



## Exploring the acceptance of delivery robots by online buyers using diffusion of innovation theory and structural equation modeling

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**ABSTRACT:** Last-mile delivery is always one of the key issues in the field of transportation and the environment. Considering the rise in the online shopping rate, last-mile delivery has become one of the most important challenges for logistics service providers. In contrast to traditional delivery methods, new methods have been proposed, including sidewalk autonomous delivery robots (SADRs). These robots are a new generation of emerging technologies for the fast delivery of goods. The present study aims to investigate the factors affecting the adoption of SADRs by online shoppers in Iran. To this end, a model was proposed based on the diffusion of innovation theory (DOI). A total of 287 respondents were surveyed using an online questionnaire, and the partial least squares structural equation modeling (PLS-SEM) was employed for modeling. The results indicated that relative advantage, compatibility, and observability had a positive and complexity had a negative impact on consumers' intention to use the delivery robot. However, no significant relationship was found between trialability and intention. Also, The findings of the present study provide significant theoretical and practical contributions to logistics service providers and marketers.

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### 1- Introduction

Today, new methods are under testing or operation for last-mile delivery [1, 2], including sidewalk autonomous delivery robots (SADRs) that deliver small-sized products, such as food, grocery, and flowers, in some places across the world [3]. Different companies, including Amazon, Starship, FedEx, and Marble, are testing and employing such robots in some thinly-crowded places, such as campuses.

Since delivery robots are a new idea, recent studies have not comprehensively covered their entire aspects. The adoption of delivery robots as a method of receiving online-purchased products by shoppers has been subject to few studies [2,4]. To the best of our knowledge, [4] was the first that proposed a model based on the Unified Theory of Acceptance and Use of Technology (UTAUT2) in Germany. It was found that performance expectancy, social influence, facilitating conditions, and hedonic motivation had a positive and price sensitivity and perceived risk had a negative effect on behavioral intention. Almost in the same context, [5] employed latent class analysis (LCA) and identified six consumer segments. They investigated factors influencing willingness to pay (WTP) during the COVID-19 pandemic.

### 2- Methodology

The present study investigates the intention of online shoppers to use delivery robots by using the diffusion of innovation theory (DOI).

According to DOI, five key factors affect the intention of individuals to use new technologies, including relative advantage, compatibility, complexity, observability, and trialability, which are defined as “the advantage of a new technology over the previous one,” “the consistency of the new technology with the requirements, lifestyles, and experience of individuals,” “the difficulty of learning and using the new technology,” “the observability of the benefits and outcomes of using the new technology,” and “the trialability of the new technology before use,” respectively [6]. Thus, five hypotheses are proposed.

- Relative advantage has a positive impact on the intention.
- Compatibility has a positive impact on the intention.
- Complexity has a negative impact on the intention.
- Observability has a positive impact on the intention.
- Trialability has a positive impact on the intention.

To test the hypotheses, an online questionnaire was designed to collect data from Iranian individuals that had made at least one online purchase. The questionnaire consisted of three sections. The first section introduced the questionnaire and briefly explained the advantages, applications, and

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functions of the delivery robots system. The second section involved the items of six constructs. The seven-point Likert scale from strongly disagree (1) to strongly agree (7) was used. Finally, the third section of the questionnaire collected the socio-demographic information (e.g., age, gender, income, and education) of the respondents.

The online questionnaire was implemented in Google Forms. Average time of 13 minutes was required to respond to the questionnaire. The questionnaire was disseminated through social networks (i.e., Twitter, Facebook, and Instagram), online messengers (i.e., Telegram and WhatsApp), and email lists (a few universities and private companies) for two months from 10 January 2020.

### 3- Results and Discussion

The structural equation model was employed to analyze the proposed model. It evaluates the relationships of latent variables with their observable indicators (known as the measurement model) and the relationships between the latent variables (known as the structural model) [7]. The structural equation model adopts two approaches, namely the covariance-based and variance-based approaches. The partial least square (PLS) method was selected as a variance-based approach to test the proposed hypotheses [8].

Reliability, convergent validity, and discriminant validity were evaluated to investigate the measurement model. The entire factor loadings were found to be larger than 0.5 and thus statistically significant [7]. Cronbach's alpha should be higher than 0.6 for reliability. It was obtained to be higher than 0.6 for the entire constructs. For convergent validity, the composite reliability (CR) value should be higher than 0.7 [8], and the average variance extracted (AVE) needs to be greater than 0.5 [9]. The entire constructs obtained permissible CR and AVE values.

Bootstrapping with 5000 subsamples was employed to test the proposed hypotheses. The modeling results indicated that H5 was statistically insignificant and rejected. In other words, except for trialability ( $\beta=0.04$ ,  $p=0.409>0.05$ ), the remaining variables were found to significantly impact the intention. This is inconsistent with [10,11]. 48.4% of the respondents were familiar with delivery robots. Since delivery robots are not yet available in Iran, these respondents obtained delivery robot familiarity through the internet. Thus, trialability might not be needed for changing and impacting the intention of these respondents to use delivery robots. As another possible explanation, there are few opportunities for consumers to test new technologies and services before using them in Iran. Most consumers use new technologies without any trials. Thus, they are not very familiar with the trialability of innovation before adoption.

The relative advantage was found as the most important variable affecting the intention ( $\beta=0.273$ ,  $p=0.000<0.001$ ). This is consistent with [4,11,12]. It was revealed that the advantage and superior characteristics of delivery robots over traditional delivery methods impacted the adoption of such robots by online shoppers and should be taken into account by online shopping programmers. Consistent with

previous studies, compatibility was expectedly found to have a significant impact on the intention [10, 11]. Individuals that consider delivery robots to more suit their lifestyles, requirements, and conditions have a better view of them and are more willing to use them. Complexity was found to have a relatively strong, negative impact on the intention [11, 12]. Individuals begin to negatively view delivery robots when they feel that it is confusing and complex to receive products by interacting with delivery robots or their application rather than delivery individuals.

The results demonstrated observability to have a positive, significant impact on the intention. The higher delivery robot familiarity of online shoppers through the internet and learning and observing their functions can change the attitude of online shoppers and make them more willing to use delivery robots. However, this relationship was not found to be significant in some studies [10].

### 4- Conclusions

This study investigated the factors influencing consumers' intention to use the delivery robot as a new idea to compete with traditional delivery methods. The authors used diffusion of innovation theory (DOI) to propose a delivery robot adoption model. The PLS-SEM was employed to test the proposed hypotheses. The results indicated that relative advantage, compatibility, complexity, and observability influenced consumers' intention to use delivery robot; however, no significant relationship was found between trialability and intention.

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