



# An evaluation of business models in e-mobile payment by using multiple criteria decision making

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## Abstract

Due to the significant growth in the usage of cell phone by customers and its availability, this tool can be considered such the best tool. For e-payment for implementing the mobile payment service, other objects and players should be considered such as banks, operators, service providers and the used technology as the effective interaction role. In addition, for effective optimization of parameters for implementing the mobile payment solution a proper model of business should be used. First of all, in this experiment, different business models in the field of mobile payment and the role of each stakeholder in these models and their positive and negative points are discussed. Moreover, by using method of Multiple Criteria Decision Making, four famous business models of the world are evaluated and the result of this evaluation highlights that the cooperation model is the most Appropriate Model in terms of mobile payment methods.

*Keywords:* Business Model; Mobile Payment; Multiple Criteria Decision Making; TOPSIS Method.

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## 1. Introduction

A prominent decision which may lead to success of mobile electronic commerce is selection of a proper and optimal payment model representing the interaction between stakeholders in a suitable manner. Diverse mobile payment business models are evolving right now. The main differences of these methods are related to various answers which are provided for the following question; who does establish the connection between end user, bank, operator and other non-bank companies? Another class of differences is associated with nature and regulations of companies or bank and non-bank representatives. General speaking, there are four potential model of mobile payment: Operator-Centric model, bank-centric model, peer to peer model and collaboration model. This study aims to examine these four models and present their advantages and drawbacks; then, using a multiple criteria decision making model the best candidate is selected for mobile electronic payment.

## 2. Different types of business models

Business models are categorized as various scenarios according to important roles of participants [5]. In this paper a few famous models are introduced and their advantages and disadvantages for different stakeholders are presented.

### 2.1. Operators-centric model

In Operator-Centric Model, mobile phone operators act independently for performance of e-payment and financial institutes don't participate in payment process. In this model, operator is production authority and e-payment manager. Many of the developed Operator-Centric models have been challenged due to no connection with present payment networks. Some examples have been commissioned with this model in the newly emerging countries but they don't

cover e-payment services methods and e-payments have been limited to payment of fund and purchase of mobile phone charge. Here, payment can be made with two methods: payment with credit card and payment through telecommunication phone bill. Therefore, major payments are not supported in this model. Operator also can create a mobile wallet independent of user account [3] [8] [21] Communication scenario between beneficiaries in Operator-Centric Model is shown in Figure 1.

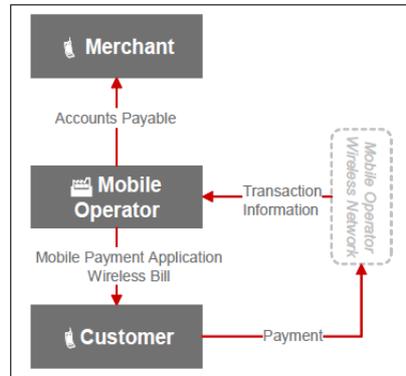


Fig. 1: Operator-Centric Model: Stakeholder Scenario [5] [21].

**2.1.1. Pros and cons for stakeholders**

The Operator-Centric Model has some benefits if it provides expedient deployment. From a logistical standpoint, this model provides the fastest and easiest approach to get an application to the mobile device since customer initiation of a download is not required. The primary benefit to mobile operators is sole control over the revenue stream. Brand recognition is an additional benefit to the operator. If the merchant acceptance infrastructure becomes widely available, consumers may view the technology as a convenience and purchase products or services that are NFC-enabled. While not specific to this model, the potential business benefits to all stakeholders are revenue growth, increased customer retention and the delivery of marketing and advertising campaigns. When utilizing this model, operators would have ultimate control of the infrastructure and the associated revenues. However, they would also incur the corresponding risks and liability.

A large deployment of the Operator-Centric Model is severely challenged by the lack of connection to existing payment networks.

Table 1 summarizes the pros and cons for each Operator-Centric Model stakeholder.

Surveyed respondents are skeptical of the Operator-Centric Model’s success due to several risks, including:

- Merchant deployment
- Additional point-of-sale devices
- Lack of business relationship between merchant and operator
- Consumer attitude on perceived convenience
- Deviation from core competencies
- Fraud/privacy/risk management concerns
- Billing/customer service issues

**Table 1:** Pros and Cons for Each Operator-Centric Model Stakeholder [5] [21]

Stakeholder	Pros	Cons
Bank	<ul style="list-style-type: none"> <li>• None</li> <li>• Control over majority of the revenue stream</li> </ul>	<ul style="list-style-type: none"> <li>• Disintermediation from mobile payments value chain</li> <li>• Assumption of risk of additional customer credit</li> <li>• Assumption of cost of theft and fraud</li> </ul>
Mobile Operator	<ul style="list-style-type: none"> <li>• Leverage of existing infrastructure to bill customers and to pay merchants</li> <li>• Customer loyalty</li> <li>• Reduced customer turnover</li> <li>• Reduced cash-handling costs, including theft, shrinkage and cash deposit charges</li> </ul>	<ul style="list-style-type: none"> <li>• Potential for low merchant acceptance of new payment approach and reluctance to adopt new POS mechanism</li> <li>• Management of integration with multiple issuers</li> <li>• Fee for low value payments</li> <li>• Reimbursement dependent on operator’s payment cycle (delay in payment)</li> </ul>
Merchant	<ul style="list-style-type: none"> <li>• Increased efficiency, through-put, and convenience</li> <li>• Reduced counterfeit exposure</li> <li>• Potential for increased impulse spending</li> </ul>	<ul style="list-style-type: none"> <li>• Exposure to mobile operator with limited payments processing experience</li> <li>• Investment required for new payment mechanism</li> </ul>

Considering the above cases and type of communication among beneficiaries in Operator-Centric Model, the presence of each of these people in this model will bring different profit and risk for them. Fig 2 graphically shows risk and profit rate for each one of the beneficiaries.

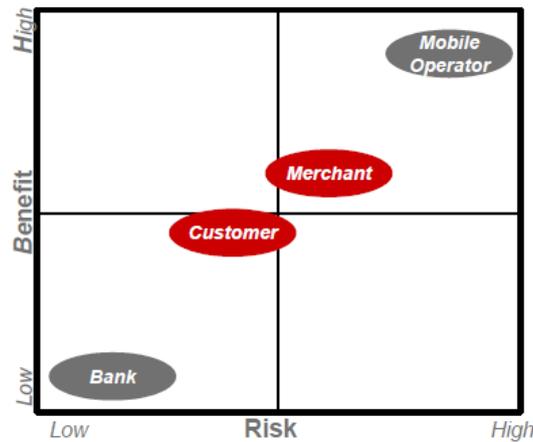


Fig. 2: Risks and Benefits for Operator-Centric Model Stakeholders [4] [21].

### 2.2. Bank-centric model

In this model, bank is responsible for production and management of e-payment service like the present credit card system. Operators don't participate in this payment process. Banks produce e-payment plans or provide e-payment devices for customers and guarantee communication point between customer and sellers. In this model, mobile network operator is used as a simple authority. However, there is benefit of operator in this model when banks use Sim Card based software technology for the mobile tools. In these cards, banks should pay rental to operators. Operators also provide their experience for guaranteeing QOS. In this model, since payments are made through bank accounts, both major and minor payments should be supported [3] [8] [21]. Figure 3 shows communication scenario between beneficiaries in the Bank-Centric Model. One of the known systems which use Business Model is Pay Box method.

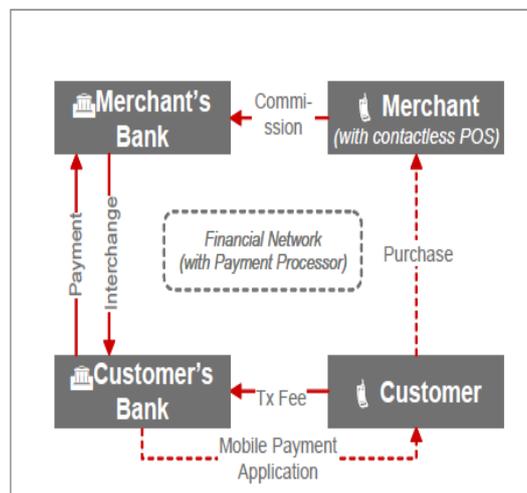


Fig. 3: Bank-Centric Model: Stakeholder Scenario [4] [21].

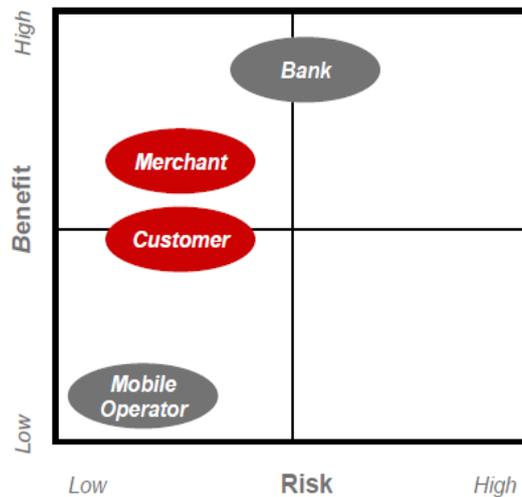
#### 2.2.1. Pros and cons for stakeholders

The key strength of this model is that it closely mirrors today's four-corner payments model and consequently is readily understood. However, the consensus of the survey respondents suggests that this model fails to reward key participants for their contributions and so will struggle to dominate long term. The survey exposed an interesting parallel when considering who is an active participant in the payment transaction. When a payment is made over the Internet, neither the Internet service provider nor the browser manufacturer takes a cut. So, for mobile payment, a reasonable question is why should mobile operators get paid for transporting the transaction or enabling the user to make the transaction? In reality, this issue is one that the industry may struggle with for some time before a compromise is reached. Table 2 provides a detailed assessment of the benefits of this model for the key stakeholders.

**Table 2:** Pros and Cons for Each Bank-Centric Model Stakeholder [5] [21]

Stakeholder	Pros	Cons
Bank	<ul style="list-style-type: none"> <li>Revenue stream capture for micro-payments</li> <li>Reduced cash/check handling</li> <li>Potential to include value-added advertising to retailers for a fee</li> <li>Potential for new customer acquisition (including unbanked)</li> <li>Enhanced security features</li> <li>Increased value of customer relationships and retention</li> </ul>	<ul style="list-style-type: none"> <li>Limited experience in application distribution or phone accessories</li> <li>Added cost of installation and maintenance of mobile applications for multiple operators, each with unique platforms</li> <li>Potential for paying “rental” fees to operators. Operators can block us-age.</li> <li>Competing form factor to cards</li> </ul>
Mobile Operator	<ul style="list-style-type: none"> <li>Possible increase in data transaction volumes and revenues</li> <li>Potential incentive fees for introducing new customers</li> <li>Reduced cash-handling costs, including theft, shrinkage and cash deposit charges</li> </ul>	<ul style="list-style-type: none"> <li>Operators bypassed in mobile payments value chain</li> </ul>
Merchant	<ul style="list-style-type: none"> <li>Increased cashier efficiency and throughput and shorter queues</li> <li>Reduced counterfeit exposure</li> <li>Increased impulse spending</li> <li>Faster payment directly into merchant's account</li> <li>Speed and convenience</li> </ul>	<ul style="list-style-type: none"> <li>Commissions/transaction fees for low-value transactions</li> <li>Merchant resistance to increasing card-based transactions due to interchange</li> </ul>
Customer	<ul style="list-style-type: none"> <li>Less disruptive -- provides access to transaction history for low-value purchases</li> <li>Alternative to costly “white-label” ATM fees.</li> </ul>	<ul style="list-style-type: none"> <li>Limited to specific bank offering a service – may not be permitted to add other applications</li> </ul>

Considering these cases, there are some barriers for execution of a successful bank centric model. First, all banks may be forced to support different and special standards of operators due to dependency of mobile phone operators. Second, banks act with trade for investment in e-payment considering that they are producing contactless debit and credit cards. Figure 4 shows risk and benefit for each one of the beneficiaries in bank-centric model.



**Fig. 4:** Risks and Benefits for Bank-Centric Model Stakeholders [4] [21].

### 2.3. Peer-to-peer model

This model is different from the above models. The third company commissions e-payment service using infrastructures of banks and operators and acts independently of financial institutes and network operators. The third company acts as a route among customers, sellers and banks. Transaction is performed peer to peer between customer and seller. This model changes the present payment ecosystem by reducing role of banks and payment networks. In addition, money can be transferred from a person to another person in this method. Therefore, this model affects business of money transfer. One of the known e-payment services which follow this business model is Pay Bal [3] [8]. Figure 5 shows communication scenario between the beneficiaries in peer-to-peer model

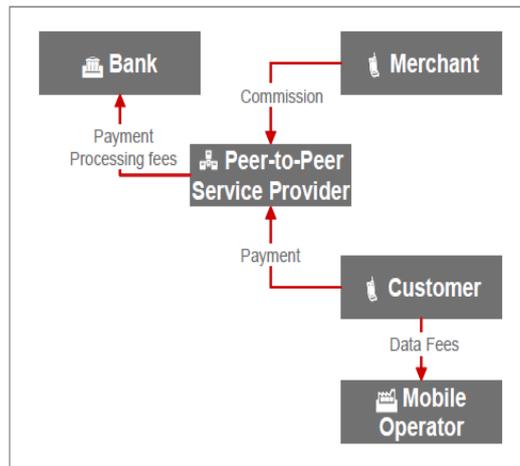


Fig. 5: Peer-to-Peer Model: Stakeholder Scenario [4] [21]

Peer to peer model is interesting for the merchant who seeks to reduce processing costs of payment credit and debit cards for non-bank customers and those who can use traditional cards. It is also suitable for the customers who seek to send money to friends and family out of their country.

However, the following cases and problems should be removed by the beneficiaries for survival of this model.

- Supporting considerable number of commercial places which can be used for customers.
- Providing sustainable income for banks so that they guide transactions toward this direction.
- Ensuring that transactions are suitable whether in POS or on line.
- Dominating over report of negative media on money laundering and security
- Settling dispute between beneficiaries

Figure 6 shows risk and benefit for each one of the beneficiaries in peer to peer model.

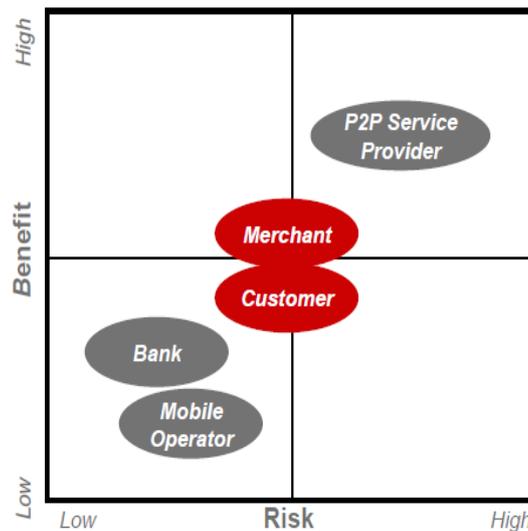


Fig. 6: Risks and Benefits for Peer-to-Peer (P2P) Model Stakeholders [4] [21].

### 2.3.1. Pros and Cons for Stakeholders

Interviewees identified the pros and cons shown in Table 3 for the stakeholders of the Peer-to-Peer Model.

Table 3: Pros and Cons for Each Peer-to-Peer Model Stakeholder [5]

Stakeholder	Pros	Cons
Bank	<ul style="list-style-type: none"> <li>• Revenue stream capture from processing fees</li> <li>• Access to broader set of customers from peer-to-peer provider</li> <li>• Potential to form partner-ships</li> </ul>	<ul style="list-style-type: none"> <li>• Potential disintermediation if the service provider utilizes another bank as the payment processor</li> <li>• Lack of visibility to customer’s transactions</li> <li>• Certification of device security</li> </ul>
Mobile Operator	<ul style="list-style-type: none"> <li>• Possible increase in data transaction volumes</li> <li>• Potential to partner with peer-to-peer provider</li> </ul>	<ul style="list-style-type: none"> <li>• Disintermediation from mobile payments value chain</li> </ul>

Peer-to-Peer Service Provider	<ul style="list-style-type: none"> <li>• Revenue capture from transaction fees and potential commissions</li> <li>• Marketing revenues</li> <li>• Cross-sell opportunities for other offerings or products</li> </ul>	<ul style="list-style-type: none"> <li>• Customer service issues: customers may call with peer-to-peer issues or inquiries</li> <li>• Significant entry costs to gain wide acceptance by merchants and customers</li> <li>• Assumption of risk for theft/fraud</li> <li>• Need for new competency for marketing/loyalty</li> <li>• Low usage to date</li> </ul>
Merchant	<ul style="list-style-type: none"> <li>• Reduced cost of cash handling and increased processing speed</li> <li>• Potential for increased transactions</li> <li>• Faster payments</li> <li>• Access to loyalty programs</li> </ul>	<ul style="list-style-type: none"> <li>• Commissions to peer-to-peer service provider for low value purchases</li> <li>• New service provider with limited equity in reputation</li> <li>• Risk of loss in case of dispute or fraud</li> <li>• Need to transfer funds to peer-to-peer provider (tying up funds)</li> </ul>
Customer	<ul style="list-style-type: none"> <li>• Potential for less expensive remittance/payment option</li> <li>• Inexpensive or free</li> <li>• Remote option</li> </ul>	<ul style="list-style-type: none"> <li>• Need to manage new bill</li> <li>• Potential fees charged by the service provider</li> <li>• Difficulty of managing disputes</li> </ul>

### 2.4. Collaboration model

Collaboration model includes collaborations between the trusted banks, operators and the third company. Service manager is responsible for management of all payment and collaboration processes among the operators and banks. This model allows beneficiaries to concentrate on their main capabilities, open door for earning new income from gradual services, direct retention and loyalty of customer and fulfill main demand of customers. Therefore, it is more possible to implement and establish collaboration model. In the survey which was performed in smart cards union, 86% of the respondents supported this model because it has the highest capability for long-term position [3]. Despite relations between actors of this model, their collaboration is very complex. ISIS and Google Wallet and Square Wallet are the payment services which follow this business model [3] [8]. Communication scenario between the beneficiaries is shown in collaboration operator model in Figure 7.

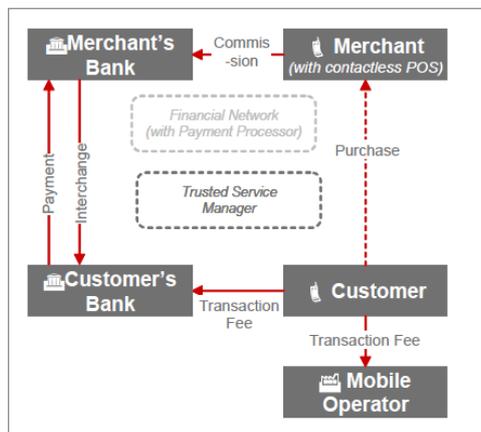


Fig. 7: Collaboration Model: Stakeholder Scenario [4].

#### 2.4.1. Pros and cons for stakeholders

Table 4: Pros and Cons for Each Collaboration Model Stakeholder [5]

Stakeholder	Pros	Cons
Bank	<ul style="list-style-type: none"> <li>• Alternative channel</li> <li>• Additional revenue from transactions</li> <li>• Potential for new customer acquisition if partnering with mobile operator</li> </ul>	<ul style="list-style-type: none"> <li>• Less need for customers to withdraw cash from ATMs resulting in lowered ATM revenue</li> <li>• Investments – creating applications, setting standards</li> </ul>
Mobile Operator	<ul style="list-style-type: none"> <li>• Focus on core competency</li> <li>• Potential for new customer acquisition</li> <li>• Revenue from transactions and data transmission</li> </ul>	<ul style="list-style-type: none"> <li>• Complexity (cost/time) of negotiating with banks/association</li> </ul>

Trusted Service Manager	<ul style="list-style-type: none"> <li>• Potential for new transaction-based business model</li> <li>• Potential to offer value-added content</li> </ul>	<ul style="list-style-type: none"> <li>• Assumption of risk of managing sensitive customer data and authentication</li> <li>• Lack of experience in integration/implementation</li> </ul>
Merchant	<ul style="list-style-type: none"> <li>• Faster transaction times</li> <li>• Reduced cash handling costs and queues</li> <li>• Customer satisfaction</li> <li>• Targeted marketing and loyalty programs</li> <li>• Banking services available from preferred bank</li> </ul>	<ul style="list-style-type: none"> <li>• Transaction fees in place of cash</li> </ul>
Customer	<ul style="list-style-type: none"> <li>• Reduced wait time</li> <li>• Convenience</li> </ul>	<ul style="list-style-type: none"> <li>• Need to obtain and activate bank-s</li> </ul>

Figure 8 shows risk and benefit for each one of the beneficiaries in collaboration model.

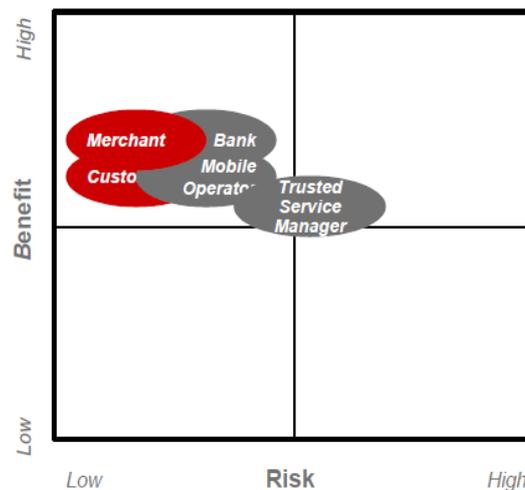
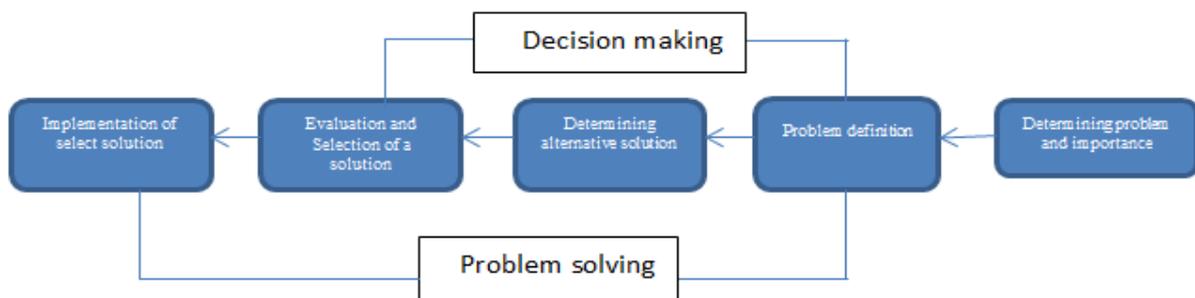


Fig. 8: Risks and Benefits for Collaboration Model Stakeholders [5].

### 3. Multiple criteria decision making (MCDM)

Decision making is one of the most crucial and essential tasks of management on which the realization of organizational objectives depends. As Her berth Simon (one of the experts in decision making) says, decision making is the main part of management. The decision making process might be demonstrated as follows [20].



Decision making, production procedure, choice evaluation and chain selection are some steps taken for solving a decision making problem [11].

One of the decision making techniques which uses quantitative data is multiple criteria decision making. Using multiple criteria decision making techniques the manager is enabled to take different criteria (which might have conflicts) into consideration and make reasonable decisions. Multiple Criteria Decision Making (MCDM) is divided into two groups; Multiple Attribute Decision Making (MADM) and Multiple Objective Decision Making (MODM). Multiple attribute decision making models and techniques are utilized to select the most suitable choice among m existing choices. In MADM usually data related to choices from different perspectives are denoted in one matrix.

Multiple attribute decision making models are divided into two groups considering type of desired attributes. These groups are called compensatory and non-compensatory models. In this paper the most important types of compensatory models are briefly described.

### 3.1. Compensatory models

These are some models composed of indices which could interact i.e. undesirable values of one index may be covered by desired values of other index. The following models might be mentioned as the most outstanding examples of compensatory models [20].

### 3.2. Analytic hierarchy process (AHP)

AHP exploits qualitative and quantitative criteria simultaneously while including investigation of inconsistency in its judgments. So it is able to deal with subjects such as urban and regional planning, optimization of product combination in an industrial unit, determining governmental organizations budget, transport planning, energy resource allocation planning, prioritization in electrical industry, prioritization of energy research projects and environmental research. Furthermore, this method provides a platform for analysis of complicated problems such that they could be transformed to simpler hierarchical problems; therefore, the planner would be capable of assessing the choices according to criteria and sub-criteria in simpler manner.

### 3.3. Fuzzy AHP

Fuzzy theory is utilized to handle most of real world phenomenon where uncertainty exists and lots of sets, numbers and phenomena in real world might be justified using fuzzy logic. In Fuzzy AHP fuzzy concepts are generalized so that paired comparison matrices could be developed.

### 3.4. Simple additive weighted (SAW)

Simple additive weighted model is one of the simplest multiple attribute decision making methods. Calculating the weights of indices this method might be simply utilized. The following steps are necessary to use this method.

- 1) Quantifying decision making scale
- 2) Linear normalization of matrix values in indices' weights
- 3) Multiplying normalized matrix by indices' weights
- 4) Selecting the best choice ( $A^*$ ) using the following criterion:

$$A^* = A_i | \text{Max} \sum_{j=1}^n (A_{ij} W_j)$$

In other words, in SAW method a candidate is selected whose sum of normalized weighted values ( $n_{ij} W_j$ ) is larger than other options [7].

### 3.5. Linear-programming for multidimensional analysis of preference

This method tries to find a candidate which has the least distance from the most ideal state. In this method  $m$  options and  $n$  indices of a given problem are considered as  $m$  vector points in an  $n$ -dimension space. The most preferred option is selected using Euclidean distances of options from the best choice.

### 3.6. TOPSIS method

This method was introduced by Huang and Yun in 1981. In this method  $m$  options are evaluated using  $n$  indices. Each problem might be considered as a geometrical system including  $m$  points in an  $n$ -dimensional space. It is based on the concept that the selected option must have the least distance from positive ideal solution (the best possible state,  $A_1^+$ ) and the largest distance from negative ideal solution (the worst possible state  $A_1^-$ ). It is assumed that desirability of each index is consistently incremental or decremented. In this paper TOPSIS method is used for final ranking of business models in mobile electronic payment which is explicated as follows [6], [21].

First step: decision matrix ( $D$ ) is normalized as follows:

$$r_{ij} = \frac{r_{ij}}{\sqrt{\sum_{j=1}^n r_{ij}^2}} \quad j=1, 2, 3 \dots n$$

$i=1, 2, 3 \dots m$

The obtained matrix is called  $N_D$ .

Second step: Normalized weights of decision matrix are derived as follows:

$$V = N_D * W_{n \times n} \quad j=1, 2, 3 \dots n$$

$i=1, 2, 3 \dots m$

Where  $V$  is the weighted normalized matrix and  $W$  is a diagonal matrix of weights achieved for indices.

Third step: the positive and negative ideal solutions are defined as follows:

Positive ideal choice:

$$A^+ = \{(MAX_i V_{ij} \mid j \in J_1), (MIN_i V_{ij} \mid j \in J_2) \mid i=1, 2, 3 \dots m\}$$

Negative ideal choice:

$$A^- = \{(MIN_i V_{ij} \mid j \in J_1), (MAX_i V_{ij} \mid j \in J_2) \mid i=1, 2, 3, \dots, m\}$$

$$A_i^+ = \{v_1^+, v_2^+, \dots, v_n^+\}$$

$$A_i^- = \{v_1^-, v_2^-, \dots, v_n^-\}$$

Such that:

$$J_1 = \{1, 2, 3, \dots, n \mid \text{for positive index elements}\}$$

$$J_2 = \{1, 2, 3, \dots, n \mid \text{for negative index elements}\}$$

Fourth step: distance magnitude based on Euclidean norm is calculated from positive and negative solutions as shown below:

$$d_i^+ = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^+)^2} \quad i=1, 2, 3 \dots m$$

$$d_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2} \quad i=1, 2, 3 \dots m$$

Fifth step: relative proximity of  $A_i$  to ideal solution is calculated as follows:

$$i=1, 2, 3 \dots m \left( C_i = \frac{d_i^-}{d_i^+ + d_i^-} \right)$$

If  $A_i = A_i^+$ , then  $d_i^+ = 0$  add  $C_i = 1$ . On the other hand, if  $A_i = A_i^-$ , then  $d_i^- = 0$ ,  $C_i = 0$ . Thus, each  $A_i$  choice

Which is closer to ideal solution,  $C_i$  value will be closer to that option.

Sixth step: considering the resulted  $C_i$  value for each option, the ranks are derived.

### 3.7. Elimination ET choice in translating to reality (ELECTRE)

In this method a new concept called outranking is utilized instead of ranking the options. For instance, it is possible that an option does not have any preferences over other options from mathematical point of view, but the decision maker or analyzer accepts it as a better choice. In this method all options are evaluated using outranking comparisons and non-effective options will be eliminated. All steps of this method are based on a coordinated set and a non-coordinated set. That is why this method is also called coordination analysis as well.

### 3.8. Simple multi attribute ranking technique (SMART)

In this method a combination of qualitative and quantitative indices might be utilized for ranking. First off, selection range for each index is defined so that weight and level of each index could be determined. Level of each index could be determined. Indices are ranked for each option using defined formulation. In the next step weight and importance of

indices are compared. At the end, final weight and priority of choices are achieved by combining the above mentioned weights.

#### 4. Related work

In [21] different business models are discussed; afterwards, among the mentioned models a collaboration model is proposed for a secure method of mobile electronic payment. In [22] a collaboration oriented payment model is proposed for mobile e-commerce whose reliability was evaluated using Petri net. In the evaluation performed in [8], different parameters (such as extensibility, security and profits) were considered. Using these parameters and ELECTRE method collaboration model was again selected as the best business model in Iran. In [9] two factors are considered; 1) service related factors including interface service offering, value proposition, dynamicity, scalability, user centric architecture and 2) organization related factors consisting of organizing model, collaboration and partnerships, responsiveness to market trend and ROI. The mentioned factors were evaluated using Analytic Hierarchy Process. In this assessment collaboration model has gained the first priority. In [10], parameters such as accessibility by customers, quality of service and security are evaluated utilizing AHP method and a business model for electronic payment is analyzed. In [] reliability of a mobile payment model is assessed using Petri net colored. The results demonstrated the percentage of reliability for the system.

#### 5. Proposed model

To evaluate different mobile payment business models some evaluation criteria should be considered. The selected criteria include extensibility, mobile payment simplicity, integration, profitability, implementation cost, security, trust ability, expected efficiency, scalability and maintenance cost. The mentioned list is provided using group discussion. The list was given to banks and operator experts; each person was able to add or remove some of these criteria. The result was 9 separate criteria (table 5). In table 7 the opinion of experts about performance of each business model are presented which was collected using questionnaire. To evaluate each criterion in each business model a value between 0 and 9 is considered.

**Table 5:** Criteria for Evaluating Mobile Payment Business Model

C1	Scalability	it depends on scalability of mobile phone operator, banks and third party companies [8], [9]
C2	Simplicity	The more simplicity (simple use of mobile devices and simple payment for customers) the more people tend to use the service [2], [18]
C3	Integration	[17][10]
C4	Profitability	It can be calculated by estimating the cost of mobile phone and transaction costs [8], [16]
C5	Implementation cost	Buying equipment, installation and so on [2], [8], [18]
C6	Security	[15][18][2][10][8]
C7	Trust ability	Believing that sellers behave according to expectations and they avoid opportunistic behavior [12], [13]
C8	Expected efficiency	The understanding of customer about the improvement of efficiency which is achieved by the system [14]
C9	Maintenance cost	The cost of executing each business model in mobile payment methods [8]

**Table 6:** Mobile Payment Business Models

A1	Operator-Centric Model
A2	bank-centric model
A3	peer-to-peer model
A4	Collaboration Model

**Table 7:**

	c1	c2	c3	c4	c5	c6	c7	c8	c9
A1	7	6	7	5	4	7	6	7	3
A2	5	7	8	6	3	9	6	7	2
A3	6	5	8	7	2	6	7	8	4
A4	8	8	7	8	2	8	8	9	2

Step 1: at the first step decision making matrix should be normalized. In this method normalization using norm is utilized. Normalization is performed on the above matrix and the resulted normalized matrix is as shown by table 8.

$$n_{ij} = \frac{a_{ij}}{\sqrt{\sum_{i=1}^m a_{ij}^2}} \tag{1}$$

**Table 8:** Normalization Matrix N

	c1	c2	c3	c4	c5	c6	c7	c8	c9
a1	0.531	0.455	0.466	0.379	0.696	0.462	0.441	0.449	0.522
a2	0.379	0.531	0.532	0.455	0.522	0.593	0.441	0.449	0.348
a3	0.455	0.379	0.532	0.531	0.348	0.396	0.515	0.513	0.696
a4	0.606	0.606	0.466	0.606	0.348	0.528	0.588	0.577	0.348

For example:

$$n_{11} = \frac{7}{\sqrt{7^2+5^2+6^2+8^2}} = 0.531, \quad n_{21} = \frac{7}{\sqrt{6^2+7^2+5^2+8^2}} = 0.379$$

Step 2: to achieve weighted normalized matrix, weights of indices are required. For this purpose, indices' weights are calculated using Shannon entropy (or other methods). These weights are obtained using equation 2 and illustrated in table 9.

$$p_{ij} = \frac{a_{ij}}{\sum_{i=1}^m a_{ij}} \tag{2}$$

**Table 9:** Calculating Matrix P

	c1	c2	c3	c4	c5	c6	c7	c8	c9
a1	0.269	0.231	0.233	0.192	0.364	0.233	0.222	0.226	0.273
a2	0.192	0.269	0.267	0.231	0.273	0.300	0.222	0.226	0.182
a3	0.231	0.192	0.267	0.269	0.182	0.200	0.259	0.258	0.364
a4	0.308	0.308	0.233	0.308	0.182	0.267	0.296	0.290	0.182

For example:

$$p_{11} = \frac{7}{7+5+6+8} = 0.269, \quad p_{21} = \frac{6}{6+7+5+8} = 0.192$$

And the entropy of j<sup>th</sup> index ( $E_j$ ,  $d_j$  and  $W_j$ ) which is presented in table 10 is calculated using equations (3), (5):

$$E_j = -K \sum_{i=1}^m [p_{ij} \ln p_{ij}], \quad k = \frac{1}{\ln(m)} \tag{3}$$

$$d_j = 1 - E_j \tag{4}$$

$$W_j = \frac{d_j}{\sum_{j=1}^n d_j} \tag{5}$$

**Table 10:** Calculating  $E_j$ ,  $d_j$  And  $W_j$

	c1	c2	c3	c4	c5	c6	c7	c8	c9
$E_j$	0.99	0.99	1.00	0.99	0.97	0.99	0.99	1.00	0.97
$d_j$	0.011	0.011	0.002	0.011	0.032	0.008	0.005	0.004	0.032
$w_j$	0.093	0.093	0.014	0.093	0.277	0.070	0.047	0.035	0.277

For instance:

$$E_1 = - \frac{((0.269 * LN(0.269)) + (0.192 * LN(0.192)) + (0.231 * LN(0.231)) + (0.308 * LN(0.308)))}{LN(4)} = 0.99$$

$$d_1 = 1 - 0.99 = 0.11$$

$$W_1 = \frac{0.011}{0.115} = 0.093$$

Now the normalized weighted matrix might be derived. The normalized matrix is multiplied by square matrix  $W_{n \times n}$  whose diagonal elements are indices' weights and its other elements are zero. The resulted matrix is called weighted normalized matrix and is denoted by  $V$ . the mentioned operation is shown in the following matrix.

**Table 11:** Index Matrix (W)

0.093	0	0	0	0	0	0	0	0
0	0.093	0	0	0	0	0	0	0
0	0	0.014	0	0	0	0	0	0
0	0	0	0.093	0	0	0	0	0
0	0	0	0	0.277	0	0	0	0
0	0	0	0	0	0.070	0	0	0
0	0	0	0	0	0	0.047	0	0
0	0	0	0	0	0	0	0.035	0
0	0	0	0	0	0	0	0	0.277

$V=N*w$

**Table 12:** Weighted Normalized Matrix (V)

0.050	0.043	0.006	0.035	0.193	0.032	0.021	0.016	0.145
0.035	0.050	0.007	0.043	0.145	0.042	0.021	0.016	0.096
0.043	0.035	0.007	0.050	0.096	0.028	0.024	0.018	0.193
0.057	0.057	0.006	0.057	0.096	0.037	0.027	0.020	0.096

Step 3: now the positive and negative ideals for each index must be calculated. For an index with positive aspect, positive ideal is the largest value of  $V$ ; inversely, for an index with negative aspect positive ideal is the smallest amount of matrix  $V$ . besides, negative ideal for positive index is the smallest value of matrix  $V$  and negative ideal for negative index is the largest value of matrix  $V$ . the values of positive and negative ideal for this conditions are as follows:

$$v_j^+ = [max v_{i1}, max v_{i2}, max v_{i3}, max v_{i4}, min v_{i5}, max v_{i6}, max v_{i7}, max v_{i8}, min v_{i9}]$$

$$= [0.05, 0.057, 0.007, 0.57, 0.096, 0.042, 0.27, 0.020, 0.96]$$

$$v_j^- = [min v_{i1}, min v_{i2}, min v_{i3}, min v_{i4}, max v_{i5}, min v_{i6}, min v_{i7}, min v_{i8}, max v_{i9}]$$

$$= [0.035, 0.035, 0.006, 0.035, 0.145, 0.028, 0.021, 0.016, 0.193]$$

Step 4: equations 6 and 7 are exploited to obtain the distance of each option from positive and negative ideals, respectively.

$$d_i^+ = \sqrt{\sum_{j=1}^m (v_{ij} - v_j^+)^2}, \forall_i \tag{6}$$

$$d_i^- = \sqrt{\sum_{j=1}^m (v_{ij} - v_j^-)^2}, \forall_i \tag{7}$$

These values for the aforementioned matrix are calculated as follows.

Step 5: in this step the proximity of each choice to ideal solution is calculated. For this purpose equation 8 is utilized:

$$CL_i^* = \frac{d_i^-}{d_i^- + d_i^+} \tag{8}$$

$d_1^+$	0.111676	$d_1^-$	0.050945
$d_2^+$	0.055617	$d_2^-$	0.109813
$d_3^+$	0.101014	$d_3^-$	0.097779
$d_4^+$	0.004712	$d_4^-$	0.141748

For instance:

$$CL_1 = \frac{0.050945}{0.050945 + 0.111676} = 0.313275$$

cl1	0.313275
cl2	0.663804
cl3	0.491863
cl4	0.967829

Step 6: thus, considering CL values, options ranking is done as follows:

$$A_4 > A_2 > A_3 > A_1$$

## 6. Conclusion

In this study four main business models for mobile payment were investigated. For this purpose the participants of business models were identified and the position of each participant was determined in these models. Profit and risk conditions for each participant were examined and the pros and cons of the models were mentioned. According to this survey, collaboration model is superior to its counterparts as all participants have almost the same amount of risk and profit. Moreover, each participant only is active in its professional field. To prove our claim and evaluation is performed using multiple criteria decision making on these models. According to this evaluation collaboration model is the best choice for mobile payment. In [21] ten famous electronic payments in the world were shown together with business models used in each one. It can be seen that collaboration model is exploited more than other models.

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