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Prioritising the Key Factors Influencing the Adoption of Mobile Wallets: an Indian Perspective in Covid-19 Era

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Abstract

The purpose of this paper is to identify and prioritise mobile wallet (m-wallet) key adoption factors (KAFs). 9 KAFs are proposed by authors on the basis of a systematic literature review. Authors have proposed one novel factor influencing adoption called 'contactless transactions' due to pandemic and new normal post-Covid-19. This has resulted in a total of 10 KAFs. The fuzzy TOPSIS approach is proposed to rank these key adoption factors (KAFs). Sensitivity analysis has also been conducted to check the robustness of the study. Examining the literature indicates that this study is among the first attempts to prioritise key adoption factors (KAFs) using fuzzy TOPSIS. The results show that perceived security, trust, performance expectancy, perceived ease of use and contactless transactions are among the top 5 adoption factors. The findings of this research will be beneficial for both academicians and practitioners. The key adoption factors (KAFs) proposed in the paper will help practitioners develop strategies for building a wider acceptance of m-wallet among customers. Moreover, the fuzzy TOPSIS technique discussed in this paper will apprise managers about critical factors to be focused upon. This study will provide an integrated framework for academicians to carry out further research in the field of mobile wallets.

Keywords: Mobile wallet adoption, Key adoption factors (KAFs), Fuzzy TOPSIS, Covid-19, New normal

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Introduction

The growing demand for digital transactions globally has resulted in radical changes in the user attitude towards mobile payments and their adoption (Alalwan et al., 2017; Singh et al., 2020). Various studies in literature established that consumers favour technology providing swift, useful and convenient services using a distinct platform. In this respect, mobile payment services are versatile services with such characteristics (Shin, 2009; Singh et al., 2020). The services are available for both physical and remote payments. Mobile payments services have been broadly classified into three main categories. The first category includes point of sale services like near field communication (NFC) payments, including debit/credit transactions from customer's banks to retailers via a safe portal (Singh et al., 2020). The second category comprises in-store and remote payment technologies like mobile wallets and quick response (QR) codes (Liébana-Cabanillas et al., 2015; Singh et al., 2020). Mobile wallets require customers to install an application in their smartphones and load money to do online transactions whereas QR code integrates debit/credit card details through store apps and banking apps. The third category covers other remote payment services such as internet payments, SMS and mobile banking (Madan and Yadav 2016; Singh et al., 2020).

The usage of mobile wallets has enhanced in India mainly post demonetisation and during the Covid-19 pandemic (Kapoor et al., 2020). Various incentives introduced by the Indian government like a service tax waiver of up to 15% on transactions worth INR 2000, reward points and cashback offers further motivated people to use m-wallets (Singh et al., 2020). Despite offering so many benefits, the numbers of m-wallet users are still less (Agarwal, 2016; Madan and Yadav, 2016). The problem lies in customers' attitudes at the bottom of the pyramid (Shen, 2015; Madan and Yadav 2016). They still prefer cash for making payments because of poor knowledge about technology and its benefits. Security is another major concern. Consumers are reluctant to share their personal information while carrying out digital transactions. They are afraid of information leaks (Hossain et al., 2019). Other obstacles/barriers include resistance, infrastructural support, lack of information about the usage of products and interoperability issues (Oliveira et al., 2016). To overcome these hurdles and enhance mobile wallet adoption among consumers, a study to identify and rank key adoption factors (KAFs) of the mobile wallet is required.

The opinions of consumers and experts are vague and not crisp, thus opinions need to be exhibited using fuzzy sets which carry the potential to represent vague data (Kahraman et al., 2007). Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) technique is a widely used technique in multi-criteria decision-making. This technique's main aspect is that the best alternative has the shortest distance from the ideal solution and the farthest distance from the anti-idle solution. In the present context since the environment is fuzzy and TOPSIS forms the base for ranking of KAFs of mobile wallet adoption, the Fuzzy TOPSIS approach seems to be

the appropriate choice for prioritising m-wallet KAFs. Thus, the study's research objectives are as follow

RO1: To identify m-wallet key adoption factors

RO2: To prioritise m-wallet key adoption factors using fuzzy TOPSIS

The remaining paper is organised as follows. The following section consists of an in-depth review of studies related to mobile wallet adoption. Mobile wallet key adoption factors (KAFs) are proposed in this section. Next, the paper discusses fuzzy TOPSIS methodology covering the various steps in the fuzzy TOPSIS approach. The illustration section describes the evaluation and prioritisation of m-wallet adoption factors using fuzzy TOPSIS. Afterwards, sensitivity analysis has been conducted. Further, the conclusions of the study are presented. Finally, limitations and future directions are discussed.

Identification of mobile wallet key adoption factors (KAFs)

To find out mobile wallet KAFs, PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines of Moher et al. (2009) were followed. The ultimate objective of PRISMA is to report a literature review clearly and transparently. It has been used in various fields like health, technology and the environment. Based on these guidelines, a review protocol was developed. The protocol covered search strategy, criteria for excluding an article and evaluation of quality, extraction of data and data analysis.

Search Strategy

The authors consulted two databases, Scopus and Web of Science for a systematic review of mobile wallet literature. The data capturing period was from 2nd May to 7th May 2020. Keywords were used for assessing the pertinent studies. Since m-wallet is an electronic financial service, authors took into consideration various studies related to the adoption of different e-financial services like mobile wallet, internet banking, electronic banking and mobile banking. Various keywords used to extract papers from databases were (“key” OR “crucial” OR “central” OR “essential” OR “critical” OR “major” OR “dominant”) AND (“adopt*” OR “accept*” OR “behav*” OR “intent*”) AND (“factor” OR “dimension” OR “determinant” OR “component”) AND (“mobile wallet” OR “m-wallet” OR “digital wallet” OR “wallet apps” OR “mobile banking” OR “internet banking” OR “e-banking” OR “mobile payment”) AND (“user” OR “customer” OR “consumer” OR “buyer”). Since there are different interfaces for command search and advance search among databases, authors have keyed the search terms carefully into each of 2 databases according to each search interface's relevancy for identifying relevant studies. Articles were screened based on exclusion criteria, as shown in table 1. Scopus and Web of Science search resulted in a total of 534 articles. Articles that come under exclusion criteria were removed. In order to extract pertinent articles related to mobile wallet adoption, the authors conducted abstracts reviews. The authors selected 78 articles for full-text review.

Table 1. Exclusion criteria

Exclusion Criteria	
Excl 1	Articles in a language other than English
Exc 2	Articles not in a peer-reviewed journal like conference papers, book chapters etc.
Exc 3	Duplicate articles
Exc 4	Articles where adoption of electronic services is not the major theme

Evaluation of Quality

Researchers did a detailed examination of the full text of shortlisted studies for their quality assessment. It helped in analysing their rigorousness, credibility and relevance. It was conducted based on the quality assessment criteria presented in table 2.

Table 2. Quality assessment criteria

Code	Criteria
C1	**Problem statement**: The research objectives are properly explained and well-motivated
C2	**Research design**: Theories such as TAM, UTAUT is used for supporting the systematic review process
C3	**Data Collection**: Factors used in the study are most relevant for achieving objectives
C4	**Data analysis**: Data analysis used in the study is properly explained
C5	**Conclusions**: Findings are clearly reported and support results.

The criterion mentioned in table 2 was adapted from Nguyen-Duc et al. (2015). Every criterion had four possible scores: entirely fulfilled (3), sufficiently fulfilled (2), little fulfilled (1) and completely unfulfilled (0). After imposing quality assessment criteria, studies were arranged based on the scores provided by the authors. Researchers shortlisted 48 studies having an average quality score greater than 1.5. The process is explained in figure 1. The shortlisted articles were analysed in depth by the authors and various adoption factors were identified from them. Word cloud of all identified factors was constructed using the 'Wordle' data visualisation tool and is shown in figure 2. The factors were discussed at length with an academician researching consumer behaviour from the last decade and using different m-wallets regularly. After a detailed discussion, 09 key adoption factors in the context of m-wallet were selected. One new dimension “Contactless transactions” was also discussed with the academician and included in the study. So, a total of 10 m-wallet key acceptance factors are proposed. Figure 3 shows a diagrammatic representation of the proposed KAFs. These factors are briefed below

Trust

Despite having a technological and support structure, trust is a significant factor for electronic transactions (Agarwal et al., 2009). It is defined as the assurance that mobile wallet service providers will carry out activities in accordance with customer’s expectations (Gafen and Strarub, 2004; Shin, 2009). Consumers must trust that payment for transactions will be settled as expected, and their personal information will not be disclosed to inappropriate parties (Shaw, 2014). Studies depicted a positive association between trust and behavioural intention to adopt

mobile wallets among consumers (Shin, 2009; Shaw 2014; Chawla and Joshi 2019; Pal et al. 2020).

Perceived Security

Perceived security is defined as the extent to which a user believes that using the mobile wallet payment channel is safe (Shin, 2008; Shin 2009). Yenisey et al. (2005) defined perceived security as the degree to which users believe that their personal information and credentials will not be shared with any unauthorised user while making payment through a mobile wallet. Perceived security includes technical aspects like authentication and confidentiality and the user's comprehensive sense of security and well-being (Shin, 2009). Security act as a key dimension in influencing consumers' behaviour in studies related to e-commerce and mobile payments (Roca et al., 2009; Kim et al., 2011). Researchers found a positive relationship between security and intention to use mobile wallets among consumers (Oliveira et al., 2016; Chawla and Joshi, 2019; Mombeuil, 2020; Soodan and Rana, 2020).

Perceived Ease of Use

It is the degree to which consumers believes that using a system will be effortless (Davis, 1989). In the case of mobile wallets, it is the extent to which the user thinks that the effort required to learn and use mobile wallets would be minimal (Chawla and Joshi, 2019). Technical constraints such as difficulty in data entry or small screen size cause dissatisfaction and non-acceptance among some users (Kalinic and Marinkovic, 2016). User-friendly application layout and ease of using anywhere round the clock allow people to use mobile wallets widely. Thus, ease of use encourages users to use mobile payments and positively influence their intention to adopt mobile payments (Shankar and Datta, 2018). Studies in past literature outline that ease of use positively impacts the intention to adopt mobile wallets among consumers (Shin, 2009; Mombeuil, 2020; Lara-Rubio et al., 2020).

Contactless Transactions

Contactless transactions have gained user’s acceptability in recent years as it is a fast, secure and convenient way to make payments. Contactless payments are tap and pay transactions that allow users to pay by holding a contactless-enabled card, wearable or smartphone about an inch or so from a point-of-sale terminal. Information is shared with the terminal through near-field communication (NFC) technology (Topolski, 2020). NFC technology facilitates data transmission over distances up to twenty centimetres (Halaweh, 2013). Covid-19 has escalated the utilisation of contactless payment transactions in India. The government has urged citizens to maintain social distancing during the pandemic. To adopt social distancing norms, the World Health Organization recommended that users switch to contactless technology from cash, debit and credit cards (WHO, 2020). Digital contactless payments need minimal physical contact between seller and shopper. Hence, it is safe. Mobile wallets service providers observe an increase in their customer base since February 2020. People are switching to digital payments to

turn down the possibility of infection from using cash (Nandi and Banerjee, 2020). According to the US payment giant Master card, "Contactless Payments" have increased by 200 basis points in the month of May 2020. In order to push digital payments and to minimise the contact between drivers and toll booth operators, the government of India has made FASTag compulsory. Metro corporations of Delhi and Mumbai are planning a contactless ticketing system. Various e-commerce platforms like Amazon, Flipkart, Myntra etc. are prompting users to pay through

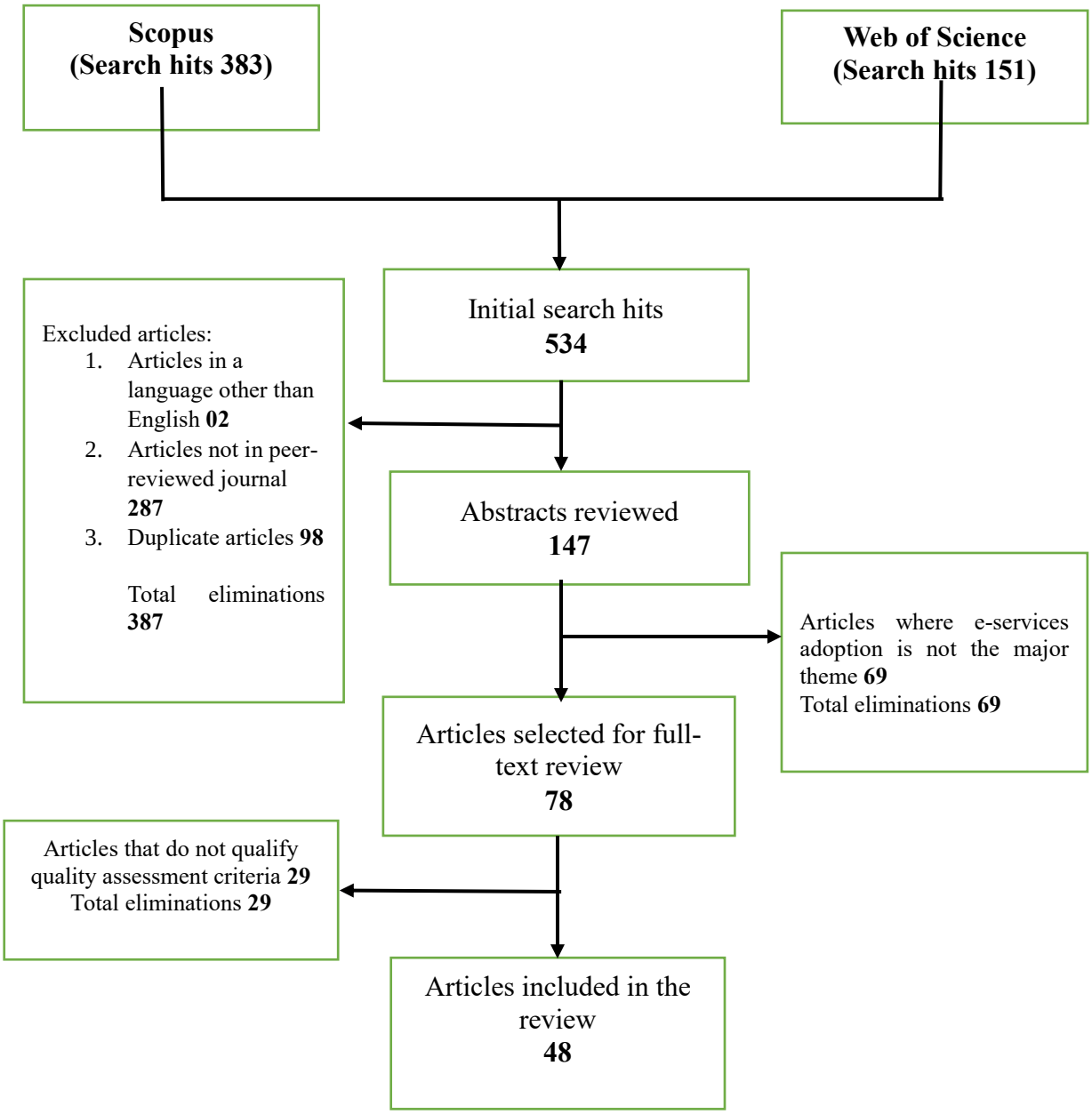

Figure 1. Procedure of systematic review

Figure 2. Adoption Factors Word cloud

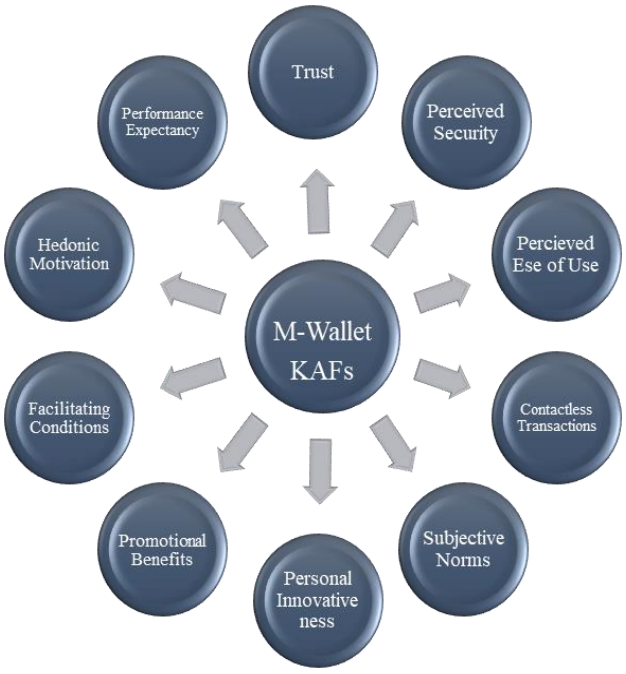

Figure 3. Mobile wallet key adoption factors

mobile wallets and other digital modes. According to Mr Sanjay Gupta, Vice President and India Country Manager NXP, People will be seeing a new normal as people will favour contactless payments even after the pandemic not only because of enhanced awareness about hygiene factors in the fight against Covid-19 but also due to the convenience that many first time users will experience in future (Bhatia, 2020).

Subjective Norms

Subjective norms examine the impact of social pressure on the user's action (Ajzen, 1985). It is the extent to which a user thinks that an important individual or group will endorse and support mobile wallet usage. Subjective norms generate social pressure which impacts consumers to choose new electronic services while making payments (Zhang and Mao, 2020). Various researchers validated the impact of subjective norms on behavioural intention in the area of mobile payments and internet banking (Lee, 2009; Schierz et al., 2010; Blaise et al., 2018; Zhang and Mao, 2020).

Personal Innovativeness

Agarwal and Prasad (1998) conceptualised the construct of 'Personal Innovativeness' in the field of information technology. It refers to an individual's willingness to check out any new information technology (Thakur and Srivastava, 2014). Personal innovativeness positively affects online shopping decisions (Blake et al., 2003; Kim et al., 2010). Many users still lack information and know-how about new mobile services. Personal innovativeness acts as a vital factor in the intention to adopt new mobile technologies (Kim et al., 2010). Pandey and Chawla (2018) outlined a significant indirect effect of personal innovativeness on m-commerce. Researchers reported a positive relationship between personal innovativeness and behavioural intention to use mobile payments (Amoroso and Chen, 2017; Lara-Rubio et al., 2020).

Promotional Benefits

With rising competition in the world of digital payments, promotional benefits have become an essential antecedent to mobile wallet adoption. It refers to various kinds of benefits like cash discounts, coupon codes, app download cash rewards, loyalty points and other freebies provided by mobile wallet service providers to consumers (Madan and Yadav, 2016). Over 50 per cent of online users in the UK and the US give due consideration to promotional benefits while making a purchase decision (Madan and Yadav, 2016). These benefits are usually communicated to consumers through mass media and impacts consumer's behaviour. Madan and Yadav (2016), Malik et al. (2019) and Prabhakaran et al. (2020) established a positive relationship between promotional benefits and behavioural intention to adopt mobile wallets among consumers.

Facilitating Conditions

Facilitating conditions refer to the extent to which customers believe that technical and organisational infrastructure is accessible to support the use of mobile wallets (Venkatesh et al.,

2003). It refers to environmental factors that affect an individual's desire to carry out a task (Teo et al., 2008). Availability of knowledge, support, and resources increase technology usage among users (Soodan and Rana 2020). Many researchers considered this factor in their studies to determine users' intention towards the adoption of technology like mobile banking, mobile commerce etc. (Yang, 2010; Amoroso and Magnier-Watanabe, 2012; Madan and Yadav, 2016). Authors in various studies established a relationship between facilitating conditions and user's intention to use a mobile wallet (Thakur, 2013; Madan and Yadav, 2016; Chawla and Joshi, 2019; Soodan and Rana, 2020).

Hedonic Motivation

Hedonic motivation is the pleasure/delight obtained by utilising technology. It is the extent to which users believe that using a mobile wallet is pleasurable (Venkatesh et al., 2012). It emphasised intrinsic benefits such as playfulness, enjoyment and joy. Customers want fun, in addition to using other services and features. Therefore, the element of entertainment has been added to the design philosophy of service providers (Dwivedi et al., 2015; Soodan and Rana 2020). Studies in the past depicted that hedonic motivation predicts consumer behaviour, specifically in ICT adoption among users (Childers et al. 2001). Researchers found a positive link between hedonic motivation and consumer’s intention to adopt mobile banking (Alalwan et al., 2016; Alalwan et al., 2017). Soodan and Rana (2020) reported a positive relationship between consumer’s hedonic motivations and their intention to use an e-wallet.

Performance Expectancy

Performance expectancy is defined as the degree to which users benefit from performing certain activities by using a particular technology (Venkatesh et al., 2012). In the context of mobile wallets, it refers to the extent to which users believe that using it as a substitute technology for executing payments will enhance and quicken their performance while doing purchase and sales transactions. Various researchers have considered performance expectancy while determining consumers' adoption intention in the context of mobile wallets (Shin, 2009; Slade et al., 2015, Yan and Yang, 2015). Researchers have established a positive relationship between performance expectancy and intention to adopt mobile wallets (Madan and Yadav, 2016; Oliveira et al., 2016; Soodan and Rana, 2020)..

Methdology

Various methods have been employed in the literature to prioritise factors. Multiple-criteria decision making (MCDM) is one of the most powerful tools widely used for dealing with unstructured problems containing multiple conflicting objectives. Various techniques have been emerged to solve MCDM problems such as the analytical hierarchy process (AHP), fuzzy AHP, data envelopment analysis (DEA), TOPSIS, fuzzy TOPSIS, VIKOR and MOORA. To solve MCDM problems, Hwang and Yoon (1981) proposed the TOPSIS method. TOPSIS utilise

different scalar values for both best and worst alternatives concurrently. It is easy to apply in comparison to other prevailing approaches (Kim et al., 1997). TOPSIS results get the least impacted when an alternative is added or removed. These strengths make TOPSIS a more robust technique in contrast to other techniques. Ratings and weights are considered in crisp numbers under the traditional TOPSIS method. Since human judgments are uncertain, subjective and might not be determined by exact numeric values, crisp numbers are inept in representing the real-life situation. To get rid of this problem, Zadeh (1965) introduced a fuzzy set theory. It deals with the vagueness and uncertainty of human judgments. Considering the benefits of fuzzy systems, researchers combined fuzzy logic with TOPSIS. Fuzzy TOPSIS is considered superior to TOPSIS for solving MCDM problems (Agrawal et al., 2016).

Researchers have used fuzzy TOPSIS in the literature to solve problems in diverse areas. Awasthi et al. (2010) evaluated the environmental performance of suppliers through fuzzy TOPSIS. Using fuzzy TOPSIS, Khanna and Sharma (2011) identified and prioritised critical success factors for implementing TQM in the manufacturing industry. Rouhani et al. (2013) used fuzzy TOPSIS for information technology service management software selection. Agrawal et al. (2016) employed fuzzy TOPSIS to prioritise critical success factors for reverse logistics implementation. In this paper, the authors have used the fuzzy TOPSIS technique proposed by Chen (1997) to prioritise m-wallet key adoption factors because this technique is considered superior compared to other techniques. Steps of fuzzy TOPSIS used for the proposed research are as follows

Step 1: This step involves data collection in linguistic terms. A suitable scale should be chosen for representing the data accurately. Respondents must be requested to choose the best linguistic term from the available alternatives for each question. After that, linguistic terms need to be converted into fuzzy numbers. Figure 4 represents a 5-point scale possessing linguistic terms low (L), fairly low (FL), medium (M), fairly high (FH) and high (H) and triangular fuzzy numbers (Agrawal et al., 2016). The reason for using triangular fuzzy numbers is its conceptual and computational simplicity (Kannan et al., 2009).

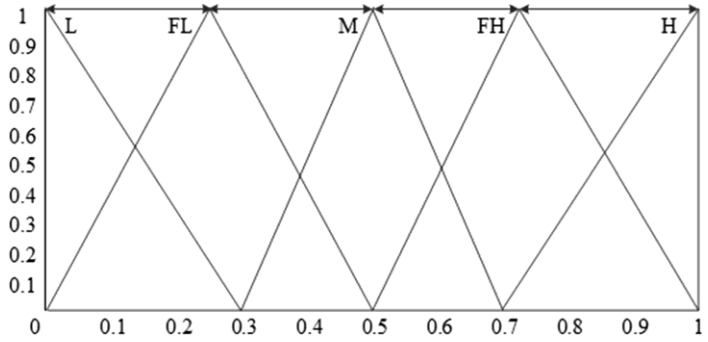

Figure 4. Linguistic scales and triangular fuzzy numbers

Linguistic ratings and the corresponding fuzzy numbers have been shown in table 3 (Agrawal et al., 2016).

Table 3. Linguistics terms and corresponding fuzzy number

Linguistic term	Fuzzy number
Low	(0.0,0.1,0.3)
Fairly low	(0.1,0.3,0.5)
Medium	(0.3,0.5,0.7)
Fairly high	(0.5,0.7,0.9)
High	(0.7,0.9,1.0)

Step 2: This step involves the computation of a fuzzy decision matrix. The fuzzy decision matrix is constructed as follows

$$D = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1j} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2j} & \dots & x_{2n} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ x_{i1} & x_{i2} & \dots & x_{ij} & \dots & x_{in} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \dots & x_{mj} & \dots & x_{mn} \end{bmatrix}, \quad (1)$$

Where x_{ij} $(= (a_{ij}, b_{ij}, c_{ij}))$ represents a fuzzy number corresponding to the linguistic term given by ith Decision Maker (DM) to jth factor. i = 1, 2, …, m represents number of decision-makers and j = 1, 2, …, n represents number of Key adoption factors (KAFs).

Step 3: This step covers neutralising the weights of the decision matrix generating an un-weighted fuzzy matrix (R). Following relation can be applied for generating

$$R = [r_{ij}]_{mxn}$$

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_j^*}, \frac{b_{ij}}{c_j^*}, \frac{c_{ij}}{c_j^*} \right), \; c_j^* = \max_i c_{ij} \quad (2)$$

Step 4: In this step weighted normalised decision matrix is computed

$$V = \left[v_{ij} \right]_{m \times n}; i = 1, 2, 3 \dots, m; \quad j = 1,2,3,\dots,n \quad (3)$$

The weighted normalized value v_{ij} is computed as follows:-

$$v_{ij} = r_{ij} * w_j \quad (4)$$

Where w_j represent the weight given to each decision-maker. $w_j = (1,1,1,1,1) \forall j \in n$, since all the decision-makers have been given the same weights in the study.

Step 5: This step involves the calculation of the fuzzy negative ideal solution and fuzzy positive ideal solution for KAFs

$$A^* = \left(v_1^*, v_2^* \cdots\cdots\cdots v_n^* \right) \quad (5)$$

$$A^{-} = \left(v_1^{-}, v_2^{-} \cdots\cdots\cdots v_n^{-}\right) \quad (6)$$

Following terms have been used for an ideal positive and ideal negative solution according to Chen (1997) approach.

$$v_j^{*} = (1, 1, 1) \quad (7)$$

$$v_j^{-} = (0, 0, 0) \quad (8)$$

Step 6: This step involves the calculation of the distance of each factor from FPIS and FNIS

$$D_j^{*} = \frac{\sum_{i=1}^{m} d\left(v_{ij} - v_i^{*}\right)}{m}, \quad \text{j= 1, 2, …, n} \quad (9)$$

$d\left(v_{ij} - v_i^{*}\right)$ represents the distance between two fuzzy numbers that can be calculated by vector algebra. For example distance between two numbers $\text{A1}(a_1, b_1, c_1)$ and $\text{A2}(a_2, b_2, c_2)$ can be computed as follows

$$d(A1 - A2) = \sqrt{\frac{1}{3}\left[(a_2 - a_1)^2 + (b_2 - b_1)^2 + (c_2 - c_1)^2\right]}$$

Likewise, a negative ideal solution can be separated as follows-

$$D_j^{-} = \frac{\sum_{i=1}^{m} d\left(v_{ij} - v_i^{-}\right)}{m}, \quad \text{j= 1, 2, …, n} \quad (10)$$

Step 7: In this step the closeness coefficient (C_j) of each factor is calculated. The closeness coefficient C_j represents the distances to the fuzzy positive ideal solution (A^*) and the fuzzy negative ideal solution (A^-) concurrently. The closeness coefficient of each factor is computed as follows

$$C_j = \frac{D_j^{-}}{D_j^{*} + D_j^{-}} \quad (11)$$

Step 8: In the final step, KAFs are prioritised based on the order of C_j values.

Illustration

For prioritising 10 mobile wallet KAFs, 5 Decision makers (2 academicians having a doctorate in an area related to e-services adoption, 2 customers who are heavy users of different m-wallet applications and websites, and 1 banker having rich knowledge of mobile wallet operations) having an average experience of more than 11 years were consulted. Decision-makers (DMs) are

requested to rate the above-mentioned key adoption factors on a 5-point scale having the linguistic terms low (L), fairly low (FL), medium (M), fairly high (FH), and high (H). Linguistic variables used by decision-makers have been shown in table 3. Based on responses received from decision-makers (DMs), a decision matrix has been developed. It has been presented in table 4.

Table 4. Linguistic rating of criteria

S. No.	Criteria for mobile wallet adoption	DM1	DM2	DM3	DM4	DM5
1	Trust (KAF1)	FH	H	H	FH	H
2	Perceived security (KAF 2)	H	H	H	H	FH
3	Perceived ease of use (KAF 3)	H	FH	FH	FH	FH
4	Contactless transaction (KAF 4)	H	FH	FH	FH	M
5	Subjective norms (KAF 5)	M	M	FL	L	FL
6	Personal innovativeness (KAF 6)	FL	FL	M	M	M
7	Promotional benefits (KAF 7)	H	M	FH	M	M
8	Facilitating conditions (KAF 8)	FH	M	FH	M	FH
9	Hedonic motivation (KAF 9)	FH	M	FH	H	M
10	Performance expectancy (KAF10)	FH	FH	H	FH	H

Linguistic variables are converted into triangular fuzzy numbers. Fuzzy matrix D has been obtained after converting the linguistic responses mentioned in table 4 into triangular fuzzy numbers with the help of table 3. In the next step, the un-weighted fuzzy decision matrix R has been computed. Subsequently, further steps have been followed to obtain a weighted fuzzy normalised decision matrix to find the ideal and negative ideal solutions of KAFs. The distance D^* and D^- of each KAF has been derived using equations (7), (8), (9), and (10). Further, closeness coefficient C has been calculated for each KAF using equation (11). The values D^* D^- and closeness coefficient C has been shown in table 5. Lastly, all the KAFs have been prioritised and presented in table 5. Among the 10 key factors, perceived security has been ranked 1, and the subjective norm has been ranked 10. The final ranking of KAFs is as follows

KAF 2> KAF1>KAF10>KAF3>KAF4>KAF9>KAF8>KAF7>KAF6>KAF5

Table 5. Closeness coefficient matrix and Ranking

S. No.	Criteria for mobile wallet adoption	D*	D-	C	Ranking
1	Trust (KAF1)	0.246	0.813	0.768	2
2	Perceived security (KAF 2)	0.214	0.844	0.797	1
3	Perceived ease of use (KAF 3)	0.310	0.750	0.708	4
4	Contactless transaction (KAF 4)	0.347	0.712	0.672	5
5	Subjective norms (KAF 5)	0.673	0.384	0.363	10
6	Personal innovativeness (KAF 6)	0.603	0.452	0.429	9
7	Promotional benefits (KAF 7)	0.420	0.634	0.601	8
8	Facilitating conditions (KAF 8)	0.415	0.642	0.607	7
9	Hedonic motivation (KAF 9)	0.384	0.673	0.637	6
10	Performance expectancy (KAF10)	0.278	0.782	0.738	3

Results

To check the impact of criteria weights on the decision-making process, the authors conducted a sensitivity analysis. 15 experiments were conducted. Details of experiments have been presented in table 6. From table 6, it can be inferred that, in the first 5 experiments criteria weights are set equal to (0.0,0.1,0.3), (0.1,0.3,0.5), (0.3,0.5,0.7), (0.5,0.7,0.9), (0.5,0.7,0.9). In experiment 6-15, one by one, the weights of each criterion is set as highest (0.5, 0.7, 0.9) and weights of the remaining criteria are set to the lowest value (0.0, 0.1, 0.3). The purpose is to check which criteria influence the decision-making process the most. For example, in experiment 8, the weight of criteria 3 is set as highest (0.5, 0.7, 0.9) and the remaining criteria weights are set to the lowest (0.0, 0.1, 0.3). Rankings have been shown in table 7. It can be seen from table 7 that KAF 2 has the highest score in 6 out of 15 experiments. (Experiment number 1-5 and 7). In the remaining experiments, KAF 1, KAF 3, KAF 4. KAF 5, KAF 6, KAF 7, KAF 8, KAF 9, and KAF 10 have scored 1 vote each. Therefore, it can be said that the decision-making process is insensitive to criteria weights with KAF 2 (perceived security) coming up as the winner with majority votes.

Table 6. Experiments for sensitivity analysis

Expt No.	Definition	Overall Closeness Coefficient									
		KAF 1	KAF 2	KAF 3	KAF 4	KAF 5	KAF 6	KAF 7	KAF 8	KAF9	KAF 10
1	$W_{KAF1-KAF10}$ = (0,0.1,0.3)	0.163	0.167	0.156	0.150	0.093	0.106	0.137	0.140	0.143	0.160
2	$W_{KAF1-KAF10}$ = (0.1,0.3,0.5)	0.293	0.301	0.277	0.265	0.160	0.185	0.241	0.246	0.253	0.285
3	$W_{KAF1-KAF10}$ = (0.3,0.5,0.7)	0.433	0.447	0.407	0.389	0.229	0.265	0.353	0.358	0.371	0.420
4	$W_{KAF1-KAF10}$ = (0.5,0.7,0.9)	0.568	0.586	0.532	0.508	0.297	0.344	0.461	0.466	0.485	0.550
5	$W_{KAF1-KAF10}$ = (0.7,0.9,1)	0.672	0.694	0.627	0.599	0.342	0.399	0.541	0.547	0.570	0.650
6	W_{KAF1} = (0.7,0.9,1), $W_{KAF2-KAF10}$ = (0,0.1,0.3)	0.672	0.167	0.156	0.150	0.093	0.106	0.137	0.140	0.143	0.160
7	W_{KAF2} = (0.7,0.9,1), $W_{KAF1,KAF3-KAF10}$ = (0,0.1,0.3)	0.163	0.694	0.156	0.150	0.093	0.106	0.137	0.140	0.143	0.160

8	W_{KAF3} = (0.7,0.9,0.1), $W_{KAF1-KAF2,KAF4-KAF10}$ = (0,0.1,0.3)	0.163	0.167	0.627	0.150	0.093	0.106	0.137	0.140	0.143	0.160
9	W_{KAF4} = (0.7,0.9,0.1), $W_{KAF1-KAF3,KAF5-KAF10}$ = (0,0.1,0.3)	0.163	0.167	0.156	0.599	0.093	0.106	0.137	0.140	0.143	0.160
10	W_{KAF5} = (0.7,0.9,0.1), $W_{KAF1-KAF4,KAF6-KAF10}$ = (0,0.1,0.3)	0.163	0.167	0.156	0.150	0.342	0.106	0.137	0.140	0.143	0.160
11	W_{KAF6} = (0.7,0.9,1), $W_{KAF1-KAF5,KAF7-KAF10}$ = (0,0.1,0.3)	0.163	0.167	0.156	0.150	0.093	0.399	0.137	0.140	0.143	0.160
12	W_{KAF7} = (0.7,0.9,1), $W_{KAF1-KAF6,KAF8-KAF10}$ = (0,0.1,0.3)	0.163	0.167	0.156	0.150	0.093	0.106	0.541	0.140	0.143	0.160
13	W_{KAF8} = (0.7,0.9,1), $W_{KAF1-KAF7,KAF9-KAF10}$ = (0,0.1,0.3)	0.163	0.167	0.156	0.150	0.093	0.106	0.137	0.547	0.143	0.160
14	W_{KAF9} = (0.7,0.9,1), $W_{KAF1-KAF8,KAF9-KAF10}$ = (0,0.1,0.3)	0.163	0.167	0.156	0.150	0.093	0.106	0.137	0.140	0.570	0.160
15	W_{KAF10} = (0.7,0.9,1), $W_{KAF1-KAF9}$ = (0,0.1,0.3)	0.163	0.167	0.156	0.150	0.093	0.106	0.137	0.140	0.143	0.650

Table 7. Ranking of KAFs

Expt. No.	Ranking
1	KAF2>KAF1>KAF10>KAF3>KAF4>KAF9>KAF8>KAF7>KAF6>KAF5
2	KAF2>KAF1>KAF10>KAF3>KAF4>KAF9>KAF8>KAF7>KAF6>KAF5
3	KAF2>KAF1>KAF10>KAF3>KAF4>KAF9>KAF8>KAF7>KAF6>KAF5
4	KAF2>KAF1>KAF10>KAF3>KAF4>KAF9>KAF8>KAF7>KAF6>KAF5
5	KAF2>KAF1>KAF10>KAF3>KAF4>KAF9>KAF8>KAF7>KAF6>KAF5
6	KAF1>KAF2>KAF10>KAF3>KAF4>KAF9>KAF8>KAF7>KAF6>KAF5
7	KAF2>KAF1>KAF10>KAF3>KAF4>KAF9>KAF8>KAF7>KAF6>KAF5
8	KAF3>KAF2>KAF1>KAF10>KAF4>KAF9>KAF8>KAF7>KAF6>KAF5
9	KAF4>KAF2>KAF1>KAF10>KAF3>KAF9>KAF8>KAF7>KAF6>KAF5
10	KAF5>KAF2>KAF1>KAF10>KAF3>KAF4>KAF9>KAF8>KAF7>KAF6
11	KAF6>KAF2>KAF1>KAF10>KAF3>KAF4>KAF9>KAF8>KAF7>KAF5
12	KAF7>KAF2>KAF1>KAF10>KAF3>KAF4>KAF9>KAF8>KAF6>KAF5
13	KAF8>KAF2>KAF1>KAF10>KAF3>KAF4>KAF9>KAF7>KAF6>KAF5
14	KAF9>KAF2>KAF1>KAF10>KAF3>KAF4>KAF8>KAF7>KAF6>KAF5
15	KAF10>KAF2>KAF1>KAF3>KAF4>KAF9>KAF8>KAF7>KAF6>KAF5

Discussion

Authors have prioritised mobile wallet key adoption factors among users using fuzzy TOPSIS. Findings revealed that perceived security emerged as a major KAF influencing mobile wallet adoption among customers. This finding is consistent with the previous studies where the high importance of security is highlighted (Shin 2009; Oliveira et al. 2016; Chawla and Joshi 2019, Mombeuil 2020; Soodan and Rana 2020). Security is the key factor because payment transactions carry personal information, and users require assurance that their data is secure, and their account is debited with an accurate amount (Shaw 2015). Trust came out as the second KAF influencing the adoption of mobile wallets, confirming previous research findings that have considered trust among the top factors (Shin 2009; Shaw 2014; Chawla and Joshi 2019; Pal et al., 2020). To promote digital transactions, the Government of India has endorsed the BHIM app to build consumers' trust (Pal et al., 2020). Performance expectancy has been prioritised as the third important KAF impacting mobile wallet adoption. This finding is supported by the corroboration of various studies that have considered it a significant factor (Madan and Yadav 2016; Oliveira et al. 2016; Patil et al 2017; Soodan and Rana 2020). Perceived ease of use has been ranked as the fourth KAF affecting mobile wallet adoption. An alike confirmation has been found in previous research studies that insisted on the user-friendly interface (Shin 2009; Chawla and Joshi 2019; Mombeuil 2020; Lara-Rubio et al. 2020). Users tend to adopt mobile wallets when they find them easy to operate in contrast with other conventional payment methods. Service providers should make the mobile wallet application simple to operate and understand. Contactless transactions have emerged as the fifth KAF. Authors have identified it in the context of the ongoing pandemic Covid-19. Covid-19 has added a new dimension to digital payments as mobile wallet companies saw an uptick in their user base. Bank for International Settlement data reported an increase in the utilisation of contactless payments in major economies (Auer et al., 2020). Digital payments are playing a vital role during the pandemic. People are avoiding cash for making payments as currency can carry the virus on its surface. Mobile payment is secure for users since it helps them avoid coming in direct contact with coins or paper notes. Thus, it acted as a medium to stick to social distancing norms. Online delivery services also stimulated mobile payment as some local governments insisted that home delivery services be cashless during lockdown (Kapoor, 2020). Personal innovativeness and subjective norms influence mobile wallets' adoption, but these KAFs have been ranked lower in the present study. This result supports the other studies that considered personal innovativeness as a driving factor at the early stages of introducing new technology services (Thakur and Srivastava, 2014).

Conclusion

The study aimed to identify and prioritise m-wallet key adoption factors. Based on a systematic literature review and discussion with experts, authors have proposed 10 KAFs of mobile wallet adoption namely trust, perceived security, perceived ease of use, contactless transactions,

subjective norms, personal innovativeness, promotional benefits, facilitating conditions, hedonic motivation and performance expectancy. Experts provided linguistic ratings to KAFs. Fuzzy TOPSIS has been applied to aggregate the ratings and thus prioritising key factors. Prioritisation is useful in determining the relative importance of factors, which helps develop strategies for successfully adopting m-wallets. Security has emerged as the most important area to focus on improving mobile wallet adoption among customers. This research makes a remarkable contribution to academics and industry by proposing a structure to evaluate and prioritise key mobile wallet adoption using fuzzy TOPSIS.

Theoretical Contributions

In terms of theoretical contribution, the study is among the pioneer studies to identify and prioritise the mobile wallet KAFs using fuzzy TOPSIS. The current study contributed to the literature by identifying KAFs of m-wallet among consumers through systematic literature review and discussion with the domain expert. In addition to extensively studied factors in literature impacting the adoption of mobile wallets among consumers, the present study amplified academic contribution by propelling a novel factor called “Contactless Transactions” and proposing a structure to prioritise KAFs to m-wallet adoption. Sensitivity analysis revealed the robustness of the study. It will serve as a knowledge base for future studies in the area of electronic financial services.

Managerial Implications

The present study offered valuable insights into the mobile wallet industry's management by prioritising the KAFs of the mobile wallet. Firstly, perceived security was found to be the topmost factor that led to adoption among consumers. So, managers need to pay attention to it. For intensifying security, m-wallet service providers might incorporate pseudo-identity techniques and digital signatures within their app. They can develop a multifactor authentication method, by combining passwords, fingerprints and PINs to amplify security. Secondly, other top-ranked factors trust, performance expectancy and perceived ease of use require emphasis to build the user base. Trust can be attained by developing a secure, robust, transparent and reliable infrastructure for providing m-wallet services. Consumers prefer mobile wallets to make payments because it makes the transaction more convenient by eliminating the requirement for the physical transfer of funds (Madan and Yadav, 2016). However, to strengthen performance expectancy, service providers should reinforce it beyond payment capabilities (Soodan and Rana 2020). For increasing perceived ease of use, service providers should make it user-friendly apps that are easy to navigate. Thirdly, the new KAF introduced by authors, i.e. 'contactless transactions', has new useful insight for the m-wallet industry's service providers. The covid-19 outbreak has accelerated the use of contactless payments. In developing countries such as India, users are usually confronted with internet connectivity issues like network issues or slow internet speed and other smartphone problems. Often these issues create a mess in making payments

through mobile wallets. Considering these obstacles, service providers need to find a reliable solution, enabling consumers to pay through offline mode. Some m-wallet service providers have launched a tap and pay card linked to m-wallet which is an NFC-based contactless card where consumers just tap on the merchant's terminal and make payment. Nevertheless, service providers need to work in this direction to find more relevant solutions. Lastly, this study will enable the mobile wallet industry managers in recognising key factors for framing the strategies. Service providers can use the results obtained from this study in framing policies that will help build their user base. Overall, this research gives a direction for enhancing the efficacy of the mobile wallet business.

Limitations and Future Scope

The KAFs for mobile wallet adoption has been evaluated and ranked based on the opinion of 5 experts. The opinion of a larger number of experts can be considered. Instead of using a 5-point linguistic scale, a 7 or 11-point linguistic scale could be used. Authors have proposed and ranked a new adoption factor "contactless transactions" considering the current pandemic Covid-19. In future, research may be carried out to analyse the impact on the ranking of this KAF post-Covid-19. Additionally, research may be conducted to prioritise the KAFs of mobile wallets by taking sub-factors of all factors. Other multi-criteria decision-making techniques may be used in future research and results attained from those methods may be compared with these research results.

Conflict of interest

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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