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Customers' Usage Intention Towards Biometric Authentication as a Payment Method: A Survey in Kathmandu Valley

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Abstract

Purpose: *The goal of the study is to determine how well-informed Kathmandu Valley consumers are about biometric authentication as a payment option. Additionally, the study evaluates the variables influencing consumers' propensity to use biometric authentication as a payment method.*

Methods: *This study employs an explanatory research design. Purposive sampling was used to select a sample of 403 respondents. It makes use of the Unified Theory of Acceptance and Use of Technology (UTAUT). Two descriptive and inferential statistics were employed to analyze the data. The data was analyzed using SEM.*

Results: *The findings indicate that attitude has a substantial impact on intention to use (β = 0.472, p & lu; 0.000), perceived usefulness (β = -0.260, p & lu; 0.000), and perceived ease of use (β = 0.279, p & lu; 0.000). Additionally, intention to utilize is significantly negatively impacted by trust (β = -0.221, p = 0.000). Social influence has a negligible impact on the intention to use biometric authentication (β = 0.028, p = 0.535).*

Conclusion: *According to this study, Usage Intention is directly impacted by Perceived Ease of Use, Perceived Usefulness, Attitude, Social Influence, and Trust, with Perceived Ease of Use, Perceived Usefulness, Attitude, and Trust having a major impact.*

Keywords: Usage intention, UTAUT, PLS-SEM

JEL Classification: G23, O33, B23

I. Introduction

FinTech, or financial technology, is regarded as an innovation that has the potential to revolutionize the financial services industry. Digital wallets and Apple Pay are examples of electronic payment solutions that are important FinTech applications (Abdo et al., 2025; Moro et al., 2023). An alternative to conventional payment authentication techniques has been proposed biometric authentication. This wave of innovation includes the use of biometric verification as a payment method (Mróz-Gorgoń et al., 2022). Fintech businesses are

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revolutionizing the way that financial transactions take place by seamlessly incorporating biometric data, such as fingerprints, facial recognition, and eye recognition, into the payment process. Authentication is the process of confirming the truth of an attribute of an entity (Kizza, 2024). It is actually the act of verifying someone's identity. The integration of biometrics in payment systems provides a level of convenience and security that has never before been possible, relieving the need for passwords PINs, and other conventional forms of authentication (Doddipatla et al., 2021). Fintech businesses, legislators, and financial institutions must have access to this data in order to tailor their services and make sure that biometric authentication meets the preferences and demands of the local population (Awotunde et al., 2021).

As a quicker, more useful, and extremely secure way to identify and authenticate people in online payment systems, biometric authentication for electronic payments is becoming more and more common (Patra et al., 2022). The payment is authorized using the customer's own biometric identity features, such as fingerprint, voice, facial recognition, etc., rather than a PIN code (Zarco et al., 2024). Mobile device makers like Apple and Samsung have significantly aided in the widespread adoption of biometrics, fueling the explosive rise of mobile commerce (m-commerce) by incorporating sensors into their product. Country like china is growing remarkably and attracting significant investments after 2015 with annual growth rate of 20.8% and an industrial scale of 23.3 billion USD (Qingyi, 2015). According to Liébana et al. (2024), The COVID-19 outbreak had a favorable effect on the mobile biometrics market because it led to a notable surge in e-commerce and the usage of digital payments. It is anticipated that BFSI (banking, financial services, and insurance) will continue to be the top consumer of mobile biometrics. According to Erwin et al. (2025), there is a high level of user acceptability of biometric technology in banking. According to a Cho et al. (2025) survey of 500 users of mobile banking apps, 78% of respondents used biometrics to access banking apps, and 85% of biometric users expressed high levels of satisfaction.

In a global context, acceptance of biometric authentication is rapidly increasing way better for its potential to enhance security and convenience in various applications, including payments (Patra et al., 2022; Moriuchi, 2021). In a world increasingly concerned with data breaches and identity theft, biometric authentication offers a promising solution to safeguarding sensitive financial information. However, the intention of customers to use biometric payments in Kathmandu Valley has been less explored. Earlier studies frequently had a global perspective and suffered from age-biased and a limited focus on a single form of biometric technology. Earlier Nepal-based research identifies the value of biometric and digital payments in social transfers and economic resilience (Thapa et al., 2025), it fails to investigate the intention of customers to utilize biometric authentication to use payments in general purposes. Nevertheless, since they cared more about social cash transfers, they could not directly deal with the intentions of customers to use biometric authentication to make overall payments. Similarly, the research mentioned by Tamang et al. (2021) highlighted the potential role of digital payments in case of the COVID-19 outbreak in Nepal. However, the key aspect of the given study is the willingness of consumers to adopt biometric payment verification which has not been explored in the previous studies which shows the clear research gap. This survey explores the attitudes and intentions of consumers to use biometric authentication to make payments in Kathmandu Valley and the importance of this issue in the academic, business, and policy domains. It helps to understand the adoption of technology and consumer behavior, as well as assist businesses to create more effective strategies and services. It also assists policy makers to formulate effective policies on the issues of privacy and security, eventually leading to safe, convenient, and generally accepted digital payment systems.

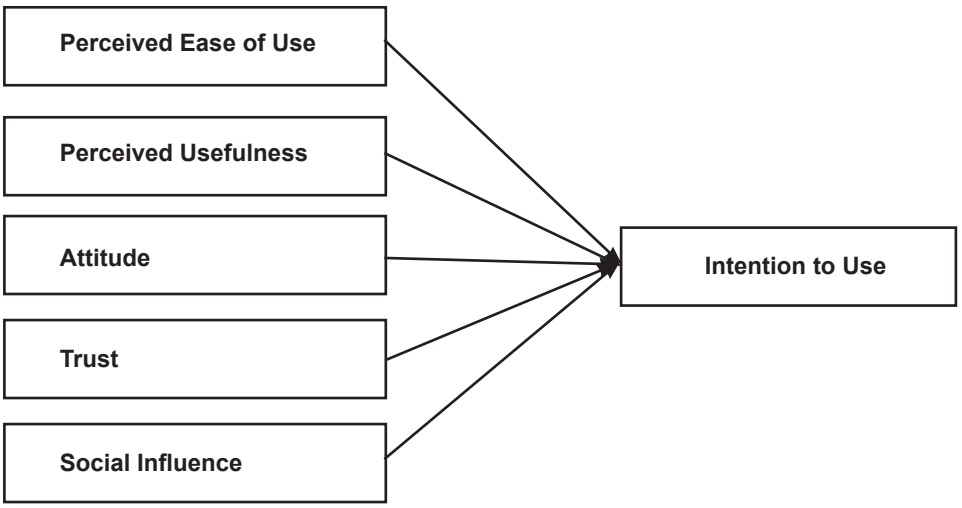
In response to this gap, the present study seeks assess the identify customers' usage intention toward biometric authentication as a payment method in the Kathmandu Valley. And specific objectives that include; assessing the awareness levels of biometric authentication as a payment method among customers in the Kathmandu Valley and identifying the factors affecting customers' usage intention of biometric.

II. Reviews

The Unified Theory of Acceptance and Use of Technology (UTAUT), Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA), Innovation Diffusion Theory (IDT), and Theory of Planned Behavior (TPB) are among the theories included in the theoretical framework section.Four factors performance expectancy, effort expectancy, social influence, and facilitating conditions have an impact on users' behavioral intention and usage of technology, according to the Unified Theory of Acceptance and Use of Technology (Srivastava et al., 2021). In this study, effort expectancy relates to perceived ease of use, while social influence is directly included as a determinant of intention to use. The Technology Acceptance Model (TAM) explains technology adoption through perceived usefulness and perceived ease of use, which shape attitude and intention (Silva, 2015), aligning with the study variables. Similarly, the Theory of Reasoned Action (TRA) and Theory of Planned Behavior (TPB) highlight the role of attitude and social influence in determining behavioral intention (Al-Suqri et al., 2015; Ajzen, 2020). Furthermore, Innovation Diffusion Theory supports the inclusion of trust and perceived usefulness, as adoption depends on users' perceptions and social context (Al-Rahmi et al., 2019). Therefore, all variables in the conceptual framework are theoretically justified and contribute to explaining intention to use.

Figure 1

Conceptual Framework



Note. Adapted and modified from (Moriuchi, 2021)

Consumers are skeptical about using technology that requires their biometric data. Two studies were conducted to investigate the trust toward these biometric payment systems. Study 1 was conducted through a survey. The study investigated antecedents that affect consumers' trust of, attitude toward, and usage of a biometric payment system. Based on the results from Study 1, Study 2 was conducted by introducing two shopping modalities in the study. The results show that consumers would rather use a biometric payment system in stores than online. Between the two modalities, consumers' trust and attitude toward the technology have a stronger mediating role for online than in-store toward their intention to use. In addition, self-efficacy consistently moderates the antecedents (performance expectation and perceived risk).

Perceived Ease of Use

Davis (1989) defines perceived ease of use as the degree to which an individual believes that using a particular system or innovation would be free of physical and mental effort. It is believed that a customer will adopt an innovation or a particular system if it is easy to learn and use. An innovation perceived to be difficult to use by customers will be less adopted according to the author in (Aizstrauta et al., 2015). According to (Ogbanufe & Kim, 2018) the ease of use of an innovation is one the most important characteristics for adoption of an innovation. This literature has led to a formulation of research hypothesis:

H_1: There is significant relationship between Perceived Ease of Use and Usage Intention

Perceived Usefulness

Davis (1989) defines Perceived usefulness as the degree to which an individual believes that using a particular system would enhance his or her job performance. Hence, it is believed that an innovation perceived to be useful is more likely to be adopted and customers will take advantage of the innovation such as mobile banking which they find useful to them (Aranuwa & Ogunniye, 2022). Perceived usefulness is one of the two most important factors affecting the acceptance of new technologies or information system. This literature has led to a formulation of research hypothesis:

H_2: There is significant relationship between Perceived Usefulness and Usage Intention.

Attitude

Attitude refers to the judgmental attitude that a person has towards an object that is determined by beliefs and feelings but not action (IBUOT, 2020) and also determines behavior as it makes the intentions of an individual guide (Gieure et al., 2020). Regarding the issue of biometrics, previous research indicates a consistent pattern of attitude on the intention to use biometrics behavior. A study by established that the attitude of government officers is predictive of their willingness to embrace biometrics, although a study by Zhang et al. (2025) revealed a positive correlation between the attitude of employees and their willingness to use the biometric systems. Therefore, the following research hypothesis was formed:

H_3: There is significant relationship between Trust and Usage Intention

Trust

The attitude or confidence that people have in the dependability, security, and efficacy of technology-mediated systems, particularly in online payment systems, is known as trust in technology. Perceptions of system integrity, data security and privacy, usability, and perceived technological proficiency are all included. Manage online payment in an efficient manner (ElSayad, 2025). People with greater trust in technology would most probably report a positive intention or willingness to use and adopt biometric authentication. Increased trust could promote trust in the safety the confidentiality of personal information revealed throughout the dispute settlement procedure (Mutimukwe et al., 2020). Additionally, it can increase biometric authentication's efficacy, efficiency, and fairness and lead to a greater adoption rate. Confidence in technology can also affect how individuals view convenience, ease of use and their overall views on the biometric authentication process and this will further affect their intention to adopt. Therefore, the following research hypothesis was formed:

H_4: There is significant relationship between Trust and Usage Intention

Social Influence

The social influence considerably contributes to the intention of people towards the use of biometric authentication since choices are highly influenced by social expectations, norms, and views of noteworthy individuals (Stylios et al., 2022). People are also likely to embrace those behaviors that are accepted among their social groups which make them more likely

to be embraced when biometric authentication is viewed as general practice and socially accepted (Kitsiou et al., 2022). The behavioral intentions towards biometric authentication are also influenced by normative pressure, informational influence and social media. These literatures have led to a formulation of research hypothesis:

H_5: There is significant relationship between Social Influence and Usage Intention

Variables and Definitions

In this part, the study's variables are discussed. The research's intended variables have already been chosen and established. Here the research is organized on table where all variables are defined with their respective sub variables.

Table 1

Variables and Definitions

Construct	Observe Variables	Indicators	Explanation
Perceived Ease of Use	Usability	PEU1	User-friendly and straightforward
	Implementation	PEU2	Feasible and promising implementation
	Effectiveness	PEU3	Highly effective
	Fund Management	PEU4	Simple process of fund management
	Simplicity	PEU5	Minimum effort, ensuring a seamless experience
Perceived Usefulness	Efficiency	PU1	Convenience performance of tasks
	Speed	PU2	Quick transactions, saving valuable time
	Necessity	PU3	Deemed necessary for modern transactions
	Security	PU4	Easier and safer transactions
	Effectiveness	PU5	Effectiveness in banking transactions
Attitude	Optimism	ATT1	Positive attitude towards biometric authentication
	Value	ATT2	Valuable to use biometric authentication
	Progress	ATT3	Positive development in banking services
	Enhancement	ATT4	Big improvement over existing methods
	Optimization	ATT5	Improve the quality of service.
Trust	Trust	T1	Sense of trust as a payment method
	Safety	T2	Superior level of safety
	Privacy	T3	Privacy is prioritized
	Confidence	T4	Enduring trustworthiness
	Reliability	T5	Assurance in the effectiveness.

Social Influence	Peer Influence	SI1	Friends' suggestions
	Family Impact	SI2	Impact of family and friends who have already adopted this method
	Colleague Adoption	SI3	Colleagues' adoption influences the use of biometric authentication
	Community Usage	SI4	Widespread use by community leads to use of biometric authentication
	Social Status	SI5	Enhancement of social status, contributing to a positive image and reputation
Intention to Use	Willingness	IU1	Willingness to use Biometric authentication
	Primary Usage	IU2	Choosing biometric authentication as the primary method
	Recommendation	IU3	Recommending to use Biometric authentication
	Personal Usage	IU4	Envisioning self-making purchases
	Regular Adoption	IU5	Regularly using biometric authentication

III. Methodology

Research methodology is a process of systematically resolving the searched problem. The systematic and theoretical analysis of the study's procedures is known as the methodology (Grewal et al., 2016). Area that is selected for this study are the main three cities of Kathmandu, Bhaktapur and Lalitpur. Kathmandu. The Kathmandu Valley which spans 800 square kilometers and is situated at 1300 meters above sea level between latitudes 2732'13" and 2749'10" north and longitudes 8511'31" and 8531'38" east. The highest points are 2,831 meters in Lalitpur, 2732 meters in Kathmandu, and 2,166 meters in Bhaktapur (Shrestha, 2021). As it is the largest economic and technological center of the Nepal with the greatest concentration of banks, digital payment services, internet users, and technologically mindful customers. Since the biometric authentication and digital payment systems are more established and implemented in Kathmandu Valley than in other areas, it will offer a suitable and representative environment to study how the users perceive the systems and how they intend to adopt them. Kathmandu Valley is densely populated, with over 2.5 million people living there. The target population of this study is the customers of banks living in Kathmandu valley. The process of choosing specific individuals or groups within a population in order to draw statistical inferences from them and evaluate the characteristics of the entire population (Devkota & Mahapatra, 2025; Mweshi et al., 2020). Sampling can be used to draw conclusions about a population or to make generalizations about current theories. There are two different kinds of sampling techniques: probability or random sampling and non-probability or non-random sampling (Stratton, 2023). This study used non-probability sampling. Since not all users of biometric authentication can be easily identified and, therefore, random sampling is impossible in this case. Non-probability sampling also enables the researcher to focus on relevant respondents, gather data at low cost and within a short period of time, and capture individuals that are experienced and knowledgeable on biometric authentication. The sample size was calculated by using Cochran's formula $n=z^2pq / e^2$, Maharjan et al. (2025) and Mirsamiee et al. (2025), Where, n = required The study's total sample size is (1.96)2 × 0.5 × 0.5/ (0.05)2 = 384.16, the tabulated value for the 5% level of significance (z) = 1.96, the prevalence of customers using brand social media brand pages (p) = 50% = 0.5, q = 1-p = 0.5, and the allowable tolerated (e) = 5%. 384.16 × 5/100 = 19.20 is the non-response error (5%). The study's sample size is therefore (384.16+19.20) = 403.36 ≈ 403. Estimators

(instance, survey, or scale) that are intended to gather data from research participants on a topic of concern are examples of testing instruments (Joshi et al., 2024; Tercanli et al., 2021). For this investigation, a structured questionnaire was employed. The survey consisted of multiple-choice, subjective, and 5-point Likert scale items. Primary data collecting serves as the research's primary source. A structured questionnaire is a set of standardized questions with a predetermined template that outlines the precise wording and order of the questions in order to gather data from respondents. Additionally, according to Kobo Toolbox, these surveys are kept up to date and were sent to those who purchase online. Data was collected using the Kobo Toolbox after the questionnaire was finalized and approved from the QIRC (Quest Institutional Research committee).

IV. Results and Discussion

This section shows the outcome of various variables which are presented in various sections and analysis is done from the questionnaire of the survey taken from the banking customers. The data are presented in two forms: descriptive and inferential. The descriptive section includes tables, charts, figures, and diagrams, here in this study, only tables and charts are presented, whereas the inferential section includes several statistical tests and findings of the Structural equation model.

Table 2

Socio-Demographic Information

Variable	Category	Frequency	Percentage (%)
Gender	Male	215	53.35
	Female	188	46.65
Marital Status	Married	319	79.16
	Unmarried	81	20.10
	Divorced	3	0.74
Age (in years)	15-24	18	4.47
	25-34	297	73.70
	35-44	87	21.59
	Above 45	1	0.25
Educational Level	Up to SLC/SEE	42	10.42
	Intermediate	36	8.93
	Bachelor's Degree	284	70.47
	Master's Degree and above	41	10.17
Employment Status	Not Employed	108	26.80
	Self-Employed	110	27.30
	Private Sector	65	16.13
	Public Sector	37	9.18
	Student	81	20.10
	Others	2	0.50

Family Monthly Income (NRs)	Up to 50,000	57	14.14
	50,000-100,000	122	30.27
	100,000-150,000	99	24.57
	150,000-200,000	11	2.73
	Above 200,000	114	28.29
Location	Kathmandu	329	81.64
	Lalitpur	54	13.40
	Bhaktapur	20	4.96

As per the data of table 2, 403 respondent are participated in this survey. 53.35% of the male contribute their participation and 46.65% female contribution occurred in this survey which shows that male respondent uses biometric authentication as a payment method more than female respondents. In a similar study conducted by Kitsiou et al. (2022) consumers are skeptical about using technology that requires their biometric data. Two studies were conducted to investigate the trust toward these biometric payment systems. Study 1 was conducted through a survey. The study investigated antecedents that affect consumers' trust of, attitude toward, and usage of a biometric payment system. Based on the results from Study 1, Study 2 was conducted by introducing two shopping modalities in the study. The results show that consumers would rather use a biometric payment system in stores than online. Between the two modalities, consumers' trust and attitude toward the technology have a stronger mediating role for online than in-store toward their intention to use. In addition, self-efficacy consistently moderates the antecedents (performance expectation and perceived risk, female respondents was 54.1% and 45.9% were male which indicates that female participation was more than male. Among these survey 79.16% are married, 20.1% are unmarried and rest of the 0.74% are divorced. Similarly, between 15-24 age group people who are the users of biometric authentication is 4.47%, between 25-34 is 73.7%, between 35-44 is 21.59% and above 45 is 0.25%, people who aged between 25-34 are the most users of biometric authentication compare to other age group. In a total number of respondent 70.47% are bachelor degree holder, 10.17% are Graduating masters and 8.93% are studying intermediate and 10.42% of the people are student of S.L.C where, 16.13% are government job holder, 9.18% are in private sector, 20.1% are student, 27.3% are self- employed, 26.8% are not employed and remaining other 0.5% are in other sector. Among all these information families who are earning upto 50000 per month is 14.14%, between 50,000- 100000 are 30.27%, 100000-150000 are 24.57% and above 150000-200000 are 30.27% and above 200000 are 28.29%. In conclusion, this survey is conducted in three cities; Kathmandu, Bhaktapur and Lalitpur so in kathmandu there are 81.64% in bhaktapur 4.96% and in lalitpur 13.4% people are using biometric authentication as payment method.

Customers Understanding on Biometric Authentication

In this section, General understanding of Biometric Authentication is discussed which was measured by considering various variables. The result shows that the majority of the respondents know what biometric authentication is. Among of those 403 respondents 98.0% of the total respondents know what is biometric authentication and the rest 1.99% has less idea about it they understand while explaining but not completely aware. Respondents, who are aware of biometric authentication, defines biometric authentication in various ways among the available definitions. 35.73% of the respondents defines biometric authentication as a modern security approach that replaces traditional passwords or PINs with personalized biological features, 27.54% of respondents defines biometric authentication as a modern security approach that replaces traditional passwords or PINs with personalized biological features, 25.31% of the respondents defines biometric authentication as a modern security

approach that replaces traditional passwords or PINs with personalized biological features' and rest 11.39% of the respondents defines biometric authentication as 'a means of verification that relies on the unchanging and highly individualistic aspects of a person's biology.'

The result also shows that the majority of the respondents have been using biometric authentication for more than 2 years. Out of the 403 respondents, 384 (95.29%) of the respondents have been using biometric authentication in their daily life whereas the remaining 19 (4.71%) respondents have not used biometric authentication. Among the respondents who have been using biometric authentication, 41 (10.17%), 24 (5.96%), 312 (79.4%) and 18 (4.47%) respondents have been using the biometric authentication for less than a year, from 1 to 2 years, from 2 to 3 years and more than 3 years respectively. In the study, most of the people used Finger and Face as the method for biometric authentication. Out of the 403 respondents, 393 (97.52%) of the respondents think that biometric payment is beneficial whereas 10 (2.48%) of the respondents don't thinks it is beneficial. There are various benefits the users of biometric authentication have achieved which is shown in the figure 2.

Figure 2

Perceived Benefits from the Use of Biometric Authentication

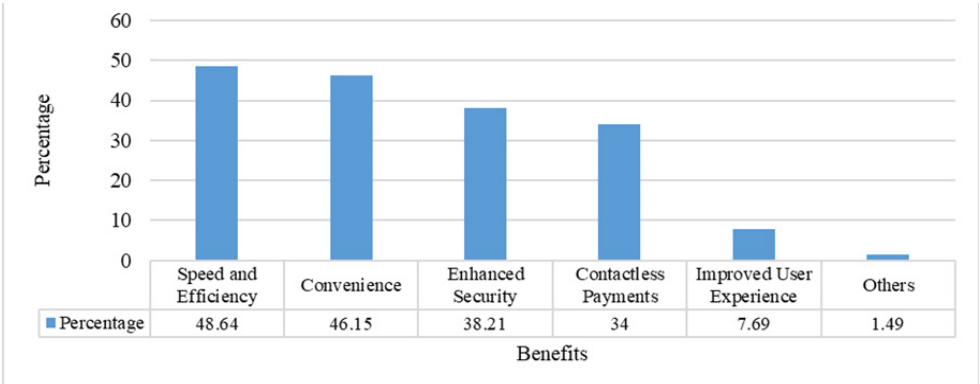


Figure 2 shows the benefits the users have achieved from the use of biometric authentication. The report indicates that 48.64% of the respondents have achieved the benefit of speed and efficiency via using biometric authentication as a payment method. Similarly, 46.15%, 38.21%, 34%, 7.69% and 1.49% of the respondents have achieved benefits like convenience, enhanced security, contactless payment, improved user experience and other respectively. This shows that most people are using biometric authentication due to its speed, efficiency and convenience.

Inferential Analysis

Common method bias is a research error that arises when the data on all variables are measured in an identical way, respondents, and time (Podsakoff et al., 2024). Due to it, the respondent mood, opinion, or habitual response to the queries may affect the responses of the respondents, which makes the correlations of the variables look stronger or weaker than they are (Westland, 2022). Simply stated, common method bias occurs because of the data collection method and not because of real relationship between the variables. Common Method bias is measured based on VIF, in this study VIF measurement is less than 3.3 so, there is no problem of Common Method bias in this study.

Table 3

Common Method Bias

	Perceived Ease of Use	Perceived Usefulness	Social Influence	Attitude	Trust	Intention to Use
VIF	1.162	1.192	1.009	1.628	1.007	1.680

A measurement model provides an insight into whether the questions or items in a study actually measure what they are supposed to measure (Wilson, 2023). In such simple terms, it examines whether the questions are gauging the right thing right. In this assessment, the measurement's Accuracy, validity, and reliability are evaluated. based on internal consistency, reliability, convergent, and discriminant validity is a measuring model. Cronbach's alpha (CA) and composite reliability (CR) were assessed for internal consistency reliability. The data must meet the requirement of CA>0.7 to exhibit internal consistent dependability (Cheung et al., 2024). According to Ramezani et al. (2025), the CAs and CRs values must be higher than 0.5 and 0.7, respectively. Better dependability levels are frequently indicated by higher CR values. For instance, Composite Reliability ratings between 0.60 and 0.70 are considered "acceptable," while those between 0.70 and 0.90 are considered "satisfactory to good." However, values of 0.95 and higher are problematic since they imply that the items are unnecessary (Dolinting & Pang, 2022).

Haji and Yusuff, (2022) standards for an AVE value of 0.5 are satisfied by factor loading and AVE requirements for convergent validity (Lawaju et al., 2024). Factor loading values of 0.7 and higher are taken into consideration, whereas items with loading values below 0.4 should be eliminated.

Table 4

Internal Consistent Reliability

Construct	Cronbach's Alpha	Composite Reliability
Attitude	0.933	0.934
Intention to Use	0.934	0.934
Perceived Ease of Use	0.820	0.857
Perceived Usefulness	0.918	0.933
Trust	0.918	0.926
Social Influence	0.816	0.924

A construct's discriminant validity measures how different it is from other constructs with which it shouldn't have a strong correlation (Kane et al., 2021). Discriminant validity was assessed using the HTMT criterion, the Fornell and Larcker criterion, and cross loading. Li et al. (2020) state that when cross-loading is taken into consideration, all factor loading indicators on the chosen build needs to have a higher loading than any other construction. The cross-loading values, which meet the requirement of having a greater factor loading than any other loading on other constructions, are displayed in Table 6.

Table 5

Convergent Validity

Construct	Indicators	Factor Loading	Average Variance Extracted (AVE)
Attitude	att1	0.886	0.789
	att2	0.891	
	att3	0.887	
	att4	0.884	
	att5	0.893	
Intention to Use	iu1	0.888	0.791
	iu2	0.893	
	iu3	0.888	
	iu4	0.883	
	iu5	0.896	
Perceived Ease of Use	peu1	0.834	0.577
	peu2	0.743	
	peu3	0.737	
	peu4	0.721	
	peu5	0.757	
Perceived Usefulness	pu1	0.899	0.751
	pu2	0.861	
	pu3	0.842	
	pu4	0.855	
	pu5	0.877	
Trust	si1	0.887	0.752
	si2	0.862	
	si3	0.848	
	si4	0.862	
	si5	0.877	
Social Influence	t1	0.862	0.555
	t2	0.690	
	t3	0.696	
	t4	0.651	
	t5	0.804	

Hu and Bentler (1999) define SRMR values less than 0.10 or 0.08 as a good fit. The SRMR value for the model is 0.044 which is less than 0.08 so it determined that the model fit is generally good (Shrestha et al., 2025).

Table 6

Factor Cost Loadings

	Attitude	Intention to Use	Perceived Ease of Use	Perceived Usefulness	Trust	Social Influence
att1	**0.886**	0.529	0.121	-0.222	-0.167	0.262
att2	**0.891**	0.552	0.080	-0.244	-0.166	0.212
att3	**0.887**	0.534	0.149	-0.184	-0.185	0.244
att4	**0.884**	0.582	0.112	-0.203	-0.170	0.244
att5	**0.893**	0.563	0.101	-0.206	-0.218	0.244
iu1	0.528	**0.888**	0.232	-0.176	-0.215	0.144
iu2	0.555	**0.893**	0.190	-0.173	-0.243	0.131
iu3	0.541	**0.888**	0.225	-0.191	-0.186	0.181
iu4	0.578	**0.883**	0.215	-0.176	-0.192	0.142
iu5	0.563	**0.896**	0.224	-0.227	-0.193	0.127
peu1	0.155	0.256	**0.834**	0.299	-0.011	0.255
peu2	0.051	0.145	**0.743**	0.274	0.052	0.251
peu3	0.044	0.158	**0.737**	0.274	0.061	0.234
peu4	0.059	0.140	**0.721**	0.275	0.074	0.265
peu5	0.126	0.187	**0.757**	0.281	-0.004	0.216
pu1	-0.214	-0.214	0.297	**0.899**	-0.197	-0.023
pu2	-0.194	-0.179	0.290	**0.861**	-0.246	-0.014
pu3	-0.157	-0.142	0.318	**0.842**	-0.189	0.072
pu4	-0.201	-0.158	0.351	**0.855**	-0.259	0.029
pu5	-0.250	-0.209	0.350	**0.877**	-0.218	0.010
t1	-0.202	-0.204	-0.000	-0.199	**0.887**	0.282
t2	-0.175	-0.188	0.010	-0.243	**0.862**	0.276
t3	-0.149	-0.168	0.083	-0.186	**0.848**	0.316
t4	-0.152	-0.194	0.046	-0.255	**0.862**	0.341
t5	-0.198	-0.236	0.025	-0.220	**0.877**	0.336
si1	0.278	0.180	0.251	-0.021	0.289	**0.862**
si2	0.155	0.056	0.265	0.047	0.266	**0.690**
si3	0.183	0.071	0.244	0.049	0.263	**0.696**
si4	0.141	0.063	0.269	0.072	0.262	**0.651**
si5	0.194	0.143	0.228	-0.014	0.286	**0.804**

Table 7

Fornell and Larcker

	Att	iu	peu	Pu	t	si
att	0.888					
iu	0.622	0.889				
peu	0.126	0.244	0.760			
pu	-0.238	-0.213	0.369	0.867		
t	-0.204	-0.231	0.035	-0.255	0.867	
si	0.271	0.163	0.318	0.012	0.358	0.745

Table 8

HTMT

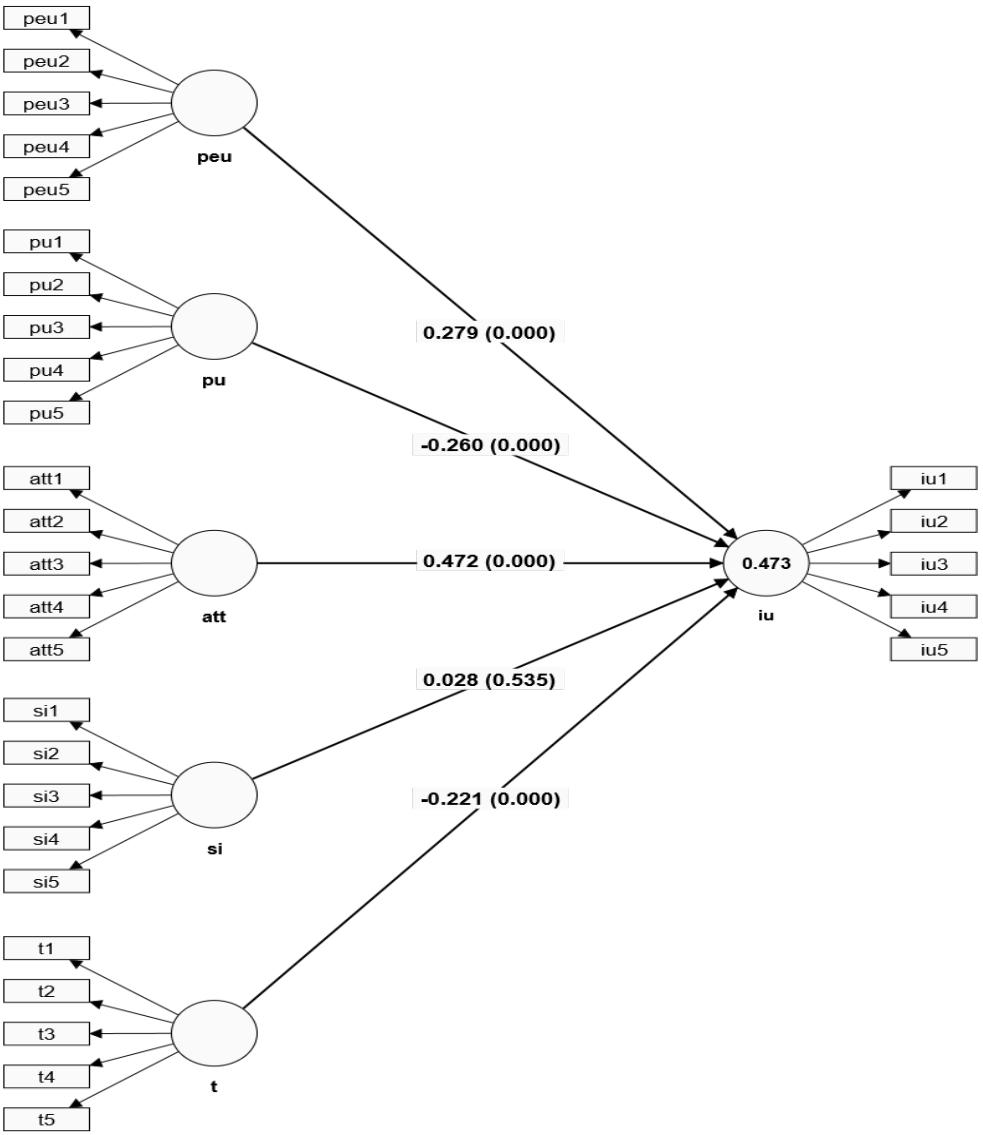
	Att	iu	peu	pu	t	si
att						
iu	0.665					
peu	0.131	0.265				
pu	0.253	0.224	0.426			
t	0.218	0.247	0.076	0.278		
si	0.288	0.155	0.413	0.077	0.415	

Structure Model Assessment

In engineering and research, structural models are widely used to analyze and predict the behavior of actual physical structures, such as buildings, bridges, and mechanical systems (Etim et al., 2024). Partial Least Squares Structural Equation Modeling is referred to as PLS-SEM. According to Legate et al. (2023), it is a statistical method for examining the connections both the connections between latent variables and their indicators and the latent variables themselves. In several disciplines, including marketing, management, and the social sciences, PLS-SEM is a widely used method. because it can test complex models with small sample sizes (Shafique et al., 2023). Abdullah et al. (2024) reported path coefficients, standard errors, t-values, and p-values for the structural model using a 10,000-sample re-sample bootstrapping approach. Based on the claim made by Lakens (2021) that p-values are a poor criterion for determining the significance of a hypothesis and their recommendation to employ a combination of criteria, such as effect sizes, confidence intervals, and p-values.

Figure

Path Analysis (Structural Model)



Hypothesis Testing

Table 9

Hypothesis Testing

Hypothesis		Beta (β)	S.D.	t-values	P values	Confidence Interval		Result
					Lower Limit	Upper Limit		
H1	att ->iu	0.472	0.060	7.898	0.000	0.362	0.598	Supported
H2	peu -> iu	0.279	0.042	6.708	0.000	0.197	0.359	Supported
H3	pu -> iu	-0.260	0.045	5.742	0.000	-0.345	-0.167	Supported
H4	t -> iu	-0.221	0.049	4.504	0.000	-0.311	-0.123	Supported
H5	si -> iu	0.028	0.045	0.621	0.535	-0.074	0.104	Not Supported

Table 9 shows the results of hypothesis testing indicating that four of the five hypotheses are accepted. Attitude (att) positively influences intention to use (iu) (= 0.472, p <0.001), meaning that a positive attitude does boost the usage intention. Intention to use (iu) is also positively affected by perceived ease of use (peu) (0.279 0.001). Conversely, perceived usefulness (pu) (= -0.260, p = 0.001) and trust (t) (= -0.221, p = 0.001) have strong negative intentions on the intention to use. Social influence (si) however does not have any significant effect on intention to use (iu) (= -0.028, p=0.535) and thus is not significant.

Discussion

The study tries to know the customers' usage intention towards biometric authentication as a payment method in Kathmandu Valley. It examined usage intention of customer through perceived ease of use, perceived usefulness, attitude, social influence and trust. Altogether 5 hypotheses were formulated in the research. Among the 5 hypotheses, 4 hypotheses were accepted whereas 1 was rejected (H5) as its p-value is more than 0.05 i.e. 0.535. To establish and test the correlation between the variables, the reliability and validity test were employed. The threshold at which p-values indicate a statistically significant has a comparison between p-values just below 0.05 (Lakens, 2015).

Hypotheses 1 is accepted this indicates that consumers' perceptions of the ease of using biometric authentication have a significant impact on their intention to use it for payments. This means that if consumers find the biometric authentication process user-friendly and uncomplicated, they are more likely to adopt it as a preferred payment method. The study by Li et al. (2018) on "Factors affecting the adoption of biometric authentication in mobile banking" found that perceived ease of use significantly influenced users' willingness to adopt biometric authentication in the mobile banking context.

Hypotheses 2 is also accepted which indicates that consumers' perception of the usefulness of biometric authentication plays a significant role in shaping their intention to use it for payments. In practical terms, this suggests that if consumers see clear benefits and advantages in using biometric authentication for transactions, they are more likely to adopt it as a preferred payment method. The study by Wu and Wang (2005) perceived risk and cost into the TAM to investigate what determines user mobile commerce (MC suggest that users' perception of the utility and advantages of biometric authentication significantly influences their intention to adopt and use it for various purposes, including payment transactions.

Hypotheses 3 is also accepted which suggests that consumers' overall attitude toward biometric authentication significantly influences their intention to use it for payments. In simpler terms, if consumers have a positive attitude toward using biometric authentication

for payments, they are more likely to express an intention to adopt and use it. A positive attitude is often an indicator of a favorable predisposition toward adopting and using a new technology or service, such as biometric authentication for payments. A study by Luarn and Lin (2005) reports on mobile banking show that potential users may not be using the systems, despite their availability. Thus, research is needed to identify the factors determining users' acceptance of mobile banking. While there has been considerable research on the technology acceptance model (TAM "Toward an understanding of the behavioral intention to use mobile banking" found a positive and significant relationship between attitude and intention to use mobile banking. Also, the study conducted by Dealand (1980) on "Trust and TAM in Online Shopping" highlighted the importance of trust, which is closely related to attitude, in influencing users' intention to engage in online shopping.

Hypotheses 4 is also accepted which implies that the level of trust that consumers place in the security and reliability of biometric authentication significantly influences their intention to use it for payments. In practical terms, if consumers perceive biometric authentication as trustworthy and secure, they are more likely to express an intention to adopt and use it as a preferred payment method. The finding underscores the importance of trust as a critical factor in shaping consumers' perceptions and decisions related to the adoption of biometric authentication for financial transactions. Trust in the security and reliability of a payment method is a key determinant of users' confidence in using that method for sensitive transactions. A study conducted by McKnight et al. (2002) explored the relationship between online trust and intention to transact in their study "Building Consumer Trust in Online Environments" where trust and intention to use was significant. Also the study conducted by Pavlou & Stewart (2000) examined the role of trust in the adoption of biometric authentication systems where there exist positive relationship between trust and intention. Their work contributes to the understanding of how trust influences users' acceptance of biometric technologies.

Hypotheses 5 is rejected which implies that social influence does not play a statistically significant role in shaping consumers' intentions to use biometric authentication for payments. In other words, factors related to the influence of others or societal norms do not significantly impact consumers' decisions regarding the adoption of biometric authentication for financial transactions. It may imply that consumers' intentions to use biometric authentication are more individualistic or personally driven, and external social factors do not exert a substantial influence on their decision-making in this specific context. Similar study by Lian & Yen (2014) previous researchers and practitioners have focused mainly on the youth market and paid less attention to issues related to the online behaviors of older consumers. To bridge the gap, the purpose of this study is to increase a better understanding of the drivers and barriers affecting older consumers' intention to shop online. To this end, this study is developed by integrating the Unified Theory of Acceptance and Use of Technology (UTAUT on "Online shopping drivers and barriers for older adults: Age and gender differences" found that social influence significantly influenced older adults' intentions to adopt mobile payment services. Also, a study by Gefen et al. (2015) on "Trust and TAM in Online Shopping" found that subjective norms, a component of social influence, significantly influenced users' intentions to engage in online shopping.

V. Conclusion and Implications

This paper has discussed the implementation of biometric authentication as a form of payment in Kathmandu Valley and has established that consumers have a good level of awareness and positive acceptance with regard to the implementation of biometric payment in payment since most of the people who responded indicated that they found benevolence in biometric payment in terms of speed, convenience, and security. The analysis by SEM showed that Attention, Perceived Ease of Use, Perceived Usefulness as well as Trust play a significant role in affecting the usage intention whereas Social Influence was found to have no significant influence. The results suggest that technological collaboration, relevant regulations, and well-designed, secure, and user-friendly biometrical payment systems are the keys to financial inclusion, and to make the Kathmandu Valley exhibit current global fintech trends, to which

the financial inclusion and technological collaboration should be prioritized by fintech firms and businesses, as well as policymakers. The concept of biometric authentication is a new research topic in the banking sector, and its future research can even explore more on its effectiveness, challenges, and opportunities as a mode of payment. As this research was only restricted to the participants in Kathmandu Valley, future research can increase the sample size in the whole of Nepal and also engage professionals in banks and other financial institutions. Since there is scarcity of literature in Nepal, it is possible to conduct a further research to include more variables and their correlation with each other to gain a wider picture of biometric authentication in the banking industry.

Reference

Abdullah, M., & Shukor, S. A. (2024). A study on propensity to indebtedness among young working malays in Malaysia. *Global Business & Management Research*, *16*. https://gbmrjournal.com/pdf/v16n3s/V16N3s-32.pdf

Aizstrauta, D., Ginters, E., & Eroles, M. A. P. (2015). Applying theory of diffusion of innovations to evaluate technology acceptance and sustainability. *Procedia Computer Science, 43*(C), 69–77. https://doi.org/10.1016/j.procs.2014.12.010

Ajzen, I. (2020). The theory of planned behavior: Frequently asked questions. *Human Behavior and Emerging Technologies*, *2*(4), 314–324. https://doi.org/10.1002/hbe2.195

Al-Rahmi, W. M., Yahaya, N., Aldraiweesh, A. A., Alamri, M. M., Aljarboa, N. A., Alturki, U., & Aljeraiwi, A. A. (2019). Integrating technology acceptance model with innovation diffusion theory: An empirical investigation on students' intention to use E-learning systems. *Ieee Access*, *7*, 26797-26809. DOI: 10.1109/ACCESS.2019.2899368

Al-Suqri, M. N., & Al-Kharusi, R. M. (2015). Ajzen and Fishbein's theory of reasoned action (TRA)(1980). In *Information seeking behavior and technology adoption: Theories and trends* (pp. 188-204). IGI Global Scientific Publishing. DOI: 10.4018/978-1-4666-8156-9.ch012

Awotunde, J. B., Adeniyi, E. A., Ogundokun, R. O., & Ayo, F. E. (2021). Application of big data with fintech in financial services. In Fintech with artificial intelligence, big data, and blockchain (pp. 107-132). Singapore: Springer Singapore. https://link.springer.com/chapter/10.1007/978-981-33-6137-9_3

Bhandari, R. K., & Koirala, A. N. (2024). The role of digital payment systems in facilitating remittance transfers to Nepal. *Law and Economy*, *3*(12), 15-19. https://www.paradigmpress.org/le/article/view/1442

Cheung, G. W., Cooper-Thomas, H. D., Lau, R. S., & Wang, L. C. (2024). Reporting reliability, convergent and discriminant validity with structural equation modeling: A review and best-practice recommendations. *Asia pacific journal of management*, *41*(2), 745-783. https://link.springer.com/article/10.1007/s10490-023-09871-y

Cho, I., Kwak, J. H., & Lee, B. G. (2025). Mobile banking usage through biometric authentication: Effects of smartphone attributes and privacy consent index. *IEEE Access, 13*, 202919-202937. DOI: 10.1109/ACCESS.2025.3631849

Clark, R. A. (2021). *Consumers perspectives on using biometric technology with mobile banking* (Doctoral dissertation, Walden University). https://www.proquest.com/openview/8bbb45d778adc903579073c35fb87ce8/1?pqorigsite=gscholar&cbl=18750&diss=y

Dash, G., & Paul, J. (2021). CB-SEM vs PLS-SEM methods for research in social sciences and technology forecasting. *Technological Forecasting and Social Change*, *173*, 121092. https://doi.org/10.1016/j.techfore.2021.121092

Davis, F. D. (1989b). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319–340. https://doi.org/10.5962/bhl.title.33621

Dealand, M. R. (1980). Regulatory alert: superfund: The debate drags on. *Environmental science and technology, 14*(10), 1175. https://doi.org/10.1021/es60170a601

Devkota, N., & Mahapatra, S. K. (2025). *Quantitative and applied research methodology in economics: Researching, reporting and publishing*. Taylor & Francis.

Dolinting, P. P., & Pang, V. (2022). Assessing the validity and reliability of adapted classroom climates instrument for Malaysian rural schools using PLS-SEM. *Int. J. Educ. Psychol. Couns*, *7*, 383-401. DOI 10.35631/IJEPC.747033

Dwivedi, Y. K., Rana, N. P., Jeyaraj, A., Clement, M., & Williams, M. D. (2019). Re-examining the unified theory of acceptance and use of technology (UTAUT): Towards a revised theoretical model. *Information systems frontiers*, *21*(3), 719-734. https://link.springer.com/article/10.1007/s10796-017-9774-y

ElSayad, G. (2025). Online customers' attitudes and intentions towards e-payment usage in Egypt during the COVID-19 pandemic: the serial mediation roles of perceived usefulness, perceived trust, and attitude. *Journal of Science and Technology Policy Management*, *16*(7), 1143-1166. https://doi.org/10.1108/JSTPM-02-2023-0024

Erwin, H. A., Rithmaya, C. L., & Sekarsari, L. A. (2025). Biometric technology in digital banking: Insights from generation z and millennials. *Journal of Business & Banking*, *15*(01), 39-58. DOI: https://doi.org/10.14414/jbb.v15i1.5378

Etim, B., Al-Ghosoun, A., Renno, J., Seaid, M., & Mohamed, M. S. (2024). Machine learning-based modeling for structural engineering: a comprehensive survey and applications overview. *Buildings*, *14*(11), 3515. https://doi.org/10.3390/buildings14113515

Gefen, D., Karahanna, E., & W. Straub, D. (2015). Trust and tam in online shopping: an integrated model1 by: Statewide agricultural land use baseline. *MIS Quarterly, 1*(1), 51–90.https://doi.org/10.2307/30036519

Gieure, C., del Mar Benavides-Espinosa, M., & Roig-Dobón, S. (2020). The entrepreneurial process: The link between intentions and behavior. *Journal of Business Research*, *112*, 541-548. https://doi.org/10.1016/j.jbusres.2019.11.088

Grewal, A., Kataria, H., & Dhawan, I. (2016). Literature search for research planning and identification of research problem. *Indian Journal of Anaesthesia, 60*(9), 635-639. DOI: 10.4103/0019-5049.190618

Haji-Othman, Y., & Yusuff, M. S. S. (2022). Assessing reliability and validity of attitude construct using partial least squares structural equation modeling. *Int J Acad Res Bus Soc Sci*, *12*(5), 378-385. DOI:10.6007/IJARBSS/v12-i5/13289

Ibuot, U. P. (2020). Attitude components and their influence on communication. *African Journal for The Psychological Studies of Social Issues*, *23*(2), 154-164. https://www.ajpssi.org/index.php/ajpssi/article/view/445

Iranmanesh, M., Ghobakhloo, M., Foroughi, B., Nilashi, M., & Yadegaridehkordi, E. (2024). Factors influencing attitude and intention to use autonomous vehicles in Vietnam: findings from PLS-SEM and ANFIS. *Information Technology & People*, *37*(6), 2223-2246. https://doi.org/10.1108/ITP-11-2022-0825

Joshi, I., Grimmer, M., Rathgeb, C., Busch, C., Bremond, F., & Dantcheva, A. (2024). Synthetic data in human analysis: A survey. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, *46*(7), 4957-4976. DOI: 10.1109/TPAMI.2024.3362821

Kane, M. J., Smeekens, B. A., Meier, M. E., Welhaf, M. S., & Phillips, N. E. (2021). Testing the construct validity of competing measurement approaches to probed mind-wandering reports. *Behavior Research Methods*, *53*(6), 2372-2411. https://link.springer.com/article/10.3758/s13428-021-01557-x

Kitsiou, A., Despotidi, C., Kalloniatis, C., & Gritzalis, S. (2022). The role of users' demographic and social attributes for accepting biometric Systems: A Greek case study. *Future Internet*, *14*(11), 328. https://doi.org/10.3390/fi14110328

Kizza, J. M. (2024). Authentication. In *Guide to Computer Network Security* (pp. 215-238). Cham: Springer International Publishing. https://link.springer.com/chapter/10.1007/978-3-031-47549-8_10Doddipatla, L., Ramadugu, R., Yerram, R. R., & Sharma, T. (2021). Exploring the role of biometric authentication in modern payment solutions. International Journal of Digital Innovation, 2(1). https://researchworkx.com/index.php/ijdi/article/view/51

Lakens, D. (2015). On the challenges of drawing conclusions from p-values just below 0.05. PeerJ, 3, e1142. https://peerj.com/articles/1142/

Lakens, D. (2021). The practical alternative to the p value is the correctly used p value. *Perspectives on psychological science*, *16*(3), 639-648. https://doi.org/10.1177/1745691620958012

Lakens, D. (2022). Sample size justification. *Collabra: psychology*, *8*(1), 33267. https://doi.org/10.1525/collabra.33267

Lawaju, P., Adhikari, S. U., & Devkota, J. (2024). Impact of AI in education: An evidence from use of ChatGPT in management education in Nepal. *Quest Journal of Management and Social Sciences*, *6*(3), 621-642.

Legate, A. E., Hair Jr, J. F., Chretien, J. L., & Risher, J. J. (2023). PLS-SEM: Prediction-oriented solutions for HRD researchers. *Human Resource Development Quarterly, 34*(1), 91-109.

Li, Y., Wen, Z., Hau, K. T., Yuan, K. H., & Peng, Y. (2020). Effects of cross-loadings on determining the number of factors to retain. *Structural Equation Modeling: A Multidisciplinary Journal*, *27*(6), 841-863. https://doi.org/10.1080/10705511.2020.1745075

Lian, J. W., & Yen, D. C. (2014). Online shopping drivers and barriers for older adults: Age and gender differences. *Computers in Human Behavior*, *37*, 133–143. https://doi.org/10.1016/j.chb.2014.04.028

Liébana-Cabanillas, F., Kalinic, Z., Muñoz-Leiva, F., & Higueras-Castillo, E. (2024). Biometric m-payment systems: A multi-analytical approach to determining use intention. *Information & Management*, *61*(2), 103907. https://doi.org/10.1016/j.im.2023.103907

Lim, S. H., Kim, D. J., Hur, Y., & Park, K. (2019). An empirical study of the impacts of perceived security and knowledge on continuous intention to use mobile fintech payment services. *International Journal of Human–Computer Interaction*, *35*(10), 886-898. https://doi.org/10.1080/10447318.2018.1507132

Luarn, P., & Lin, H. H. (2005). Toward an understanding of the behavioral intention to use mobile banking. *Computers in Human Behavior, 21*(6), 873–891. https://doi.org/10.1016/j.chb.2004.03.003

Maharjan, J., Lawaju, P., & Karki, D. (2025). The role of financial literacy in investment decision: A study in kathmandu valley. *Quest Journal of Management and Social Sciences*, *7*(2), 390-408.

McKnight, D. H., Choudhury, V., & Kacmar, C. (2002). Developing and validating trust measures for e-commerce: An integrative typology. *Information Systems Research, 13*(3), 334–359. https://doi.org/10.1287/isre.13.3.334.81

Mirsamiee, S. F., Moslemi, A., Lal Bar, A., & Haji Sharifi, N. (2025). Modeling factors affecting financial health using structural equations. *International Journal of Nonlinear Analysis and Applications*, *16*(12), 147-157. 10.22075/IJNAA.2024.33916.5058

Moriuchi, E. (2021). An empirical study of consumers' intention to use biometric facial recognition as a payment method. *Psychology and Marketing*, *38*(10), 1741–1765. https://doi.org/10.1002/mar.21495

Moro-Visconti, R., & Cesaretti, A. (2023). FinTech and digital payment systems valuation. In *Digital Token Valuation: Cryptocurrencies, NFTs, Decentralized Finance, and Blockchains* (pp. 411-458). Cham: Springer Nature Switzerland. https://link.springer.com/chapter/10.1007/978-3-031-42971-2_13

Mróz-Gorgoń, B., Wodo, W., Andrych, A., Caban-Piaskowska, K., & Kozyra, C. (2022). Biometrics innovation and payment sector perception. *Sustainability*, *14*(15), 9424. https://doi.org/10.3390/su14159424

Mutimukwe, C., Kolkowska, E., & Grönlund, Å. (2020). Information privacy in e-service: Effect of organizational privacy assurances on individual privacy concerns, perceptions, trust and self-disclosure behavior. *Government Information Quarterly*, *37*(1), 101413. https://doi.org/10.1016/j.giq.2019.101413

Mweshi, G. K., & Sakyi, K. (2020). Application of sampling methods for the research design. *Archives of Business Review–Vol*, *8*(11), 180-193. DOI: 10.14738/abr.811.9042.

Aranuwa, F., & Ogunniye, G. (2022). Enhanced biometric authentication system for efficient and reliable e-payment system in nigeria. *International Journal of Applied Information Systems, 4*(2), 56–61. https://doi.org/10.5120/ijais12-450676

Ogbanufe, O., & Kim, D. J. (2018). Comparing fingerprint-based biometrics authentication versus traditional authentication methods for e-payment. *Decision Support Systems, 106*, 1–14. https://doi.org/10.1016/j.dss.2017.11.003

Pai, C. K., Wang, T. W., Chen, S. H., & Cai, K. Y. (2018). Empirical study on Chinese tourists' perceived trust and intention to use biometric technology. *Asia Pacific Journal of Tourism Research, 23*(9), 880-895. https://doi.org/10.1080/10941665.2018.1499544

Patra, G. K., Rajaram, S. K., Boddapati, V. N., Kuraku, C., & Gollangi, H. K. (2022). Advancing digital payment systems: combining ai, big data, and biometric authentication for enhanced security. *International Journal of Engineering and Computer Science*, *11*(08), 10-18535. http://dx.doi.org/10.18535/ijecs/v11i08.4698

Pavlou, P. A., & Stewart, D. W. (2000). Measuring the effects and effectiveness of interactive advertising. *Journal of Interactive Advertising, 1(*1), 61–77. https://doi.org/10.1080/15252019.2000.10722044

Podsakoff, P. M., Podsakoff, N. P., Williams, L. J., Huang, C., & Yang, J. (2024). Common method bias: It's bad, it's complex, it's widespread, and it's not easy to fix. *Annual Review of Organizational Psychology and Organizational Behavior*, *11*(1), 17-61. https://doi.org/10.1146/annurev-orgpsych-110721-040030

Qingyi, W. (2015). Energy Data 2015. https://www.igdp.cn/wp-content/uploads/2019/06/2016-12-28-IGDP-Data-Manual-EN-2015-Energy-Statistics.pdf

Ramezani, S. G., & Mostafavi, Z. S. (2025). Developing and validating a comprehensive scale for accreditation standards and quality assurance in e-learning institutions. *Education and Information Technologies*, 1-49. https://link.springer.com/article/10.1007/s10639-025-13587-5

Shafique, S., & Naz, I. (2023). A mediating and moderating analysis of the relationship between team emotional intelligence and team performance. *Sage Open*, *13*(1), 21582440231155074. https://doi.org/10.1177/21582440231155074

Shrestha, H. L. (2021). *Trends in urban expansion in kathmandu valley, Nepal* (Doctoral dissertation, University of Salzburg, Austria). https://unigis.at/files/Mastertheses/Full/105540.pdf

Shrestha, P., Lawaju, P., & Poudel, D. K. (2025). Investing with a conscience: exploring individual investors' intentions toward socially responsible investment in Kathmandu valley. *Quest Journal of Management and Social Sciences*, *7*(1), 107-127.

Silva, P. (2015). Davis' technology acceptance model (TAM)(1989). *Information seeking behavior and technology adoption: Theories and trends*, 205-219. DOI: 10.4018/978-1-4666-8156-9.ch013

Srivastava, C., Mahendar, G., & Vandana, V. (2021). Adoption of contactless payments during COVID-19 pandemic –An integration of Protection Motivation Theory (PMT) and Unified Theory of Acceptance and Use of Technology (UTAUT). *Academy of Marketing Studies Journal*, *25*(1), 2678. https://search.proquest.com/openview/caf951e06e5ad3d64b4e3bcb0a10ebb8/1?pq-origsite=gscholar&cbl=38744

Stylios, I., Kokolakis, S., Thanou, O., & Chatzis, S. (2022). Key factors driving the adoption of behavioral biometrics and continuous authentication technology: an empirical research. *Information & Computer Security*, *30*(4), 562-582.*https://doi.org/10.1108/ICS-08-2021-0124*

Tamang, A., Bhaskar, P. K., & Chatterjee, J. M. (2021). Acceleration of digital payment adoption during Covid-19 pandemic: A case study of Nepal. *LBEF Research Journal of Science, Technology and Management, 3*(2), 1-13. https://www.lbef.org/journal/3-2/download/3-2-1-13.pdf

Tercanli, H., Martina, R., Ferreira Dias, M., Wakkee, I., Reuter, J., Amorim, M., ... & Gutiérrez Pérez, J. (2021). Educational escape rooms in practice: research, experiences, and recommendations. DOI: 10.34624/rpxk-hc61

Thapa, S., & Sejuwal, S. (2025). Factors Affecting Customers' Adoption of Digital Payment in Nepal. https://www.theseus.fi/handle/10024/884200

Varpio, L., Paradis, E., Uijtdehaage, S., & Young, M. (2020). The distinctions between theory, theoretical framework, and conceptual framework. *Academic Medicine, 95*(7), 989-994.DOI: 10.1097/ACM.0000000000003075

Westland, J. C. (2022). Information loss and bias in likert survey responses. *PloS one, 17*(7), e0271949. https://doi.org/10.1371/journal.pone.0271949

Wilson, M. (2023). *Constructing measures: An item response modeling approach*. Routledge. https://doi.org/10.4324/9781003286929

Wu, J. H., & Wang, S. C. (2005). What drives mobile commerce? An empirical evaluation of the revised technology acceptance model. *Information and Management, 42*(5), 719–729. https://doi.org/10.1016/j.im.2004.07.001

Zarco, C., Giráldez-Cru, J., Cordón, O., & Liébana-Cabanillas, F. (2024). A comprehensive view of biometric payment in retailing: A complete study from user to expert. *Journal of Retailing and Consumer Services, 79*, 103789.https://doi.org/10.1016/j.jretconser.2024.103789

Zhang, W., Zhang, H., & Deng, Z. (2025). Public attitude and media governance of biometric information dissemination in the era of digital intelligence. *Scientific Reports, 15*(1), 2419. https://www.nature.com/articles/s41598-025-86603-w