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Consumers' Attitude and Intention to Use the Internet of Things (IoT) in Courier Services in Bangladesh

Saiful Islam[1] & Ekramul Huda[2*]

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ABSTRACT

Purpose: This study explores the user intention to adopt and use IoT-enabled courier services in emerging economies, specifically Bangladesh.

Methodology: Using convenience sampling, data has been collected from 389 consumers through a structured survey questionnaire, and partial least squares structural equation modeling (PLS-SEM) has been used to assess the measurements and structural models of the study.

Findings: Among the five predictors, except for social influence, all four—performance expectancy, effort expectancy, facilitating conditions, and trialability—are found to significantly positively influence the users' intention to use IoT in courier services in Bangladesh. The findings also confirm a positive effect of users' behavioral intention to use IoT-enabled courier services on their actual use.

Practical implications: Theoretically, it broadens the existing understanding of technology adoption by blending the variables of UTAUT and IDT into a single framework. Empirically, this study investigates IoT adoption and users' intentions in an emerging economy, which was previously not explored. In terms of managerial implications, this study outlines the factors that influence users' intention to adopt IoT in courier services, which service providers should work on.

Originality/Value: This study is the first that explores the possibility and adoption of IoT in courier services in Bangladesh.

Research Limitation: This study is focused only on one emerging country, based on a small sample size and cross-sectional data, which limits the generalization in interpretations.

1. Introduction

Courier service specializes primarily as an outsourcing medium to transport consumer products or consignments (e.g., documents, packages, printed resources, shipping containers, postcards, and mail) from a particular location to another, ensuring the fastest possible delivery time (Mahamad et al., 2018; Yao et al., 2022). Firms, including courier services, are increasingly adopting advanced analytics and information technologies due to their ability to generate satisfactory results in complex and dynamic environments (Allioui & Mourdi, 2023). The implementation of advanced technologies, like the Internet

* Corresponding Author

1. Department of International Business, University of Dhaka, Dhaka-1000, Bangladesh, saifulib@du.ac.bd, Orcid 0000-0002-0180-4436
2. Department of International Business, University of Dhaka, Dhaka-1000, Bangladesh, ekram.ib@du.ac.bd

of Things (IoT), in the courier service enhances the efficacy and efficiency of firms significantly and improves the integrity, visibility, and deliverability of packages (Prapinit et al., 2024). Vailshery (2024) predicts that the global number of IoT devices will nearly double from 15.9 billion in 2023 to a staggering 32.1 billion in 2030. Additionally, by 2030, over 60% of companies are expected to adopt IoT technologies or transform their regular business activities into IoT-enabled digital operations (Iji & Gurung, 2023).

IoT in courier services becomes a game-changer for both suppliers and consumers in the courier services industry (Aydınocak, 2022; Prapinit et al., 2024). Generally, clients assess a courier service's effectiveness based on how soon their packages reach their intended location. Despite the benefits of IoT in courier services, firms and users worldwide have adopted this technology to varied degrees (Alhasan et al., 2022; Alhothali et al., 2024; Liu et al., 2022; Mital et al., 2018; Tu, 2018). Previous studies indicate that how much businesses adopt IoT in certain areas depends on several factors, including how useful they think IoT is for improving service, how easy they believe it is to use IoT systems, the impact of others' opinions on their decision to adopt IoT, their confidence in using IoT technology, and other important factors from various technology models (Kamal et al., 2020; Zhou et al., 2020).

However, studies have also contended that factors motivating users to adopt a technology, e.g., IoT, vary from country to country and depend on the attitudes and intentions of users. No earlier studies have been able to provide a consistent list of factors that apply to IoT adoption across different countries, particularly in emerging economies, which could adopt new technologies but have not been studied much before (Alhothali et al., 2024; Shi et al., 2022). Therefore, further investigation is worthwhile to determine the factors affecting IoT adoption in courier services in specific emerging countries, e.g., Bangladesh.

This study considers Bangladesh a representative of emerging economies due to its enormous potential in the logistics industry, which has yet to be exploited. The digitalization process patronized by the government to make the country an "Innovative Bangladesh" by 2041 UNDP (2021) intensified the adoption of different technologies of the 4th industrial revolution and opened a new avenue for IoT in different business domains, e.g., courier services (Hasan, 2023). Industry analysis revealed that the freight and logistics sector in Bangladesh was valued at $28.7 billion in 2023 and is anticipated to expand at a rate of over 6.5% annually untill 2028 (Rahman & Yadlapalli, 2024). In Bangladesh, the e-commerce and f-commerce sectors dominate the market for local logistics service providers, accounting for a significant 60% share (M. Hasan, 2021). Pathao, RedEx, Biddyut, Paperfly, and eCourier are the dominant players in the market, collectively holding 90% of the total market share (Saha & Chowdhury, 2020).

Unlike tech-based service providers, traditional courier services in Bangladesh are struggling to secure a significant share in the e-commerce and f-commerce markets. Therefore, prominent courier companies are transforming their business models and adding newer features in service offerings to uphold their reputation (Saha & Chowdhury, 2020). This scenario creates opportunity for IoT-enabled technology in courier services, which can improve customer satisfaction by offering services such as real-time monitoring, delivery route management, and package visibility. Previous studies suggest that users' intention to adopt IoT technology varies among nations. So, it would be worthwhile to assess users' intention to adopt and use IoT-enabled courier services in Bangladesh before companies actually implement the technology with substantial investment. However, to the best of the researchers' knowledge, there is no previous research that explored the possibility and adoption of IoT in courier services in Bangladesh. Therefore, this study aims to extend the existing literature on technology adoption by exploring users' intention to adopt IoT in courier services in Bangladesh and addresses the following specific research questions,

RQ1: What are the factors that affect the users' intention to adopt IoT-enabled courier services in Bangladesh?

RQ2: What is the relationship between the behavioral intention and actual use of IoT-enabled courier services in Bangladesh?

This study offers several theoretical, empirical, and managerial implications. Theoretically, this study broadens the existing understanding of technology adoption by blending the variables of the Unified Theory of Acceptance and Use of Technology (UTAUT) and Innovation Diffusion Theory (IDT) in a single framework. Empirically, this study investigates IoT adoption and users' intentions in an emerging economy, which was previously not explored. The findings would be useful in policymaking and planning in Bangladesh, as well as in other comparable emerging economies. Finally, in terms of managerial implications, this study outlines the factors that influence users' intention to adopt IoT in courier services, which service providers should acknowledge and incorporate into their service offerings. Moreover, as IoT applications are relatively new in emerging economies like Bangladesh, service providers, along with other stakeholders, should develop a holistic approach to creating a supportive environment for the IoT-enabled courier service industry.

The remainder of the paper is structured as follows: theoretical background and hypothesis development are presented in Section 2. Section 3 outlines the methodology, while Section 4 presents the main findings. Section 5 presents the relevant discussion, followed by the conclusion, major theoretical and practical implications, limitations of the study and scope of future research in Section 6.

2. Literature Review

2.1 Theoretical Background

Several theories have emerged in research on technology diffusion and adoption, i.e., Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), Diffusion of Innovations Theory (DOI), Technology Acceptance Model (TAM), Extended TAM (ETAM), Theory of Interpersonal Behavior (TIB), and Social Cognitive Theory (SCT). According to Arfi et al. (2021), the concept of intention in these theories clarifies why people embrace technology, while behavior indicates to what extent individuals use it (Chuong et al., 2024). However, given the criticisms that these earlier models faced, Venkatesh et al. (2003) proposed a new model named UTAUT after thoroughly studying eight previous models. The original UTAUT model includes four independent variables, two dependent variables, and four factors that can change the results to make predictions more accurate (Arfi et al., 2021; Venkatesh et al., 2003). Compared to earlier models, UTAUT showed better predictions and gave the clearest understanding of how users intend to behave and use an innovation (Chu et al., 2022; Shiferaw & Mehari, 2019).

Considering the widespread use of UTAUT in academic research, previous studies argued for the need to extend the original UTAUT model to gain a more profound understanding of users' behavioral intentions in different settings (Mashat et al., 2024). A possible extension of UTAUT can be the blending of other technology adoption frameworks. Therefore, this study extends the original UTAUT model by integrating both overlapping and independent constructs from the IDT model. Among the non-overlapping IDT constructs, trialability is included as it has the potential to help alleviate the concerns and skepticism of courier service providers by offering them free trials (Yuen et al., 2018). The blending of different variables for UTAUT and IDT in a single framework is expected to broaden the existing understanding of a specific technology, i.e., IoT adoption in a specific industry, i.e., courier service.

With the adoption of technological innovations like blockchain, big data analytics, and IoT, the courier service industry has undergone a significant change globally (Mashat et al., 2024). However, research on this area remains scant. Previous studies on IoT adoption are concentrated on higher-income nations, i.e., Singapore, France, Saudi Arabia, the USA, and China, including some of the Asian and Middle Eastern nations, keeping lower-income and emerging nations less explored (Ardito et al., 2019). Additionally, most of this research considered various contexts such as healthcare (Kamal et al., 2020;

Liu et al., 2022; Talukder et al., 2020), e-commerce (Yuen et al., 2018; Zhou et al., 2020), food and restaurants (Jeon et al., 2020; Pitchay et al., 2022), logistics (Alhothali et al., 2024; Chuong et al., 2024; Tu, 2018), education (Alhammadi et al., 2023; Andrews et al., 2021), and agriculture (Ronaghi & Forouharfar, 2020).

Even though IoT has a much wider application in logistics and supply chains, there is still a lack of focus on it in courier services, especially in emerging economies like Bangladesh. To the best of researchers' knowledge, Shi et al. (2022) conducted the only study in the Bangladeshi context, exploring the willingness to pay for and adopt IoT technology in the agricultural industry. However, given the contextual disparity, the study's findings may not be entirely applicable in explaining the intention of Bangladeshi users to adopt IoT technology in courier services. In addition, Shi et al. (2022) focused solely on a particular demographic, e.g., Bangladeshi farmers, which failed to capture the diverse demographic groups of the courier service industry. As a result, this study seeks to fill this existing void by specifically investigating factors that influence Bangladeshi users' intentions to adopt and use IoT in courier services.

2.2 Hypothesis Development

2.2.1 Performance Expectancy and Intention to Adopt

Performance expectancy (PE) is based on the notion that implementing a system will improve one's ability to execute their job and the perceived utility of doing so (Andrews et al., 2021; Venkatesh et al., 2003). In courier services, PE refers to the extent to which an individual believes that using IoT-enabled technology, such as IoT-enabled GPS trackers, optimized delivery routes, and automated notifications, will improve the operational efficiency and overall effectiveness of the service. Several previous studies have indicated that PE is the strongest indicator of technological adoption in different contexts such as logistics (Alhothali et al., 2024); tourism (Ali et al., 2024); the elevator industry (Chu et al., 2022); and agriculture (Shi et al., 2022). A positive correlation between the level of practicality of technologies and how enthusiastic individuals are about using them are also evident (Alhothali et al., 2024). Consequently, it can be anticipated that an increase in the PE of IoT will result in a corresponding increase in customers' inclination to pay for it. Therefore, it is hypothesized that

H_1: *Performance expectancy has a positive impact on the adoption of IoT in courier service.*

2.2.2 Effort Expectancy and Intention to Adopt

Effort expectancy (EE) is used to assess user adoption of new technology by quantifying the mental and physical efforts of individuals in mastering it. The EE is also synonymous with perceived ease of use (Andrews et al., 2021; Pitchay et al., 2022; Venkatesh et al., 2003). When it comes to IoT in courier services, if users find IoT-enabled features easier to use and require less effort, they will be more likely to choose the feature in their courier needs over traditional methods. Previous studies also demonstrated that attitudes toward EE have had varying effects on the adoption of IoT in different contexts, i.e., smart home (Aldossari & Sidorova, 2020), e-health (Arfi et al., 2021), intelligent elevator (Chu et al., 2022), and smart farming (Ronaghi & Forouharfar, 2020). This study uses EE as a predictor to investigate the positive correlations it has with users' behavioral patterns in relation to their adoption of IoT in courier services. Therefore, it is hypothesized that

H_2: *Effort expectancy has a positive impact on the adoption of IoT in courier service.*

2.2.3 Facilitating Conditions and Intention to Adopt

In courier services, consumers believe that the existence of favorable facilitating conditions (FC), such as stable internet access, adequate training, and suitable gear and software, will improve their experience of using the service (Chuong et al., 2024; Gunasinghe et al., 2019; Shiferaw & Mehari, 2019). Individuals who possess a higher level of expertise and reside in well-equipped surroundings tend to be

more open to embracing new technologies in their everyday routines (Alhothali et al., 2024). Therefore, a positive relationship exists between FC and consumers' intention to adopt IoT technology (Arfi et al., 2021; Chuong et al., 2024; Ronaghi & Forouharfar, 2020; Shi et al., 2022). This study seeks to determine whether there is a correlation between FC and consumers' intention to adopt IoT in courier services. Therefore, it is hypothesized that

H_3: *Facilitating conditions has a positive impact on the adoption of IoT in courier service.*

2.2.4 Social Influence and Intention to Adopt

Social influence (SI) pertains to the extent to which an individual regards the opinions of others. i.e., family, friends, peers, and supervisors, as crucial in shaping their behavior toward adopting the new system. In courier service, an individual's intention to behave in a certain way will be positively influenced by social factors if they believe that utilizing an IoT-enabled courier service will improve their sense of belonging, especially if their superiors also use it. Several previous studies have also found a direct positive relationship between SI and users' inclination to adopt technology in different service settings, including drone food delivery (Jasim et al., 2022), telemedicine (Kamal et al., 2020), and online food delivery (Pitchay et al., 2022). Therefore, it can be expected that if peers highly value the use of IoT technologies, potential users will be more inclined to adopt them. So, it was hypothesized that

H_4: *Social influence has a positive impact on the adoption of IoT in courier service.*

2.2.5 Trialability and Intention to Adopt

Trialability is a measure of how readily an innovation can be experimented with or tested on a temporary basis (Giglio & Maio, 2022). Several studies have verified that trialability does have a significant positive effect on the intention to use the technology (Alhammadi et al., 2023; Neto & Vieira, 2023; Sitorus & Alexandra, 2020). According to Yuen et al. (2018), a higher level of trialability reduces the hesitation and skepticism individuals may feel when considering whether to adopt an innovation, as they have the opportunity to learn by trying it out. Trialability in this study pertains to the degree to which consumers are provided with unrestricted access and a secure setting to experiment with the newly introduced courier service. This study predicts that consumers who believe that IoT-enabled courier services are simple to test will regard their use of such services with less uncertainty, resulting in higher adoption intentions.

H_5: *Triability has a positive impact on the adoption of IoT in courier service.*

2.2.6 Intention to Adopt and Actual Use

Behavioral intention is regarded as the initial indicator of adoption and often serves as a determinant of usage behavior shortly thereafter (Ali et al., 2024; Gunasinghe & Nanayakkara, 2021). The term "intention to adopt" in this study refers to individuals' willingness and deliberate attempts to integrate IoT-enabled technologies into their routine to track delivery updates, with the expectation of improving their overall courier experience. Conversely, actual use behavior characterizes the frequency and intensity of an IoT-enabled technology's use. Many studies on technology adoption has examined multiple facets of behavioral intention, including the intention to adopt (Andrews et al., 2021; Balapour et al., 2019; Chen et al., 2020; Chuong et al., 2024; Liu et al., 2022; Shi et al., 2022), the intention to continue to use (Gu et al., 2019; Koohang et al., 2022; Marandu et al., 2023), and the intention to recommend (Kaur et al., 2020; Octavius & Antonio, 2021). Previous studies have shown a strong link between what people intend to do and how they use technology in different situations (Alhammadi et al., 2023; Ali et al., 2024; Jasim et al., 2022; Jeon et al., 2020; Ronaghi & Forouharfar, 2020; Shiferaw & Mehari, 2019). Therefore, this study hypothesized that

H_6: *Intention to adopt IoT in courier services positively influences consumers' actual use.*

Based on the relationships among variables discussed above, Figure 1 presents the conceptual framework of this study.

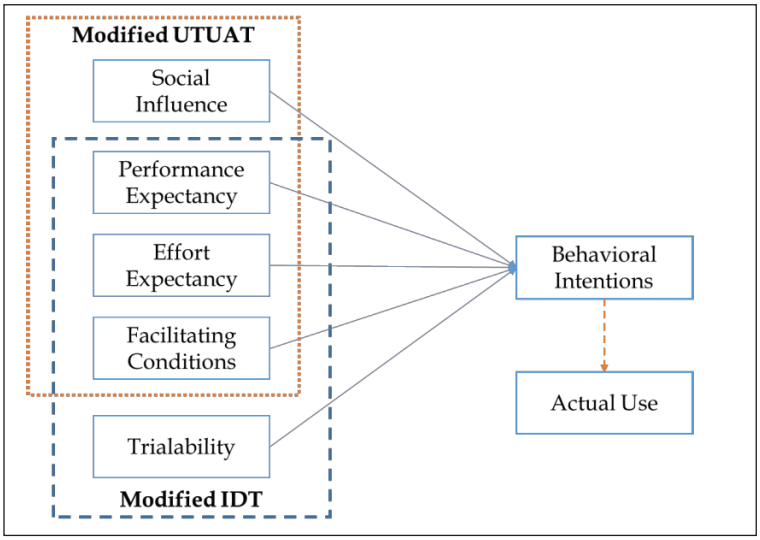

Figure 1. *Conceptual framework of the study*

3. Methodology

3.1 Research Approach

Aligned with the principles of positivism, this research explored the hypothesized relationships using a deductive reasoning approach. According to Saunders et al. (2009), the deductive method is well-suited for examining theoretical constructs within the framework of positivist philosophy. This study employed a quantitative research methodology to evaluate theoretical propositions by analyzing the interplay between selected variables through rigorous statistical techniques (Islam & Khayer, 2018). Additionally, confirmatory analytical methods were utilized to validate the study's theoretical framework, specifically, a Confirmatory Factor Analysis (CFA) was employed to confirm the factor structure of observed variables (Prudon, 2015). CFA rigorously evaluates predefined models rooted in theoretical insights or prior empirical evidence (Harrington, 2008), which enables researchers to confirm the reliability of measurement models by assessing the interactions between latent constructs and their corresponding indicators (Brown, 2006).

3.2 Population and Sample

Determining the exact number of individuals who have utilized IoT-enabled courier services is challenging, rendering the population size unknown. As a result, this research opted for a sampling approach rather than attempting to encompass the entire population. When population parameters are undefined, non-probability sampling methods are crucial and enable researchers to select participants based on specific criteria, ensuring the sample aligns with the target population's characteristics (Singh & Masuku, 2014). Specifically, this study employed a convenience sampling method, which is widely used in social sciences to collect data efficiently without requiring intricate sampling frames or randomized procedures (Etikan et al., 2016).

The survey questionnaire was initially distributed to 450 potential participants who had utilized IoT-enabled courier services at least once within the past year. After excluding incomplete data and conducting a normality test, the final sample size was confirmed as 389 responses, yielding an effective

response rate of 86.4%. Hoe (2008) suggests that for multivariate research, a sample size exceeding 200 is generally sufficient for robust data analysis, while Bougie and Sekaran (2019) recommend that sample size should be ten times or more than the number of variables in the study. According to these guidelines, the minimum required sample size for this study would be 60. Thus, the final sample size of 389 clearly satisfies these criteria, affirming its adequacy for the research.

3.3 Measures

This study adopts a structured questionnaire for evaluating the relationships among the observed and latent variables. Data are collected on specified latent constructs and their associated indicators. Each construct was measured using well-established and validated scales summarized in Table 1. Each item was rated using a five-point Likert scale, where 5 represented "strongly agree" and 1 represented "strongly disagree." This consistent Likert-scale approach ensured uniformity in evaluating responses across all constructs.

3.4 Data Analysis

The collected data were analyzed using SPSS (Statistical Package for Social Sciences) and Smart PLS version 4.0.8.9. Structural Equation Modeling (SEM) is performed utilizing the Partial Least Squares (PLS) approach, which has gained prominence as a widely recognized methodology in the field of business management (Garcés-Ayerbe et al., 2012). PLS-SEM is particularly advantageous for analyzing complex relationships among variables and is effective even with smaller sample sizes. The PLS-SEM analysis process involves two key stages. The first stage is the evaluation of the measurement model, where the reliability of indicators and the validity of the model are assessed. The second stage is the structural model assessment, which entails testing the proposed hypotheses, examining the coefficient of determination (R^2), evaluating predictive relevance (Q^2), analyzing effect size (f^2), and assessing other measures of model fit to determine its overall suitability.

4. Results

4.1 Measurement Model Evaluation

The measurement model was evaluated to ensure the reliability and validity of the constructs. Construct reliability was assessed using Cronbach's Alpha and composite reliability, following (Chin's 2009) recommendations. These metrics demonstrated that the constructs were sufficiently reliable, as most exceeded the acceptable threshold. Validity was also examined through four key indicators: convergent validity was assessed using average variance extracted (AVE), while discriminant validity was evaluated through the Fornell & Larcker criterion, the HTMT ratio, and cross-loadings.

Following the guidelines of Hair et al. (2019), the factor loadings of individual indicators were reviewed to ensure that they exceeded the recommended threshold of 0.708, implying that more than 50% of the variance in the indicators is explained by the constructs. As shown in Table 2, most items in the study meet or exceed this threshold, indicating strong correlations with their respective constructs.

For example, items for PE (e.g., PE2: 0.835, PE3: 0.813) and EE (e.g., EE3: 0.868, EE4: 0.823) exhibited high loadings, confirming their reliability. Similarly, SI (SI3: 0.917) and Usage Behavior (UB2: 0.891) demonstrated robust factor loadings, reinforcing the constructs' robustness. Some items, e.g., FC (FC4: 0.579) and Trialability (TR1: 0.672), fell below ideal threshold of 0.708 but were still deemed acceptable due to the overall validity of the construct, as supported by the AVE score. The high factor loadings confirm that the items consistently measure the intended constructs, contributing to the strength of the measurement model.

Table 1. *Measures used in the Study*

Constructs		Items	Reference
Performance Expectancy	PE1	I would find order tracking useful in my order and getting parcels.	Venkatesh et al. (2003)
	PE2	Using order tracking allows me to complete tasks more quickly.	
	PE3	Using order tracking, I can complete my order in a better way.	
	PE4	If I use order tracking, my life would be more convenient.	
Effort Expectancy	EE1	My interaction with the order tracking system is clear and understandable.	Venkatesh et al. (2003)
	EE2	It would be easy for me to become skilful at using order tracking.	
	EE3	I would find the order tracking services easy to use.	
	EE4	Learning to use order tracking services is easy for me.	
Social Influence	SI1	People who influence my behavior think that I should use order tracking.	Venkatesh et al. (2003)
	SI2	People who are important to me think that I should use order tracking.	
	SI3	Most people surrounding me have been helpful in the use of order tracking.	
	SI4	The society in which I live has support for the use of th order tracking services.	
Facilitating Condition	FC1	I have the resources (smartphone, internet) necessary to use the order tracking.	Venkatesh et al. (2003)
	FC2	I have the knowledge to use the order tracking services.	
	FC3	Order tracking service is not compatible with the other services I use.	
	FC4	Help from other people is available if I have problems using an Order tracking.	
Trialability	TR1	I would be able to use order tracking on a trial basis.	Karahanna et al. (1999)
	TR2	I would be able to try out order tracking properly.	
	TR3	I would be permitted to use an order tracking system long enough to see what it can do.	
Behavioral Intention	BV1	I intend to continue using the order tracking system in the future.	Venkatesh et al. (2012)
	BV2	I will always try to use the order tracking system in my daily life.	
	BV3	I plan to continue to use the order tracking system frequently.	
Use Behavior	UB1	I have been using the order tracking system for last few weeks	Venkatesh et al. (2012)
	UB2	I am using the order tracking system regularly now.	
	UB3	I depend on the order tracking system.	

Source: Authors' development based on previous literature

Table 2. *Factor Loadings of Latent Variables*

Construct	Items	Statements	Loadings
Performance Expectancy	PE1	I would find order tracking useful in getting parcels.	0.763
	PE2	Using order tracking allows me to complete tasks more efficiently and effectively.	0.835
	PE3	Using order tracking, I can complete my order in a better way.	0.813
	PE4	Order tracking makes my life more convenient.	0.765
Effort Expectancy	EE1	I Clearly Understand the order tracking system.	0.762
	EE2	It would be easy for me to become skilful at using order tracking.	0.652
	EE3	I would find the order tracking system easy to use.	0.868
	EE4	Learning to use the order tracking system is easy for me.	0.823
Social Influence	SI2	People who are important to me think that I should use order tracking.	0.740
	SI3	Most people surrounding me have been helpful in the use of order tracking.	0.917

Facilitating	FC2	I have the knowledge to use the order tracking services.	0.749
	FC3	Order tracking service is compatible with the other services I use.	0.768
	FC4	Help from other people is available if I have problems using an Order tracking.	0.579
Trialability	TR1	I would be able to use order tracking on a trial basis.	0.672
	TR2	I would be able to try out order tracking properly.	0.866
	TR3	I would be permitted to use an order tracking system long enough to see what it can do.	0.811
Behavioral Intention	BVI1	I intend to continue using the order tracking system in the future.	0.752
	BVI2	I will use the order tracking system consistently.	0.837
	BVI3	I plan to use the order tracking system in the coming months.	0.762
Usage Behavior	UB1	I have been using the order tracking system for several weeks.	0.835
	UB2	I use the order tracking system to monitor all my deliveries regularly.	0.891
	UB3	I depend on the order tracking system.	0.704

Source: Primary Data, 2024

4.1.1 Reliability Analysis

Table 3. *Alpha value and CR of Vonstructs*

Construct	α	CR
PE	0.805	0.872
EE	0.783	0.861
SI	0.782	0.818
FC	0.792	0.744
TR	0.696	0.829
BVI	0.698	0.827
UB	0.747	0.853

Note: PE = Performance Expectancy; EE = Effort Expectancy; SI = Social Influence; FE = Facilitating Conditions; TR = Trialability; BVI = Behavioral Intention; UB = Usage Behavior
Source: Primary Data, 2024

Reliability analysis is a critical step in evaluating the consistency and dependability of constructs in research. This study assesses reliability using Cronbach's alpha (α) and composite reliability (CR), with thresholds of 0.70 or higher considered acceptable for both metrics (Hair et al., 2017; Hair et al., 2014) The results indicate that most constructs in the model demonstrate adequate reliability, with both α and CR values meeting or exceeding the recommended benchmarks. Table 3 also reveals PE and EE demonstrate strong internal consistency with $\alpha > 0.78$ and $CR > 0.86$, reflecting robust reliability. Additionally, SI, FC, Trialability (TR), Behavioral Intention (BVI), and Usage Behavior (UB) exhibit reliability within acceptable ranges. While some constructs have marginally lower Cronbach's alpha (e.g., TR: 0.696, BVI: 0.698), their composite reliability scores exceed the threshold of 0.70, indicating satisfactory construct reliability.

4.1.2 Convergent Validity Analysis

Convergent validity ensures that the items within a construct effectively measure the intended concept. This is commonly assessed using Average Variance Extracted (AVE) and outer loadings. An AVE value of 0.50 or higher is considered acceptable, as it indicates that at least 50% of the variance in the indicators is explained by the construct (Fornell & Larcker, 1981). Furthermore, individual outer

loadings should ideally exceed 0.50, provided the construct's AVE meets or exceeds the minimum threshold (Hair et al., 2017).

As illustrated in Table 4, the AVE values for all constructs in this study range from 0.595 to 0.695, indicating strong convergent validity. Each construct meets or surpasses the threshold of 0.50, supporting the robustness of the measurement model and affirming that the indicators are reliable measures of their respective constructs (Fornell & Larcker, 1981; Hair et al., 2017).

Table 4. *AVE value of Constructs*

Construct	AVE
PE	0.631
EE	0.609
SI	0.695
FC	0.595
TR	0.620
BVI	0.616
UB	0.662

Note: PE = Performance Expectancy; EE = Effort Expectancy; SI = Social Influence; FE = Facilitating Conditions; TR = Trialability; BVI = Behavioral Intention; UB = Usage Behavior
Source: Primary Data, 2024

The Table 4 also reveals that all constructs exceed the minimum 0.50 threshold, indicating that over half of the variance in their indicators is explained by the constructs. SI has the highest AVE value (0.695), indicating strong convergent validity, while constructs like PE and UB also demonstrate robust reliability with AVE values of 0.631 and 0.662, respectively. Additionally, while the AVE for FC is slightly lower (0.595), it still comfortably exceeds the minimum requirement, ensuring the construct's validity.

4.1.3 Discriminant Validity Analysis

Discriminant validity ensures that a construct is truly distinct from other constructs within the model. Three methods are commonly used to evaluate discriminant validity: the Fornell & Larcker criterion, the Heterotrait-Monotrait (HTMT) ratio, and cross-loadings of indicators. According to the Fornell and Larcker (1981) criterion, the square root of each construct's AVE should be higher than its correlation with any other construct in the model. As depicted in Table 5, the diagonal values, which represent the square roots of each construct's AVE, are higher than the off-diagonal correlation values with other constructs, fulfilling the Fornell and Larcker criterion and confirming discriminant validity.

Table 5. *Discriminant Validity of Latent Constructs through Fornell and Larcker*

	PE	EE	SI	FC	TR	BVI	UB
PE	**0.794**						
EE	0.502	**0.781**					
SI	0.277	0.231	**0.833**				
FC	0.466	0.549	0.284	**0.704**			
TR	0.356	0.388	0.189	0.356	**0.787**		
BVI	0.408	0.441	0.207	0.414	0.39	**0.785**	
UB	0.171	0.217	0.152	0.116	0.113	0.431	**0.814**

Note: PE = Performance Expectancy; EE = Effort Expectancy; SI = Social Influence; FE = Facilitating Conditions; TR = Trialability; BVI = Behavioral Intention; UB = Usage Behavior
Source: Primary Data, 2024

Additionally, the HTMT ratio provides another measure of discriminant validity by comparing the average correlations between constructs. According to Henseler et al. (2015), a HTMT value below 0.90 is indicative of adequate discriminant validity, suggesting that the constructs are sufficiently distinct from one another. As shown in Table 6, all HTMT values are well below the threshold of 0.90. For example, the highest HTMT value of 0.839 between FC and EE is still under the cut-off, further confirming that the constructs in the model are sufficiently distinct.

Table 6. *Discriminant Validity of Latent Constructs through HTMT Criterion*

	PE	EE	SI	FC	TR	BVI	UB
PE							
EE	**0.638**						
SI	0.397	**0.333**					
FC	0.714	0.839	**0.540**				
TR	0.465	0.532	0.272	**0.555**			
BVI	0.533	0.591	0.300	0.685	**0.534**		
UB	0.222	0.266	0.232	0.195	0.165	**0.589**	

Note: PE = Performance Expectancy; EE = Effort Expectancy; SI = Social Influence; FE = Facilitating Conditions; TR = Trialability; BVI = Behavioral Intention; UB = Usage Behavior
Source: Primary Data, 2024

Finally, cross-loadings are another key method to examine discriminant validity by comparing the outer loadings of the indicators on each construct. For discriminant validity to be confirmed, each indicator should load higher on its assigned construct than on any other construct. As shown in Table 7, the indicators load most strongly on their respective constructs. This pattern demonstrates that the indicators are well-associated with their intended constructs and not with other constructs, providing further support for discriminant validity in the model.

4.2 Structural Model Evaluation

The evaluation of the structural model is a critical step in determining the strength and significance of the relationships between constructs. Several key criteria are used to assess the model, including collinearity testing, predictive relevance, the explanation of variance (R^2), path coefficients (β), and statistical significance (p-values). These indicators collectively provide a comprehensive understanding of the model's reliability and predictive power.

Table 7. *Discriminant Validity through Cross Loadings*

	PE	EE	SI	FC	TR	BVI	UB
PE1	**0.763**	0.419	0.179	0.316	0.268	0.315	0.033
PE2	**0.835**	0.437	0.197	0.462	0.307	0.336	0.113
PE3	**0.813**	0.386	0.262	0.372	0.285	0.340	0.176
EE1	0.338	**0.762**	0.128	0.389	0.325	0.315	0.108
EE2	0.414	**0.652**	0.148	0.356	0.294	0.273	0.185
EE3	0.426	**0.868**	0.218	0.509	0.318	0.378	0.193
EE4	0.400	**0.823**	0.213	0.444	0.286	0.393	0.190
SI2	0.200	0.172	**0.740**	0.184	0.105	0.123	0.136
SI3	0.257	0.211	**0.917**	0.276	0.195	0.207	0.126

FC2	0.443	0.543	0.153	**0.749**	0.327	0.328	0.061
FC3	0.308	0.367	0.209	**0.768**	0.306	0.314	0.107
FC4	0.202	0.196	0.268	**0.579**	0.067	0.217	0.080
TR1	0.216	0.285	0.107	0.172	**0.672**	0.211	0.113
TR2	0.359	0.360	0.167	0.334	**0.866**	0.360	0.126
TR3	0.248	0.273	0.164	0.304	**0.811**	0.326	0.037
BVI1	0.467	0.442	0.162	0.463	0.485	**0.752**	0.162
BVI2	0.287	0.281	0.240	0.290	0.224	**0.837**	0.468
BVI3	0.181	0.307	0.068	0.198	0.188	**0.762**	0.396
UB1	0.151	0.203	0.086	0.122	0.073	0.371	**0.835**
UB2	0.144	0.222	0.175	0.137	0.106	0.412	**0.891**
UB3	0.124	0.070	0.103	-0.015	0.102	0.240	**0.704**

Note: PE = Performance Expectancy; EE = Effort Expectancy; SI = Social Influence; FE = Facilitating Conditions; TR = Trialability; BVI = Behavioral Intention; UB = Usage Behavior
Source: Primary Data, 2024

4.2.1 Collinearity Testing

Collinearity testing is conducted to ensure that there is no high correlation between predictor constructs, which could inflate the standard errors and compromise the reliability of the path coefficients. To evaluate collinearity, researchers use the Variance Inflation Factor (VIF), which measures how much the variance of an estimated regression coefficient increases due to collinearity. A high VIF value indicates potential collinearity issues, while a low VIF suggests the absence of multicollinearity. According to Hair et al. (2011), a VIF value less than 5 is generally considered acceptable, and values below 10 suggest that multicollinearity does not pose a significant concern. Similarly, Kock and Lynn (2012) further affirms that VIF values below 5 are indicative of a model free from collinearity bias. In this study, all VIF values are well below the threshold of 5, with the highest VIF value being 2.083. Table 8 confirms that the model of this study is not affected by collinearity, and there is no indication of multicollinearity among the predictor constructs.

4.2.2 Predictive Power and Relevance

The predictive power of the structural model is evaluated using two key metrics: R^2 (coefficient of determination) and Q^2 (predictive relevance). R^2 measures the proportion of variance in the dependent variable explained by the independent variables, while Q^2 assesses the model's predictive relevance for each construct. In Table 9, the Q^2 values indicate the predictive relevance of the constructs. The Q^2 values for PE, EE, SI, FC, and TR are all 0.000, suggesting that the model does not have predictive relevance for these constructs. However, for the constructs BVI and UB, the Q^2 values are greater than 0, indicating that the model has predictive relevance for these constructs. Specifically, BVI has a Q^2 of 0.163, and UB has a Q^2 of 0.115, suggesting that these constructs can be predicted with some relevance based on the independent variables.

Table 8. *Collinearity Testing Using VIF Score*

Items	Inner VIF
PE1	1.529
PE2	1.859
PE3	1.701
PE4	1.552
EE1	1.544
EE2	1.300
EE3	2.083
EE4	1.741
SI2	1.203
SI3	1.203
FC2	1.110
FC3	1.160
FC4	1.084
TR1	1.275
TR2	1.533
TR3	1.388
BVI1	1.212
BVI2	1.566
BVI3	1.459
UB1	1.550
UB2	1.797
UB3	1.381

Note: PE = Performance Expectancy; EE = Effort Expectancy; SI = Social Influence; FE = Facilitating Conditions; TR = Trialability; BVI = Behavioral Intention; UB = Usage Behavior
Source: Primary Data, 2024

Table 9. *Model predictive power & Predictive Relevance*

Items	Q^2predict	R^2
PE	0.000	
EE	0.000	
SI	0.000	
FC	0.000	
TR	0.000	
BVI	0.163	0.292
UB	0.115	0.186

Note: PE = Performance Expectancy; EE = Effort Expectancy; SI = Social Influence; FE = Facilitating Conditions; TR = Trialability; BVI = Behavioral Intention; UB = Usage Behavior
Source: Primary Data, 2024

The R^2 values presented in the Table 9 also show the proportion of variance explained by the model. The R^2 values for BVI (0.292) and UB (0.186) indicate a moderate explanation of variance, further supporting the predictive relevance of these constructs. However, the low R^2 values for PE, EE, SI, FC, and TR (all 0.000) indicate limited explanatory power for these constructs. Overall, the results suggest that while the model has some predictive relevance for certain constructs like BVI and UB, its overall predictive power remains limited, particularly for PE, EE, SI, FC, and TR.

4.2.3 Effect Size (f^2)

Table 10 presents the effect sizes (f^2) for the relationships between the exogenous constructs and their corresponding endogenous constructs. The effect size (f^2) is an important measure that indicates the strength of the effect of a predictor variable on a dependent variable. Values of f^2 are categorized as small ($f^2 = 0.02$), medium ($f^2 = 0.15$), and large ($f^2 = 0.35$). The results in Table 10 show that most of the effect sizes for the relationships between the exogenous variables (PE, EE, SI, FC, TR) and BVI (are small, with values ranging from 0.003 to 0.043. This indicates a relatively weak effect of these predictors on behavioral intentions. The relationship between BVI and UB shows a larger effect size of 0.228, suggesting a medium-sized effect of BVI on UB. In summary, while the exogenous constructs (PE, EE, SI, FC, and TR) exhibit weak effects on BVI, the impact of BVI on UB is moderate, demonstrating that BVI has a significant influence on the outcome variable (UB).

Table 10. *Values*

Path Relationship	f-square
PE--> BVI	0.026
EE --> BVI	0.034
SI --> BVI	0.003
FC --> BVI	0.012
TR--> BVI	0.043
BVI--> UB	0.228

Note: PE = Performance Expectancy; EE = Effort Expectancy; SI = Social Influence; FE = Facilitating Conditions; TR = Trialability; BVI = Behavioral Intention; UB = Usage Behavior
Source: Primary Data, 2024

4.3 Test of Hypothesis

Table 11 summarizes the results of the hypothesis testing for the structural model. The analysis shows that five out of six hypotheses are supported, as their respective p-values are below the significance level of 0.05, and the confidence intervals do not include zero.

Table 11. *Test of Hypotheses*

Hypothesis	Path Relations	B	Std. Dev	T Values	P values	2.50%	97.50%	Decision
H1	PE -> BVI	0.159	0.060	2.634	0.008	0.044	0.279	Supported
H2	EE -> BVI	0.191	0.061	3.12	0.002	0.071	0.312	Supported
H3	SI -> BVI	0.037	0.048	0.776	0.438	-0.062	0.127	Not Supported
H4	FC -> BVI	0.154	0.060	2.579	0.010	0.029	0.263	Supported
H5	TR -> BVI	0.197	0.059	3.338	0.001	0.076	0.311	Supported
H6	BVI -> UB	0.431	0.048	8.997	0.000	0.324	0.515	Supported

Note: PE = Performance Expectancy; EE = Effort Expectancy; SI = Social Influence; FE = Facilitating Conditions; TR = Trialability; BVI = Behavioral Intention; UB = Usage Behavior
Source: Primary Data, 2024

In hypothesis 1, PE has a positive and significant effect on BVI, with a path coefficient of 0.159 ($p = 0.008$), indicating that PE significantly contributes to shaping users' behavioral intentions. In hypothesis 2, EE also positively influences BVI, with a path coefficient of 0.191 ($p = 0.002$). The strong t-value of 3.12 further supports the significance of this relationship. Then, in hypothesis 3, SI does not have a significant effect on BVI, as indicated by the path coefficient of 0.037 ($p = 0.438$) and a t-value of 0.776. The confidence interval (0.062, 0.127) includes zero, further confirming the lack of support for this hypothesis. In hypothesis 4, FC significantly impacts BVI, with a path coefficient of 0.154 ($p = 0.010$). This demonstrates that FC plays a meaningful role in influencing users' intentions. In hypothesis 5, TR has a significant and positive effect on BVI, with a path coefficient of 0.197 ($p = 0.001$), which highlights the importance of trust in driving behavioral intentions. Finally, in hypothesis 6, BVI strongly predicts UB, with a path coefficient of 0.431 ($p < 0.001$). This relationship has the highest t-value (8.997), indicating a robust and significant impact.

5. Discussion

This study explores the factors affecting the users' intention to adopt and actual usage of IoT in courier services in Bangladesh, combining the modified version of UTAUT and IDT models. Both UTAUT and IDT models share three common constructs: performance expectancy, effort expectancy, and facilitating conditions. Social influence is considered exclusively from the UTAUT model, whereas trialability is exclusively from IDT. These five constructs are hypothesized in this study to predict the users' intention to use IoT in courier services in Bangladesh, which subsequently predicts the users' actual use of IoT in courier services. The proposed model of the study explains 29.20% of the variance in the users' intentions to use IoT, whereas 18.60% is in the actual use of IoT in the courier services.

Among the five predictors of intention to use IoT in courier services in Bangladesh, all the predictors are found to significantly positively influence the users' intention except one—social influence. While several previous studies predicted that social influence would have a significant positive influence on the users' intention to use a new technology (Jasim et al., 2022; Kamal et al., 2020; Pitchay et al., 2022), this study found no significant relationship. In previous research, it was predicted that users would have a positive attitude toward a new technology like IoT if they believed that utilizing it would improve their sense of belonging, especially if other members of society, peers, friends, and colleagues also used it. As IoT-enabled courier services are only emerging now, and only a few people are familiar with the benefits of this technology, social influence has no significant impact on the users' intention to use it. It can also be assumed that if IoT-enabled courier services get recognition and acceptance among the majority in society, users' intention to use the technology would be increased substantially.

Among the other constructs that significantly influence the users' intention to use IoT-enabled courier services, trialability stands out as the best predictor. Similar to previous studies, this study also found a significant positive influence of trialability on users' intention to use IoT-enabled courier services (Alhammadi et al., 2023; Neto & Vieira, 2023; Sitorus & Alexandra, 2020). By offering free trials, customers can explore and experience IoT-enabled courier services before making a purchase, allowing them to explore and test the latest products before regular use. The second-best predictor is the effort expectancy, which is found to significantly positively influence the intention to use IoT-enabled courier services, like several previous studies (Aldossari & Sidorova, 2020; Arfi et al., 2021; Chu et al., 2022; Ronaghi & Forouharfar, 2020). The findings verify that, as IoT-enabled courier services are easier and require less time and energy, users are willing to accept them over traditional courier services.

Also, like in several earlier studies (Alhothali et al., 2024; Ali et al., 2024; Chu et al., 2022; Jawad et al., 2023; Shi et al., 2022), it was found that how much users believe IoT-enabled courier services will improve their experience significantly affects their intention to use these services in Bangladesh. Performance expectancy is the degree to which a person thinks that utilizing IoT-enabled

technology—such as GPS trackers, optimized delivery routes, and automated notifications—will increase the service's overall efficacy and operational efficiency. Similarly, facilitation conditions also found significantly positively influence users' intention to use IoT enabled courier services in Bangladesh (Arfi et al., 2021; Chuong et al., 2024; Ronaghi & Forouharfar, 2020; Shi et al., 2022). Users think that having favorable enabling factors, including reliable internet connectivity, sufficient training, and appropriate hardware and software, will enhance their IoT-enabled courier service experience over traditional services.

Finally, this study finds a positive effect of users' intentions toward using IoT-enabled courier services on their actual usage in Bangladesh. This finding matches well with previous studies on technology adoption across diverse contexts, including smart learning (Alhammadi et al., 2023; Ali et al., 2024; Jasim et al., 2022; Jeon et al., 2020; Ronaghi & Forouharfar, 2020; Shiferaw & Mehari, 2019). Therefore, consumers anticipate an enhancement of their overall courier experience by integrating IoT-enabled devices into their daily activities to monitor delivery updates. Consequently, they will begin to use this technology on a regular basis.

6. Conclusion, Implications and Scope of Future Research

The IoT has significantly transformed businesses, particularly courier service companies, by enhancing the integrity, visibility, and deliverability of packages. Courier service companies benefitted from cost-cutting, operational efficiency, standardized processes, quality assurance, and sustainability, as well as constant improvement and reduction of costs. While studies on adopting IoT-enabled courier services are burgeoning in developed and developing countries, they remain scant in emerging economies. To the best of the researchers' knowledge, Bangladesh has not been the subject of any such previous studies. This study fills this gap in literature by combining the modified UTAUT and IDT models. The study hypothesizes that these constructs predict users' intention to use IoT in courier services and their actual use. Among the five predictors of intention to use IoT in courier services in Bangladesh, all the predictors are found to significantly positively influence the users' intention except one—social influence.

The findings of this study contribute both theoretically and practically. In terms of theory, this study extends the UTAUT model by integrating the IDT framework. This novel combination is a robust model for understanding the drivers of users' intention and actual use of IoT-enabled courier services in emerging economies, specifically in the context of Bangladesh. The successful integration of the IDT framework into the UTAUT model also demonstrates that a single, foundational model may not be sufficient to explain adoption behaviors comprehensively. Therefore, it opens scope for future research in the same or similar context to test combinations of other theories to reflect the users' behavior in adopting a technology. Such a combined theoretical model offers a richer, more holistic lens that accounts for both the individual's psychological perceptions and the inherent characteristics of the technology itself. This theoretical model should also help other emerging and developing countries in similar industries. The empirical validation of this proposed theoretical model also fills a critical gap in literature, which has largely focused on developed markets.

In terms of practical implications, this study is the first that explores the factors influencing the adoption of IoT-enabled courier services in Bangladesh. To the best of the researchers' knowledge, there is no previous research that explored the possibility and adoption of IoT in courier services in Bangladesh. Therefore, this study gives valuable information to the different stakeholders of the courier service industry of Bangladesh. For the service providers, factors identified in this study would be crucial for offering better IoT-enabled courier services. Managers in the courier companies would benefit by considering these factors in their strategy and decision-making. In addition, they should also develop promotional activities to make consumers familiar with the benefits of IoT in their courier service experience. Once consumers develop a positive attitude toward IoT-enabled courier services, they will increase their actual usage.

The findings also underscore the imperative for multi-stakeholder collaboration encompassing merchants, regulatory bodies, and policymakers to establish a comprehensive digital ecosystem conducive to well-functioning courier service in emerging markets. The development of such an enabling environment necessitates systematic investments in digital infrastructure, the establishment of institutional frameworks, and the implementation of comprehensive security protocols safeguarding both data and parcels. These foundational elements are anticipated to positively influence user perceptions and intentions regarding IoT adoption in courier and analogous service domains, ultimately facilitating enhanced actual usage patterns. The establishment of an IoT-enabled digital courier ecosystem is also expected to generate spillover effects across interconnected industries, creating value propositions that benefit both consumer constituencies and business entities through improved operational efficiency and service quality. This ecosystem approach aligns with contemporary theoretical frameworks, emphasizing network effects and digital transformation imperatives in emerging market economies.

While this study has both practical and theoretical implications, it is not without limitations, which opens avenues for further research. As the data used in this study are gathered from a specific emerging economy—Bangladesh—any comments on the emerging economies should be made with caution. Additionally, this study considers only a small sample size. A larger representative sample should therefore be considered in future studies. The theoretical model developed and validated in this study can be studied in other country settings, i.e., in other LDCs or emerging countries, to see whether the theoretical proposition suggested in this study is equally applicable in those countries. In future studies, IoT-enabled courier services can be compared with traditional courier services.

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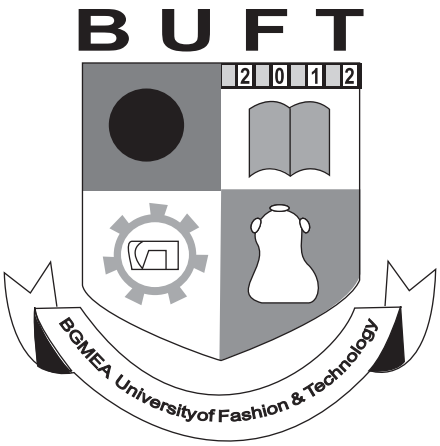
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