Research on the Security Protection of E-Commerce Information under the Background of Mobile Consumption

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Abstract

With the development of mobile network technology, mobile e-commerce is becoming mature, so opportunities and challenges are brought to businesses; therefore, the information security protection of mobile e-commerce is one of challenges. To strengthen the protection, X enterprise was taken as an example to conduct risk assessment in aspects of transactions, organization, data and third-party cooperation using the analytic hierarchy process and triangular fuzzy entropy. It was shown that the information security risk of the enterprise is overall low; transactions are the very common information leakage incident of the four aspects, and third-party cooperation is the safest. Finally, relevant suggestions of information safety protection were put forward based on the assessment results of the four aspects.

Keywords: Analytic Hierarchy Process; E-Commerce; Information Security; Triangular Fuzzy Entropy

1 Introduction

With the development of mobile network technology, mobile terminals have already popularized in people's life, which leads to a new business pattern, mobile e-commerce [1, 9]. At present, mobile e-commerce has features such as high openness, interoperability and no time limitation, so it has become the primary element of modern economic informatization. It can reduce costs, simplify processes and increase trade opportunities in trade activities. Despite the rapid development of e-commerce, the actual proportion of e-commerce in the whole economic trade volume is still very low, which is mainly caused by security problems [14]. As e-commerce does not need to be face to face, the personal privacy of consumer information is required, and the information of the seller or merchant is a trade secret. Therefore, the security of information is crucial in mobile e-commerce.

Zhang *et al.* [15] proposed a single electronic watermarking algorithm for six applications in e-commerce: graphics physical paper, electronic paper anti-counterfeiting, electronic seal, copyright protection, digital fingerprint generation and secure communication protection was verified with the effectiveness of the algorithm through simulation experiments. Jang *et al.* [7] studied the trust issues between smart phone and information security through empirical research based on users. Their purpose was to study the relationships among computer literacy, network literacy, knowledge of mobile phone virus and the trust (confidentiality, integrity, and availability) of information security management (ISM) principle of the smart phone users. It was shown that the network literacy had a positive effect on virus knowledge, but the computer literacy didn't have. Barai [5] analyzed the operation mode of e-commerce system to solve a security problem of database encryption, and introduced an encryption method based on symmetric and asymmetric encryption technology to overcome the single encryption technology of the traditional electricity system, and then the method was verified to be effective by simulation experiments. In the study, X enterprise was taken as an example to conduct risk assessment in aspects of transactions, organization, data and third-party cooperation using the analytic hierarchy process (AHP) and triangular fuzzy entropy (TFE), and then relevant suggestions were put forward based on the assessment results.

2 Concepts of Mobile E-Commerce

2.1 Mobile E-Commerce

Mobile e-commerce allows users to trade online through wireless networks. Customers can communicate with mer-

chants and visit the key business information any time through mobile terminals. As mobile terminals are used in information interaction, mobile e-commerce has characteristics of mobile terminals: mobility, convenience, positioning and real-time connection [14].

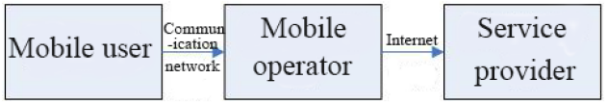

Figure 1: Mobile e-commerce implementation

Figure 1 is the implementation process of mobile e-commerce, and the whole process is simple. As long as the mobile operator opens corresponding wireless services to e-commerce participants on both sides, they can communicate online through the terminals and obtain transaction information anytime.

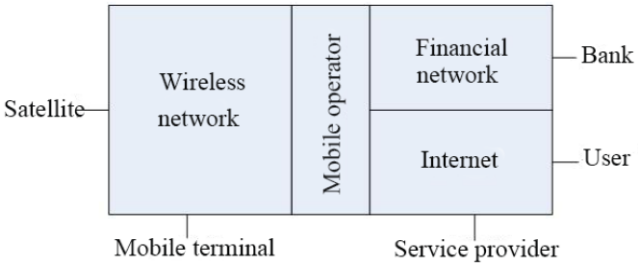

Figure 2: Mobile commerce frame

Figure 2 is a simplified mobile e-commerce frame [12]. Mobile e-commerce transaction is implemented based on Internet, Intranet and financial Intranet, and the transaction is finally implemented under the influence of wired network and infinite network. Mobile users can enjoy the services provided by merchants everywhere.

2.2 Security Problems Of Mobile E-Commerce

With the popularization of mobile terminals (mobile phones, iPads, *etc.*), the technology of mobile network has developed rapidly. Further, the business model has already changed before the relevant credit system, user privacy measures and policies are improved [3]. From the perspective of current development, many problems in mobile e-commerce still need to be solved [11]:

1) Hackers can get trade secrets or customer information illegally by breaking the business system of enterprises;
2) Information is destroyed by spreading viruses, for example, the bitcoin virus maliciously, and then blackmaillmg users;
3) The authority of the internal administrator of the business system is limited and not reasonable.

In order to solve the above problems, it is indispensable to establish a security system for mobile e-commerce. Figure 3 is a simple model of a security system.

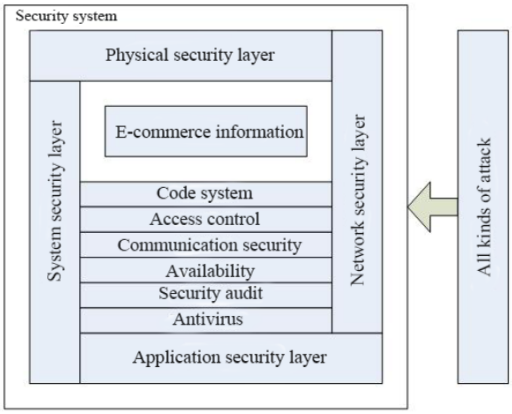

Figure 3: Security system model

It could be noted from the model [5] as shown in Figure 3 that the whole security system includes the application security layer, system security layer, network security layer and physical security layer, which realize the security protection of e-commerce information. The evaluation of security system is also part of security protection research, so this study researches the evaluation of e-commerce information security system to improve the security protection of e-commerce information

3 Evaluation Method of E-Commerce Information Security System

3.1 Analytic Hierarchy Process

AHP is one of multi-objective decision analysis methods [4], which combines qualitative with quantitative. It firstly divides a complex system into several subsystems, and then the subsystems into the target layer, criterion layer and indexes layer according to their characteristics, making the target analysis in order; security protection measures are provided based on the analysis results. The evaluation process includes system decomposition, security judgment and comprehensive judgment. The model of AHP [8] is shown in Figure 4.

3.2 Triangle Fuzzy Number

The mathematical formula of triangular fuzzy number [16] is:

$$\widetilde{N}(x) = \begin{cases} 0, & x \le a \\ \frac{x-a}{b-a}, & a < x \le b \\ \frac{c-x}{c-b}, & b < x \le c \\ 0, & x > c. \end{cases} \quad (1)$$

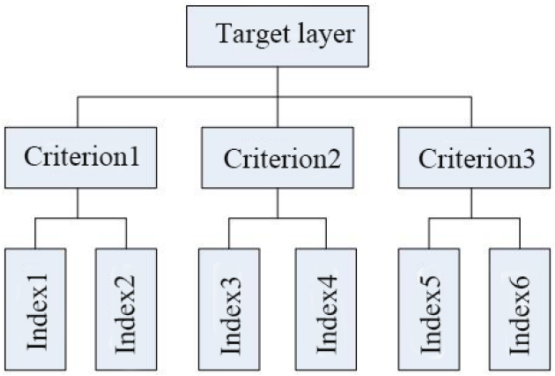

Figure 4: The hierarchical model

where $\widetilde{N}$ is the triangular fuzzy number, which is denoted as (a, b, c). The positive fuzzy number is only considered in the system risk assessment, so Equation (1), $\forall x < 0$, $\widetilde{N}(x) = 0$ also should be satisfied. In the evaluation, a represents the most pessimistic estimate, b represents the most likely estimate, and c is the most optimistic estimate.

3.3 The Entropy Weight Method

Entropy is a value that measures the uncertainty or information amount of the system. Its definition [6] is:

$$H = -\alpha \sum_{i=1}^{m} p_m \log p_i, \tag{2}$$

where H stands for the entropy of the system, and m stands for the status number, $0 \le p_i < 1$ and $\sum_{i=1}^{m} p_i = 1$. The entropy value of the system can be used to describe the degree of variation of the system; the greater the value, the greater the degree of variation and the less information. In this way, the entropy weight of i-th evaluation index in the system is defined as [10]:

$$\varepsilon_i = \frac{1 - H_i}{n - \sum_{i=1}^{n} H_i} \quad (i = 1, 2, \cdots, n), \tag{3}$$

where $0 \le \varepsilon_i \le 1$, $\sum_{i=1}^{n} \varepsilon_i = 1$. The effective information degree of an index in the system is expressed as entropy weight.

4 Case Analysis

4.1 Assessment of The Enterprise Profile

A Chinese enterprise X whose main business was mobile e-commerce and its existing information security protection level was evaluated. With the advent of mobile Internet, the enterprise X transformed its business and began to reduce the traditional electronic commerce to adapt to the development trend of the market, and then this enterprise used the model of online "brand + operation" to increase mobile electronic commerce activities which mainly included "boost business", "pull business" and "interactive business". As the business was related to the personal information of customers closely, it was crucial to protect the e-commerce information security, and some corresponding countermeasures should be put forward based on risk evaluation.

4.2 Evaluation Method

1) The information security protection risk of X enterprise was evaluated through questionnaire survey in aspects of organizational risk, data risk, transaction risk and third-party cooperation risk. A total of 200 questionnaires were randomly distributed in a ratio of 1:2:4 to middle-level leaders, grassroots cadres and ordinary employees, and the score of each index was between 0 and 100.

2) The results recorded after questionnaires were recycled, and a standardized matrix was constructed based on the score formula of positive and negative indicators [13], and standardized data was obtained. Then the entropy weight of each index was determined, referring to Equation (3).

3) Six experts were invited to evaluate the information security protection of enterprises, and the subjective evaluation matrix of experts could be obtained. The triangular fuzzy weight derived by the fuzzy synthesis matrix was obtained by the weight set of experts, and then the comprehensive weight of indicators was determined. The calculation formula of triangular fuzzy weight is:

$$\omega_i = \frac{\mu_i}{\sum_{i=1}^{n} \mu_i} \tag{4}$$

where μ_i stands for the weight vector of the i-th index in the triangular fuzzy set; the formula of comprehensive weight is:

$$\sigma_i = \theta \varepsilon_i + (1 - \theta)\omega_i, \tag{5}$$

where θ is the weight ratio of the objective preference coefficient, here $\theta = 0.4$.

4.3 Evaluation Results and Analysis

Table 1 shows the weight of each indicator and their results. It can be seen that the final evaluation of 13 indicators is:

$$D = [0.016\ 0.0329\ 0.0517\ 0.0661\ 0.0187\ 0.0245\ 0.0641\ 0.0496\ 0.0925\ 0.1103\ 0.0136\ 0.0374\ 0.0389]^T;$$

and the evaluation score of each criterion layer is $(1006, 1093, 0.3165, 0.0899)$.

Table 1: Weight of each indicator and evaluation results

Criterion layer	IL	EW	TFW	CW	AR
"Organization" risk (A1)	Financial Guarantee (A11)	0.0347	0.0474	0.0423	0.016
	Personnel Risk (A12)	0.0414	0.0564	0.0504	0.0329
	Safety Gear(A13)	0.108	0.0776	0.0898	0.0517
Data risk (A2)	Database Security (A21)	0.1066	0.096	0.1002	0.0661
	Information Encryption Security (A22)	0.0498	0.0547	0.0527	0.0187
	Integrity Strategy (A23)	0.0693	0.0445	0.0544	0.0245
"Transaction" Risk (A3)	Access Security (A31)	0.0895	0.1026	0.0974	0.0641
	Application Security (A32)	0.0856	0.0875	0.0867	0.0496
	Network Security (A33)	0.132	0.1143	0.1214	0.0925
	Terminal Security (A34)	0.1665	0.1142	0.1351	0.1103
Third-party "cooperation" risk (A4)	Risk of Relationship Weakening (A41)	0.0107	0.0475	0.0328	0.0136
	Contract Control Ability (A42)	0.0453	0.0828	0.0678	0.0374
	Partner Level(A43)	0.0606	0.0745	0.0689	0.0389

IL: Index Layer; EW: Entropy weight; TFW: Triangular Fuzzy Weight; CW: Comprehensive Weight; AR: Assessment Result.

Table 2 shows combined weight, assessment result and final risk value of each criterion layer. The final risk values are 0.0184 for A1, 0.0227 for A2, 0.1394 for A3, and 0.0152 for A4, and the total risk value of the security protection of e-commerce information of the whole enterprise is 0.1957. The risk degree of information security protection of the enterprise could be evaluated through the risk value calculated above. In general, the final risk value means high risk when it was larger than 0.7, and low risk when it was less than 0.3. The overall risk value of enterprise X was 0.1957, which means that the information security protection risk was low. The comparison suggested that the risk value of A3 was the highest, followed by A2, A1 and A4, showing that the most possible link of information security protection risk was the mobile transaction link, while the third party cooperation was relatively safe.

The comparison of different weights and evaluation results of indicators in the criterion layer are shown in Figure 5.

In terms of transaction risk, it was found from the comparison of transaction risk block that when the entropy weight is 0.1665, integrated weight is 0.1351, evaluation results are the highest, and the triangular fuzzy weights (0.1142) was relatively high, showing that the mobile terminal was most likely to affect the risk of information security protection in trading. Information leakage could cause a wide range of serious problems. The enterprise should pay real attention to the aspect of transaction risk.

In terms of data risk, the entropy value weight (0.1066), triangle fuzzy weight (0.096), integrated weight (0.1002) and evaluation results (0.0661) are much higher compared with the information encryption security and integrity strategy in Figure 5. The risk of database security is the highest so that the enterprise should pay real attention to database security. The integrated weights of the other

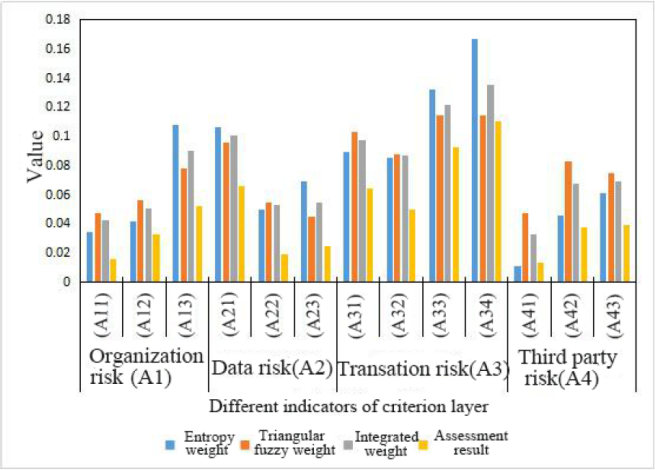

Figure 5: Comparison between weight and evaluation result of each indicator

Table 2: Evaluation results and final risk values of the criterion layer

Criterion layer	Combined weight	Assessment result	Final risk value
Organization risk (A1)	0.1825	0.1006	0.0184
Data risk (A2)	0.2073	0.1093	0.0227
Transaction (A3)	0.4406	0.3165	0.1394
Third-party cooperation risk (A4)	0.1695	0.0899	0.0152
Total	-	-	0.1957

two indicators are moderate. The evaluation results are relatively low, indicating that the loss and influence of enterprises are the least while accidents occurring because of the well protective measures. As the entropy weight and triangle fuzzy weight are paid attentions to by employees and experts at different degrees, the two weights are different, and the indicators paid less attentions to cause greater loss in the event of accidents.

In terms of organizational risk, the evaluation result of information security institutions is the largest, the risk of organizational personnel is the second, and financial security is the smallest as shown in Figure 5, and the integrated weight of financial security is relatively close to that of organizational personnel risk, 0.0423 vs. 0.0504, respectively, showing that the risk level between them is similar. While the evaluation result of financial security (0.016) is far lower than that of organizational personnel risk (0.0329), indicating that the enterprise pays enough attention to information security protection of financial security.

In terms of the third cooperation risk, the integrated weight of the level of the third-party cooperators, contract control, and weakened customer relationship risk are relatively low, 0.0689, 0.0678 and 0.0328, respectively as shown in Figure 5. The results of risk assessment are also low, indicating that the enterprise performs well in managing third-party cooperation, and for cooperators that have high of information, their risks of information security protection are less likely to happen.

4.4 Measures for Strengthening Information Security

Protection According to the assessment results and the analysis above, corresponding measures can be taken from several aspects of the criterion layer to improve the security protection of e-commerce information and reduce security risks under the background of mobile consumption.

1) In terms of organizational risk, the enterprise should strengthen the awareness of information security protection and regard it as the core content in the training of information security operation of employees. Moreover, it should strengthen employees' sense of belonging to improve the overall information literacy; according to the business arrangement and status, and requirements of information security, the enterprise should also formulate the framework of information security protection based on current management and protection technologies, keep up to date with the information security control system and focus on the implement of enterprises' supervision.

2) In terms of transaction risk, the enterprise should ensure the confidentiality and integrity of the information during the network communication transactions between the two parties, strengthen the management of relevant keys and the ability of resisting external attacks of the internal network, and strictly manage the use of employees' rights in the information network to minimize the risks of customers in communication transactions; in the meanwhile, the enterprise should also ensure the accuracy of identification in the interaction between mobile terminals and the network, and pay attention to technologies such as voice print recognition and fingerprint identification to help the enterprise improve the identification ability so to ensure the security and authenticity of data interaction.

3) In terms of data risk, databases should be encrypted effectively to prevent data theft caused by attacks in the internal system. Identification, recovery of lost data, isolation of physical storage devices, detection of network ports and data backup are all the encryption methods applied to databases, and the encryption of the physical level also needs the isolation of physical facilities and regular maintenance of equipment.

4) In terms of third-party cooperation, the enterprise should ensure the stability of the internal organization and the source of funds, strengthen the awareness of information security protection of employees and relevant security expertise, and select the third-party operators carefully to ensure that both parties have high levels of information management to ensure the information security protection in transactions.

5 Conclusion

In the study, security protection degree of e-commerce under the background of mobile consumption was evaluated by AHP and TFE. X enterprise was taken as an

example to conduct risk assessment in aspects of transactions, organization, data and third-party cooperation, and the results achieved are that the overall risk of the security protection of e-commerce information is low; the risk of transaction is the highest while the risk of the third-party operation is the lowest. The mobile terminal has the worst information security protection in the risk of transactions. The enterprise should pay more attention to information encryption and integrity strategy due to the lowest security protection of database. In the aspect of organization risk, the highest risk was the information security protection, and the enterprise performed well in managing third-party cooperation; cooperators have high levels of information, so their risks of information security protection are less likely to happen. In the end of the study, several suggestions were proposed for e-commerce information security protection.

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Biography

Yun Zhang, female, born in January 1978, graduated with a master's degree from the major of management science and engineering in Chongqing University of Posts and Telecommunications, China. Now she is a teacher in Zhejiang Yuexiu University of Foreign Languages, Shaoxing, Zhejiang, China. Her interests of research are E-commerce, mobile e-commerce and marketing.