Risk Assessment of Computer Network Security in Banks

Anjani Kumar Singha

Delhi College of Arts and Commerce
Email id:Kumaranjani348@gmail.com

Abstract

The importance of computer system security of banks can never be exaggerated. Conducting risk assessment of computer system security of banks can increase safety management and ensure normal operation. This paper firstly figures out risk assessment indexes for computer system security of banks through literature review and survey. Secondly, it uses AHP to confirm the weight of indicators and establishes five security levels. According to the judgment of experts, it finally establishes the risk assessment model for computer system security of banks.

Keywords*: computer; AHP; weight; risk assessment; fuzzy evaluation*

1. Introduction

Banks are an integral part of state-owned enterprises. With the development of computer network and the expansion of trading channel of banks, online services become more and more open and banks have experienced continuous upgrading. The computer network is placed a priority in banks. However, the computer network is easy to be attacked by viruses and Hackers. A damaged network will cause dire consequences and hit the bank greatly. Therefore, risk assessment of computer system security of banks can detect loop-holes in advance and warn the bank to increase the security level of computer network, ensuring that the bank is operated in a normal state.

In response to the facts that the computer network of banks has multiple trading channels, the system is quite open and system data can be concentrated, banks and the government have followed closely network security. This paper intends to assess the computer system security of banks, makes reasonable warning of the security and establishes an appraisal model of computer system security of banks. In recent years, security loopholes loom large. For example, deposit is missing for no reasons and bank credit card becomes invalid. All these worry people a lot. Many banks recruited professionals to assess the computer network security in order to avoid unnecessary losses. Thus, it is important to conduct risk assessment of computer system security of banks, as it can increase the security level of banks, guarantees normal operation maintains bank's reputation and promotes a normal and stable life.

Computer system security of banks has been studied many times. There are 52835 research results relevant to this topic on National Knowledge Infrastructure and 18570 relevant to risk assessment of computer system security of banks.

2. Evaluation Indicator System for Computer System Security of Banks

Based on the questionnaires to Rural Commercial Bank, Agricultural Bank of China and China Construction Bank and relevant literature review, and according to the operation of computer network of banks (TCP/IP Internet model is adopted), there are four layers of evaluation indexes for the computer system security of banks, namely the

physical layer, the network layer, the data layer and the emergency layer. Each layer contains several second level evaluation indexes, as shown in Table 1.

Table 1. Risk Assessment System for Computer System Security of Bank P

first level evaluation index	second level evaluation index
physical layerP_1	computer hardware P_{11}; computer network facilitiesP_{12};wiring system P_{13};bank staff P_{14};
network layerP_2	firewall P_{21}; vulnerability detection P_{22}; alarm system P_{23}; safety system P_{24}; certificate validation P_{25};
data layerP_3	data detection P_{31}; data transmission P_{32}; data backup P_{33}; identity recognition P_{34}; log auditing P_{35};
emergency layerP_4	emergency response P_{41}; emergency measureP_{42}; emergency recovery P_{43};

3. Index Weight of Computer System Security of Banks

AHP is used to confirm the index weight of computer system security of banks.

Firstly, the layer structure of computer system security of banks is established to do the assessment, as shown in Figure.1.

Figure 1. Evaluation System Structure for Computer System Security of Banks

Secondly, the 1-9 scale is used to construct the comparative judgment of all indexes.

The comparative judgment is established by comparing the influence of indexes of the sub-layer on that of the dominant-layer. The influence is confirmed according to experts' judgment.

Table 2. 1-9Value of Scale Mark

Scale a_{ij}	**Comparison results between index I and index j**
1	same influence of index i and index j
3	the influence of index i is a bit stronger than index j
5	the influence of index i is stronger than index j
7	the influence of index i is much stronger than index j
9	the influence of index i is absolutely stronger than index j
2,4,6,8	The comparative influence of index i and index j lies in between 1,3,5 and 9
$\frac{1}{2}, \ldots, \frac{1}{9}$	The comparative influence of index i and index j is the interval number of a_{ij}

Thirdly, use the geometric method to calculate the weight of indexes

(1) Compute the product of elements in each line in the comparative judgment and get vector ;
(2) (2)Subject vector to extraction and get vector ;
(3) Normalize vector and get the corresponding weight vector .

Finally, subject the comparative judgment to consistency test with the following two

steps.

$$CI_{\max} \frac{n}{\frac{1}{n}\sum_{j=1}^{n} a_{ij} r_j}$$

(1) Compute the consistency index $\sum_{i=1}^{n} r_i$, where $n-1$.

(2) Compute the consistency radio $CR = \frac{CI}{RI}$, where RI refers to random consistency index. Its value is shown in Table 3.

Table 3. Random Consistency Indexes

n	1	2	3	4	5	6
RI	0	0	0.58	0.90	1.12	1.24

Neutrally, when $CR < 0.10$, subject the comparative judgment to consistency test. Use AHP to calculate the index weight of computer system security of banks:

Table 4. Comparison Matrix and Test Results of the First Level Evaluation Indexes Relative to the Target Layer

Target layer	computer system security of banks P					maximum eigenvalue	consistency ratio
first level evaluation index	physical layer P_1	network layer P_2	data layer P_3	emergency layer P_4	weight		
physical layer P_1	1	1/6	1/3	5	0.1238	4.2501	0.0937
network layer P_2	6	1	4	9	0.5956		
data layer P_3	3	1/4	1	7	0.2396		
emergency layer P_4	1/5	1/9	1/7	1	0.0410		

Table 5. Comparison Matrix and Test Results of the Second Level Evaluation Indexes Relative to the First Level Evaluation Indexes

first level evaluation index	physical layer P_1						consistency ratio
second level evaluation index	computer hardware P_{11}	computer network facilities P_{12}	wiring system P_{13}	bank staff P_{14}	weight		
computer hardware P_{11}	1	1/5	1/3	1/4	0.0736	4.0514	0.0192
computer network facilities P_{12}	5	1	3	2	0.4709		
wiring system P_{13}	3	1/3	1	1/2	0.1715		
bank staff P_{14}	4	1/2	2	1	0.2840		

Table 6. Comparison Matrix and Test Results of the Second Level Evaluation Index Relative to the Network Layer Indexes P2

first level evaluation index	network layerP_2							
second level evaluation index	firewall P_{21}	vulnerability detection P_{22}	alarm system P_{23}	safety system P_{24}	certificate validation P_{25}	weight	maximum eigenvalue	consistency ratio
firewall P_{21}	1	5	3	1/4	2	0.1815	5.4410	0.0984
vulnerability detection P_{22}	1/5	1	1/3	1/8	1/9	0.0365		
alarm system P_{23}	3	3	1	1/7	1/2	0.0751		
safety system P_{24}	4	8	7	1	8	0.5587		
certificate validation P_{25}	1/2	9	2	1/8	1	0.1482		

first level evaluation index	emergency layerP_4				
second level evaluation index	emergency response P_{41}	emergency measureP_{42}	emergency recovery P_{43}	weight	maximum eigenvalue
emergency response P_{41}	1	1/6	1/3	0.0915	3.0985
emergency measureP_{42}	6	1	5	0.7071	
emergency recovery P_{43}	3	1/5	1	0.2014	

Table 7. Comparison Matrix and Test Results of the Second Level Evaluation Index Relative to the First Level Data Layer Indexes P3

first level evaluation index	data layerP_3							
second level evaluation index	data detection P_{31}	data transmission P_{32}	data backup P_{33}	identity recognition P_{34}	log auditing P_{35}	weight		consistency ratio
data detection P_{31}	1	5	9	3	4	0.4901	5.1856	0.0414
data transmission P_{32}	1/5	1	5	1/3	1/2	0.1052		
data backup P_{33}	1/9	1/5	1	1/6	1/4	0.0364		
identity recognition P_{34}	1/3	3	6	1	2	0.2284		
log auditing P_{35}	1/4	2	4	1/2	1	0.1399		

Table 8. Comparison Matrix and Test Results of the Second Level Evaluation Index Relative to the First Level Emergency Layer Indexes P4

As *CR* is smaller than 0.10, P, P1, P2, P3, P4all pass the consistency test.
The index weight of computer system security of banks is concluded as in Table 9.

Table 9. The Index Weight of Computer System Security of Banks

first level evaluation index	weight	second level evaluation index	weight
physical layerP_1	0.1238	computer hardware P_{11};	0.0736
		computer network facilitiesP_{12};	0.4709
		wiring system P_{13};	0.1715
		bank staff P_{14};	0.2840
network layerP_2	0.5956	firewall P_{21};	0.1815
		vulnerability detection P_{22};	0.0365
		alarm system P_{23};	0.0751
		safety system P_{24};	0.5587
		certificate validation P_{25};	0.1482
data layerP_3	0.2396	data detection P_{31};	0.4901
		data transmission P_{32};	0.1052
		data backup P_{33};	0.0364
		identity recognition P_{34};	0.2284
		log auditing P_{35};	0.1399

emergency layerP_4	0.0410	emergency response P_{41};	0.0915
		emergency measureP_{42};	0.7071
		emergency recovery P_{43};	0.2014

4. Risk Assessment Model for Computer System Security of Banks

Risks of computer system security of banks are categorized into five levels: very safe, relatively safe, neutral, relatively dangerous and very dangerous. Establish risk assessment model for computer system security of banks.

Establishing the risk assessment set

The risk assessment set is shown in Table 10.

Table 10. Risk Assessment Set for Computer System Security of Banks

second level evaluation index	Security level				
computer hardware P_{11};	very safe	relatively safe	neutral	relatively dangerous	very dangerous

computer network facilitiesP_{12};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
wiring system P_{13};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
bank staff P_{14};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
firewall P_{21};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
vulnerability detection P_{22};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
alarm system P_{23};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
safety system P_{24};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
certificate validation P_{25};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
data detection P_{31};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
data transmission P_{32};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
data backup P_{33};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
identity recognition P_{34};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
log auditing P_{35};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
emergency response P_{41};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
emergency measureP_{42};	very safe	relatively safe	neutral	relatively dangerous	very dangerous
emergency recovery P_{43};	very safe	relatively safe	neutral	relatively dangerous	very dangerous

(2) Confirm the fuzzy evaluation judgment

Expert judgment method is employed to confirm the judgment matrix. Suppose the judgment result of the i-thsecond level evaluation index in the first level evaluation indexP1is $r_{i1}^{(1)}$, $r_{i2}^{(1)}$ $r_{i3}^{(1)}$ $r_{i4}^{(1)}$ $r_{i5}^{(1)}$ where i 1, 2, 3, 4. The

of second level evaluation index is:

$$R_1 = \begin{matrix} r_{11}^{(1)} & r_{12}^{(1)} & r_{13}^{(1)} & r_{14}^{(1)} & r_{15}^{(1)} \\ r_{21}^{(1)} & r_{22}^{(1)} & r_{23}^{(1)} & r_{24}^{(1)} & r_{25}^{(1)} \\ r_{31}^{(1)} & r_{32}^{(1)} & r_{33}^{(1)} & r_{34}^{(1)} & r_{35}^{(1)} \\ r_{41}^{(1)} & r_{42}^{(1)} & r_{43}^{(1)} & r_{44}^{(1)} & r_{45}^{(1)} \end{matrix},$$

Where r_{ij} the number of experts who rate j-class/ total number of experts.

Similarly:

$$R_2 = \begin{matrix} r_{11}^{(2)} & r_{12}^{(2)} & r_{13}^{(2)} & r_{14}^{(2)} & r_{15}^{(2)} \\ r_{21}^{(2)} & r_{22}^{(2)} & r_{23}^{(2)} & r_{24}^{(2)} & r_{25}^{(2)} \\ r_{31}^{(2)} & r_{32}^{(2)} & r_{33}^{(2)} & r_{34}^{(2)} & r_{35}^{(2)} \\ r_{41}^{(2)} & r_{42}^{(2)} & r_{43}^{(2)} & r_{44}^{(2)} & r_{45}^{(2)} \\ r_{51}^{(2)} & r_{52}^{(2)} & r_{53}^{(2)} & r_{54}^{(2)} & r_{55}^{(2)} \end{matrix},$$

$$R_3 = \begin{matrix} r_{11}^{(3)} & r_{12}^{(3)} & r_{13}^{(3)} & r_{14}^{(3)} & r_{15}^{(3)} \\ r_{21}^{(3)} & r_{22}^{(3)} & r_{23}^{(3)} & r_{24}^{(3)} & r_{25}^{(3)} \\ r_{31}^{(3)} & r_{32}^{(3)} & r_{33}^{(3)} & r_{34}^{(3)} & r_{35}^{(3)} \\ r_{41}^{(3)} & r_{42}^{(3)} & r_{43}^{(3)} & r_{44}^{(3)} & r_{45}^{(3)} \\ r_{51}^{(3)} & r_{52}^{(3)} & r_{53}^{(3)} & r_{54}^{(3)} & r_{55}^{(3)} \end{matrix},$$

$$R_4 = \begin{matrix} r_{11}^{(4)} & r_{12}^{(4)} & r_{13}^{(4)} & r_{14}^{(4)} & r_{15}^{(4)} \\ r_{21}^{(4)} & r_{22}^{(4)} & r_{23}^{(4)} & r_{24}^{(4)} & r_{25}^{(4)} \\ r_{31}^{(4)} & r_{32}^{(4)} & r_{33}^{(4)} & r_{34}^{(4)} & r_{35}^{(4)} \end{matrix}.$$

According to the weight of second level evaluation index, compute the fuzzy evaluation judgment of the first level evaluation index:

$$R = r_1^T R_1 \; r_2^T R_2 \; r_3^T R_3 \; r_4^T R_4,$$

Then, according to the weight of the first level evaluation index, compute the risk assessment vector of the computer system security of banks:

$$w\ r^T R$$

According to the maximum principle, the highest risk is the class in which the computer network is categorized.

5. Model Application-Risk Assessment of a Certain Computer System Security of Banks

A state-owned bank was subject to risk assessment. A team of 20 experts was asked to score 17 second level evaluation indexes of the computer system security. The judgment results are shown in Table 11.

Table 11. Expert Assessment of a Computer System Security of a Domestic Bank

second level evaluation index	Assessment result				
computer hardware P_{11};	6	10	3	1	0
computer network facilitiesP_{12};	15	4	1	0	0
wiring system P_{13};	10	6	4	0	0
bank staff P_{14};	8	11	1	0	0
firewall P_{21};	15	3	2	0	0
vulnerability detection P_{22};	13	5	1	1	0
alarm system P_{23};	11	6	3	0	0
safety system P_{24};	10	6	3	1	0
certificate validation P_{25};	18	2	0	0	0
data detection P_{31};	13	5	2	0	0
data transmission P_{32};	9	7	3	1	0
data backup P_{33};	18	1	1	0	0
identity recognition P_{34};	12	7	1	0	0
log auditing P_{35};	16	2	2	0	0
emergency response P_{41};	9	8	2	1	0
emergency measureP_{42};	13	3	2	1	1
emergency recovery P_{43};	10	5	3	1	1

Subject the results to data processing, as shown in Table 12.

Table 12. Assessment Results after Data Processing

second level evaluation index	Assessment results after data processing				
computer hardware P_{11};	0.3	0.5	0.15	0.05	0
computer network facilitiesP_{12};	0.75	0.2	0.05	0	0
wiring system P_{13};	0.5	0.3	0.2	0	0

bank staff P_{14};	0.4	0.55	0.05	0	0
firewall P_{21};	0.75	0.15	0.1	0	0
vulnerability detection P_{22};	0.65	0.25	0.05	0.05	0
alarm system P_{23};	0.55	0.3	0.15	0	0
safety system P_{24};	0.5	0.3	0.15	0.05	0
certificate validation P_{25};	0.9	0.1	0	0	0
data detection P_{31};	0.65	0.25	0.1	0	0
data transmission P_{32};	0.45	0.35	0.15	0.05	0
data backup P_{33};	0.9	0.05	0.05	0	0
identity recognition P_{34};	0.6	0.35	0.05	0	0
log auditing P_{35};	0.8	0.1	0.1	0	0
emergency response P_{41};	0.45	0.4	0.1	0.05	0

emergency measureP_{42};	0.65	0.15	0.1	0.05	0.05
emergency recovery P_{43};	0.5	0.25	0.15	0.05	0.05

Use MATLB (in the Appendix) to compute the judgment vector of risk assessment of the computer system security of banks:

$$w \quad 0.6166 \quad 0.2547 \quad 0.1054 \quad 0.0215 \quad 0.0019 .$$

According to the maximum principle, it is found that the computer system security of banks is very safe.

Conclusion

In response to the media report of loops holes in bank's system and to the credit crisis of banks, banks should enhance security management of its computer system and increase the safety level. Priority should be given to risk assessment of computer system security, so as to ensure a normal operation of bank's business.

Appendix: MATLB

```
program a=load
('yhjsjwlaq.txt');
w= [0.1238 0.5956 0.2396 0.0410];
w1= [0.0736, 0.4709, 0.1715, 0.2840];
w2= [0.1815, 0.0365, 0.0751, 0.5587, 0.1482];
w3= [0.4901, 0.1052, 0.0364, 0.2284, 0.1399];
w4= [0.0915, 0.7071, 0.2014];
b (1,:)=w1*a([1:4],:);
b (2,:)=w2*a([5:9],:);
b (3,:)=w3*a([10:14],:);
b (4,:)=w4*a([15:end],:);
c=w*b
c =
  0.6166  0.2547  0.1054  0.0215  0.0019
```

References

[1] M. Ali Aydın, A. Halim Zaim, K. Gökhan Ceylan. "A hybrid intrusion detection system design for computer network security [J]". Computers and Electrical Engineering, vol.35, no. 3, **(2009)**, pp.517-526.

[2] J M. Estévez-Tapiador, ı -Teodoro, . ı z-Verdejo. "NSDF: a computer network system description framework and its application to network security [J]". Computer Networks, vol.43, no. 5, **(2003)**, pp.573-600.

[3] S Zhang. "A model for evaluating computer network security systems with 2-tuple linguistic information [J]". Computers and Mathematics with Applications, vol.62, no. 4, **(2011)**, pp.1916-1922.

[4] R Lübben, M Fidler, J Liebeherr, "Stochastic bandwidth estimation in networks with random service [J]", IEEE/ACM Transactions on Networking (TON), vol.22 , no. 2, **(2014),** pp.484-497.

[5] T J. Rothwell. "Job applications and network security, or, how to not limit the online applicant pool [J]". Ubiquity, **(2003)** (April), pp.2-2.

[6] G B. White, E A. Fisch, U W. Pooch. "Computer System and Network Security". EDPACS, vol.25, no. 8, **(1998)**.
[7] G Gercek, N Saleem, "Securing Small Business Computer Networks: An Examination of Primary Security Threats and Their Solutions," Information Security Journal: A Global Perspective, vol.14, no. 3, **(2005)**.
[8] Y-K Lin, C-L Pan. "Considering retransmission mechanism and latency for network reliability evaluation in a stochastic computer network [J]". Journal of Industrial and Production Engineering, vol.31, no. 6, **(2014),** pp.350-358.
[9] L T o, "Application of Fuzzy Mathematics in the Evaluation of Customer Satisfaction in Supermarket [ ]", Journal of Capital Normal University, no. 3, **(2015)**, pp. 15-18.
[10] L Tao, "Fuzzy Mathematics Evaluation based on University Network Risks [J]". Journal of Huaiyin Teachers College (Natural Science Edition), no. 2, **(2015)**, pp. 60-64.
[11] W ie, "Analysis of Computer Network Security [J]". Guangxi Journal of Light Industry, no. 2, **(2011)**, pp. 64-65.
[12] X Zhe, "On the Existing Problems and Countermeasures of the University Network Security [D]". **(2012)**.
[13] L Bingqi, "The Factors Inlfuencing the Computer Network Security and Countermeasures [J]". Computer Engineering & Software, no. 3, **(2014)**, pp. 152-154.
[14] H Zhonggeng. "Mathematical Modeling Methods and Application [M]". Beijing: Higher Education Press,**(2005).**
[15] S Jingwei, W Xinyi. "Application of Comprehensive Evaluation for the Quality of the Physical and Chemical Laboratory by Fuzzy Mathematics [J]". Shanghai Journal of Preventive Medicine, vol. 6, no. 14, **(2002),** pp. 265-266.
[16] Z Lijuan, W Qingxi n, "Application of Fuzzy Analytic Hierarchy Process Model in Network Security Situation Assessment [J]". Computer Simulation, no. 12, **(2011)**, pp. 138-140.
[17] L T o, "The Environment Impact Evaluation based on Urban Land Planning Project[J]". International Journal of Earth Sciences and Engineering, no. 2, **(2015)**.