaning the theory merely functions to model/explain the real-world decision making process instead of guiding people to find the optimal decision.

Unlike the expected utility theory [15] that also concerns with individual’s preferences over alternatives with uncertainty, the Prospect Theory formulates preference as a function of decision weights, and it assumes that such decision weights are not linearly corresponding to the probability. Additionally, instead of using the notion of “utility” that represents the net satisfaction of alternatives, the Prospective Theory suggests that what really matters in people’s daily decision making is the sense of “value” which is defined in terms of gains and losses (deviation from the reference point). More importantly, the value function evolves with a different shape (i.e., slopes of the curves) with respect to gains and losses. Figure 1 shows the graphical illustration of the Prospect Theory. In the rest of this section, we will introduce several customer’s irrational behaviors that can be explained using the Prospect Theory.

Figure 1: Graphical illustration of the Prospect Theory [13]

Certain Effect means that people tend to overweight the values of certain events and underestimate the values of uncertainty ones. Influenced by such a tendency, in front of a high probability event, the decision makers are risk-averse over alternatives involving gains, and they become risk-seeking over alternatives involving losses. First, consider the following example concerning gains:

- **Alternative (a):** a 100% chance of winning $3000
- **Alternative (b):** a 80% chance of winning $4000, and a 20% chance of winning nothing.

Given the above two alternatives, the Prospect Theory proves that majority of people will select alternative (a) instead of alternative (b) [13], although the expected utility of (b) is actually higher than that of (a) according to the Expected Utility Theory [15]. This is to say that, provided alternatives involving gains, people have the nature tendency of settling with a certain gain rather than taking the extra risk to seek for a higher gain, due to the fear of disappointment. Next, consider the following example concerning losses:

- **Alternative (c):** a 100% chance of losing $3000
- **Alternative (d):** a 80% chance of losing $4000, and a 20% chance of winning nothing.

Experiment shows that majority of people will choose alternative (d) over alternative (c), although the expected utility of (d) is actually lower than that of (c) (i.e., -3200 vs. -3000). Compared to the previous example, it should be noted that, people’s risk attitude shifts from risk-adverse to risk-seeking. This is also called the reflection effect.

Probability Effect probability effect deals with low probability events. This is in sharp contrast with the above Certainty Effect that concerns with high probability events. The Probability Effect means that, in general, people tend to overweight the significance of low probability events. As a result of such tendency, positioned with a low probability of gains, decision makers become risk-seeking. For example, majority of people will remain purchasing lottery, even if they are fully aware of the extremely low chance of winning. On the other hand, positioned with a low probability of losses, decision makers will once again become risk-adverse. For instance, all kinds of insurance policies somehow rely on people’s fear of large losses to exist, and they take advantage of the low probability of such events to actually make profits.

Reflection Effect means that people’s risk attitudes are opposite depending on if the outcome concerns with gains or losses, and what is the probability of the outcome. Specifically, in front of a high probability outcome, people are risk-adverse if the outcome means gains, and they become risk-seeking if the outcome means losses, accordingly (as...
illustrated by the Certainty Effect). In contrast, positioned with a low probability outcome, people are risk-seeking when the outcome means gains, and they become risk-averse when the outcome means losses, respectively (as illustrated by the Probability Effect). The four patterns of risk attitudes and their reflection effects are summarized in Table 1.

| Patterns of risk attitudes and their reflection effects. |
|--------------------------------------------------------|
| **Gain** | **Losses** |
| Certainty Effect (High Probability) | Risk Averse | Risk Seeking |
| Probability Effect (Low Probability) | Risk Seeking | Risk Averse |

**Pseudocertainty Effect** indicates people’s natural tendency to consider an uncertain outcome to be certain. It explains the observation that an individual’s risk attitude (i.e., risk-averse or risk-loving) is affected by the amount involved and whether the decision making involves an improving or worsening outcome. For example, the Pseudocertainty Effect can be used to explain the reason why the same person buys both car insurance (i.e., risk-averse) and lottery ticket (i.e., risk seeking) at the same time. Because the former object (i.e., car) involves a larger amount than the latter object (lottery), leading to the decision maker’s change of risk attitude.

**Framing Effect** means that people will behave differently over the same choice depending on whether the choice’s outcome is “framed” as a loss or as a gain. In general, people tend to avoid risks in front of a positive frame (i.e., a gain), and to seek risks in front of a negative frame (i.e., a loss), respectively. According to the Prospect Theory, the ”pain” caused by a loss means more significantly than the “happiness” caused by a gain, even if magnitude of the loss and the gain is actually equivalent. For example, according to a previous study, 93% of Ph.D. students chose to register early when “a penalty fee for late registration” was emphasized, whereas only 67% chose to do the same when the same amount was presented as “a discount for early registration” [16]. It should be noted that though, the Framing Effect differs itself from the Reflection Effect in the sense that, the outcome here is only phrased to be a gain subjectively, while in fact it remains to be a loss objectively.

**Endowment Effect** reflects people’s tendency to subjectively appraise higher values to the things that they own than something owned by others. The Endowment Effect exists because once people establish the sense of ownership over a particular item, abandoning it will yield the perception of losses, even though there is no cause for attachment to the item or the item was just obtained a while ago. The Endowment Effect can be quantitatively measured by the distance between an individual’s willingness to accept (WTA) and his/her willingness to pay (WTP), where the WTA means the minimum amount that an individual is willing to accept selling an item that belongs to him/her (or to tolerate something negative), and the WTP means the maximum amount an individual is willing to pay for an item that he/she desires (or to avoid something undesirable). For example, one previous experiment shows that people’s WTA for the football game tickets that they own were 14 times higher than their WTP to buy the same tickets from others [17].

3. Practical Applications of the Prospect Theory on PSS

This section aims to explain how the Prospect Theory can be applied in the context of product service systems. The particular PSS that we choose is a car-sharing service provider – Zipcar. Section 3.1 presents a brief introduction of the Zipcar and explains how it can be regarded as a use-oriented PSS. Section 3.2 analyzes how the Prospect Theory is used to explain customer’s decision making over alternatives of car sharing, car renting and car owning, as well as over different kinds of Zipcar service plans. Section 3.3 briefly discusses the future evolvement of the car sharing service.

3.1 Car Sharing as PSS

Car sharing refers to a particular model of car rental that allows its users to rent cars for a short period. Strictly speaking, car sharing is not a completely new idea, and there exist many literatures discussing the past, present, and future of the car sharing service [18-20]. But only until recent years it is gaining sufficient market momentums and customer’s acceptance, largely because of the increasing social awareness of sustainability at both societal and individual levels. A number of exclusive car sharing service providers had emerged such as Autolib, City Car Club, Greenwheels, Stadtmobil, and Zipcar; many traditional car rental service providers had introduced their car sharing services such as Hertz on Demand, Enterprise Car Share, UHaul Car Share; and even some major auto manufacturers also began to offer their own car sharing services, for example, Daimler AG’s car2go, BMW’s Drive Now, and VW’s Quicar. Among the various service providers existing in the market, the particular case that we select to study is Zipcar, which is a leading car sharing service provider based on the United States. As of July 2013, Zipcar had successfully attracted more than 810,000 members, it operates more than 10,000 different kinds of vehicles (including various clean fuel vehicles and plug-in vehicles) throughout U.S., Canada, United Kingdom, Spain, and Austria, and it is advertised to be the world’s largest car sharing service provider [21].

The main value proposition of the care sharing service is that the individuals can still receive the benefits of a private car but without concerning the cost and responsibility associated with actually owning a car. In the past, a number of past studies have attributed car sharing as a product service system, a use-oriented PSS in particular [2-3, 22]. In practice, the primary target customers of the car sharing service include the following [21]:

1. Customers who have difficulties affording a variety of high costs, such as insurance, parking, gasoline, etc. which are associated with owning and maintaining a private car.
(2) Customers who sometimes need a different type of car for some occasional transporting purposes, such as a SUV for off-road excursions or a VAN for carrying large goods.

(3) Customers who mostly take public transportation for daily work but once in a while will need a car for personal business such as grocery shopping.

(4) Customers who are frequent travelers and need cars in major cities and airports around the world.

(5) Customers who have strong awareness of sustainability and hence desire a "greener" life style.

3.2 Application of Prospect Theory

The car sharing service differs itself from the traditional car renting service and the car owning in many aspects. It should be noted that, the notion "car renting" used in this paper refers to the short-term car rental service on the daily basis (that are supplied by the third-party car rental service providers such as Avis, Enterprise, Budget, etc.) as opposed to the long-term car rental on the yearly basis (that are provided by the auto manufactures or its dealers directly). Here we explain some representing differences between car sharing, car renting, and car owning (as summarized in Table 2).

(a) The most significant difference between car sharing and car renting is that the former service allows its members to use the car by hours as opposed to by days as required by the latter service, making the customer experience of car sharing a big step closer towards that of actually owning a private car.

(b) Unlike the traditional car renting service, a membership is usually required to join the car sharing service. Take the Zipcar for instance, it involves a non-refundable one time application fee (i.e., $25) to sign up the membership, and an additional annual fee (i.e., $60) to sustain the membership. In return, the Zipcar membership includes a variety of member exclusive benefits such as free gasoline, insurance, online reservation system, mobile phone application, and exclusive parking spaces.

(c) Customers pay for the gasoline in both car renting and car owning, whereas the gasoline cost is normally covered in the car sharing service. Take the Zipcar for instance, there is a pre-paid fuel card inside every shared vehicle, which can be used by its members to pay for gasoline.

(d) Similar to the free gasoline, the car sharing service also provides free car insurance. In contrast, users must pay for additional car insurances in both car renting and car owning. Take the Zipcar for instance, each member will automatically receive an insurance coverage of $300,000. For the accidents that are determined to be a member’s fault, the member is responsible for a damage fee of up to $750. In addition, the individuals who have clean accident histories, are eligible to purchase a damage fee waiver when signing up for memberships for $60 per year.

(e) The car sharing service requires its members to pick-up and return the vehicle in the same location, while the car renting service allows renters to return the vehicle to a different rental office with certain additional charges.

Next, we will employ the Prospect Theory to analyze customer’s decision making regarding the above three car-related product/service alternatives: car sharing, car renting, and car owning. Different customers will likely choose different alternatives depending on who they are and how often they will (or will NOT) need a car on a daily (or weekly, monthly) basis. Two assumptions are made with respect to the customer’s perceptions of the risk and gain/loss associated with the three alternatives. In terms of the risk of failing to satisfy the customer need of “transporting”, car owning involves the least risk, whereas car sharing involves the highest risk. It should be noted that, the reason why we consider the car sharing to be risker than the car renting is because the latter presently features with more service providers, larger networks, and more vehicles. With respect to the cost, we assume that car owning involves the highest cost, and car sharing involves the lowest cost.

Risk: car sharing > car renting > car owning

Cost: car sharing < car renting < car owning

The Certainty Effect, which concerns with high probability events, can be used to explain the customer’s decision making in between “transporting” products (i.e., car owning) and services (i.e., car renting or car sharing). On one hand, for the individuals who are highly certain that he/she will need a car on a daily basis (e.g., the fulltime workers who will commute between home and workplace every day), it is likely that they will choose product (i.e., car owning) over service (i.e., car sharing or car renting), even though they are fully aware that the former alternative involves a much higher cost. This is because such customers are fear of the potential large losses (e.g., late for work) caused by being unable to securing a car through services. On the other hand, for the individuals who are highly certain that they will NOT need a car on the daily basis (e.g., college students who live near or on campus), they are more likely to accept the car renting or car sharing services, largely because they tend to avoid the high cost associated with car owning. Likewise, the Probability Effect that deals with low certainty events will guide us to arrive at similar analysis results. And the reflection effect is illustrated in Table 3.

Similarly, we can also use the Certainty and Probability Effects to explain different customers’ decision making in between car sharing with car renting, and the analysis results are summarized in Table 4. Note that, since customers who will need a car on a daily basis are likely to choose car owning according to the above analysis, the comparison between car sharing and car renting is conducted based on the car usage on the weekly/monthly basis.
the traditional car-sharing model in which the service provider providers include RelayRides and Getaround. Different from a peer-to-peer sharing model. In practice, such service als.

Table 3: Decision making between transporting product (i.e., car owning) and service (i.e., car sharing or car renting)

| Usage duration | Membership | Gasoline | Car return | Insurance |
|----------------|------------|----------|------------|-----------|
| Car sharing    | By hours   | No-free  | Free       | Same space| Free      |
| Car renting    | By days    | Free     | No-free    | Limited spaces | No-free |
| Car owning     | By hours   | Free     | No-free    | Any place | No-free   |

Table 3: Decision making between transporting product (i.e., car owning) and service (i.e., car sharing or car renting)

Table 4: Decision making between car sharing and car renting

| Service package | Application Fee | Gasoline | Insurance | Annual/Monthly Fee | Hourly and Daily Rate |
|-----------------|-----------------|----------|-----------|--------------------|-----------------------|
| Occasional      | $25             | Free     | Free      | $60/year           | $9/hour and $73/day   |
| Monthly         | $25             | Free     | Free      | $6/month           | $9/hour and $73/day   |
| Extra value     | $25             | Free     | Free      | Pre-pay $50/month  | 8.10/hour and 65.70/day |

Furthermore, the Certainty and Probability Effects may also be used to analyze customer’s decision making over different car sharing service plans. For example, Zipcar currently provides three service plans, namely “occasional driving”, “monthly driving”, and “extra value” [21], which involve different rates and benefits. The comparison of the three service plans are summarized in Table 5. For example, the Certainty Effect explains why student members, who are highly likely to need a car on a weekly/monthly basis, tend to irrationally choose the “occasional driving” plan over the “extra value” plan (i.e., because they tend to avoid the disappointment of failing to spend the $50 prepaid monthly fee), although the latter service plan will actually yield a higher utility.

3.3 Future Evolvement of Car Sharing Service

With respect to the future evolvement of the car sharing service, there is an emerging trend that it is evolving towards a peer-to-peer sharing model. In practice, such service providers include RelayRides and Getaround. Different from the traditional car-sharing model in which the service provider owns, maintains, manages, and upgrades the vehicles, the peer-to-peer sharing allows private car owners to rent their vehicles to renters at a price mutually agreed by both parties, while the service provider merely offers, operates a platform to match complementary car owners and car renters. The unique value of the peer-to-peer car sharing service hinges on its great potentials to evolve towards a particular kind location-based service [24], in which individuals who are located near each other share usage of their different vehicles for some common transporting needs such as grocery shopping, work-home commute, etc. Additionally, there exist abundant opportunities to integrate the car sharing service with other location-based services such as social networking services.

The future flourishing of the peer-to-peer car sharing service might be hindered by the Endowment Effect that suggests that people tend to overvalue the products that they own and underestimate the product owned by others, as well as the Probability Effect that implies that people tend to overestimate the occurrence of low probability events. From the car owner’s perspective, according to the Endowment Effect, it is possible that he or she may charge a unreasonably high service price that can be hardly afforded by the car renter; and in light of the Probability Effect, the car owner might become “over-scared” by the risk of car accident and damage, even though the probability of such events could be very low due to a strict car renter screening procedure. Similarly, from the car renter’s perspective, affected by the Endowment and Probability Effects, it is likely that the renter will tend to underestimate the vehicle values and hence become more concerned of the vehicle conditions.
One possible way to overcome the negative Endowment and Possibility Effects is through well designed third-party insurance policies. For example, Relayrides [25] currently provides the car owner a $1 million liability insurance for third party injuries and property damages, as well as a full insurance for vehicle damages; and it provides the car renter a $300,000 liability coverage and a damage fee of up to $500. Such insurance, which is a transfer of risk and uncertainty from one to another in exchange for payment, plays critical roles in promoting the car sharing services. As a result, the Prospect Theory can also be used to analyze customer’s preferences over different insurance policies. For example, the Pseudocertainty Effect may be used to explain why customers are much more likely to choose a zero-liability insurance for a rented car (see alternative 1 below) over an accidental protection service for a private SLR digital camera (see alternative 2 below), although the latter alternative has a higher utility assuming that the “severe accidents” occur at a 5% chance in both scenarios.

Alternative (1): purchase a 1-year damage fee waiver for $60 from Zipcar, otherwise the user is responsible for a car damage fee of up to $750 in case of severe accidents.

Alternative (2): purchase a 1-year accidental protection plan for $69 from Bestbuy, otherwise the user loses the value of a SLR camera (i.e., $1500) in case of severe accidents.

4. Conclusion

This paper presents some of our preliminary investigations of applicability of the Prospect Theory on product service system. Using car sharing service as an illustrative example of use-oriented PSS, we explained how the Certainty, Probability, and Reflection effects in the Prospect Theory can be used to explain people’s irrational decision making over product (i.e., car owning) and services (i.e., car sharing and car renting), as well as over different kinds of car sharing service plans. Furthermore, we also explained how the Endowment and Probability Effects could possibly hinder the evolution of the current car sharing service towards the future peer-to-peer sharing.

Based on our discussions, it seems that a number of customer’s irrational decisions over services can indeed be properly explained using the Prospect Theory. One explanation is that customer’s sense of certainty is often established based on “tangibility” as opposed to “functionality”. As a result, customers often mistakenly regard a product to be more certain than the service because the former is more tangible than the latter, not because a product is more functional than a service. Hence, values of the product are often over weighted, whereas that of the service are often underestimated.

The original contribution of the paper hinges on its unique proposition – integration of relevant knowledge of engineering design and behavioral economics – to describe, explain, and analyze customer’s decision making process between products and services. With respect to future works, we will carry out a series of rigorous experiments to seek for concrete evidences of the applicability of the Prospect Theory on customer’s attitudes over products, services, and product-service integrations in different product categories. Based on the experiment results, we intend to propose a few improved value-adding services that are more easily acceptable by end users.

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