A Study of Electronic Ticket Verification Methods

Shu-Ping Lu[†], Chih-Wei Chao[†], and Chi-Hua Chen[††]

[†]Service Systems Technology Center, Industrial Technology Research Institute, Hsinchu, 310 Taiwan
[††]Telecom Laboratories, Chunghwa Telecom Co., Ltd., Taoyuan, 326 Taiwan

Abstract
Information and communication technologies (ICT) and electronic commerce (EC) are flourishing dramatically. Furthermore, using electronic ticket is possible to reduce the costs of ticket management for companies and users. The business organizations have been restlessly evaluating the revenue potential of the electronic tickets market and exploit the he profit potential of the market quick shopping, variety of merchandises and shopping worldwide at home can offer to consumers. However, due to the ease of copy of electronic contents and privacy issues, the security issue is important in the real application of the electronic ticketing systems. Therefore, this study proposes four electronic ticket verification methods which include QR (Quick Response) code, QR code with digital certificates, RFID (Radio Frequency Identification) card, and credit card to provide safe and convenient transactions. Then this study proposes statistics models to evaluate the relations between the user acceptances of electronic ticket verification methods and uses profiles (e.g., sex, age, education, experience of electronic ticket transaction). In experiments, 186 questionnaires are collected and analyzed for evaluation. The practical results show that RFID card and credit card are popular for users. Furthermore, no significant differences are in these relations. Therefore, EC transactions can be designed with RFID card and credit card to verify electronic ticket in the future.

Key words:
Electronic Commerce, Electronic Ticket, Security, Certification、*Authentication*

1. Introduction

Information and communication technologies (ICT) are flourishing dramatically. As wireless network developments, it is expected that emerging electronic commerce continues to see phenomenal growth [1]. A variety of market transactions has been described by Electronic Commerce (EC), conducted over the electronic network and enabled by information technology. Traditional commerce involved a variety of processes such as identification of items of services, buying payment, trading transactions, information exchange, delivery, customer support, marketing, feedback and research, design, manufacturing of new products, and their distribution. In other words, traditional commerce involves not only a great number of processes but also the buying and selling transaction. Connectivity provided by the network infrastructure and the use of information technology simplifies many processes. Thus, electronic commerce is not about simply buying and selling over the network, but includes the use of the electronic network for many of the processes in traditional commerce [2].

Nowadays, paper-based tickets users have to move to the ticket issuer entity in order to receive it, causing loss of time, or managing a device that could print the ticket. Using electronic ticket is possible to reduce the costs of ticket management for companies and users. The use of electronic tickets affects the user and the business itself. Mobile devices (Smart phones, mobile phones or Personal Digital Assistants (PDAs)) are considered the best positioned devices in the electronic ticketing systems [3].

Electronic markets have a very important effect in the world. The business organizations have been restlessly evaluating the revenue potential of the electronic tickets market and exploit the he profit potential of the market quick shopping, variety of merchandises and shopping worldwide at home can offer to consumers. However, due to the ease of copy of electronic contents and privacy issues, the security issue is important in the real application of the electronic ticketing systems. Therefore, this study proposes four electronic ticket verification methods which include QR (Quick Response) code, QR code with digital certificates, RFID (Radio Frequency Identification) card, and credit card to provide safe and convenient transactions. Then this study proposes statistics models to evaluate the relation between the user acceptances of electronic ticket verification methods and uses profiles (e.g., sex, age, education, experience of electronic ticket transaction).

The remainder of the paper is structured as follows. Section 2 provides background knowledge through the description of related technologies, such as the concept of EC and electronic ticket. Section 3 proposes four electronic ticket verification methods to provide safe and convenient transactions. The implementation and evaluation of electronic ticket verification methods are presented in Section 4. Finally conclusion and future work are given in Section 5.

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2. Related Work

The electronic ticket verification methods is designed to provide safe and convenient transactions for EC. Necessary research background and relevant technology include: (1) EC and (2) electronic ticket.

2.1 Electronic Commerce

EC [4-9], commonly known as E-commerce or eCommerce, offers a thorough and complete explanation of what EC is, how its being conducted and managed, and how to assess its major opportunities, limitations, issues, and risks all in the social-computing business environment [7].

EC is directly dependent on integration of network connectivity with information and communication technologies. Many of EC advantages are the same as those that make the internet a preferred infrastructure. Anyone connects through EC internet is available to receive globally and distributes information twenty four hours a day, seven days a week.

The availability and cost of price and product information are important determinants of economic behavior. In the new era of emerging electronic communities, marketing organizations have to learn to provide the concept of the one-stop-shop. Consider the business role involved in promoting tourism that plans to cater an electronic community. The organization has to provide the full range of products and services to attract the online community [2]. The strategic impact of electronic communication is important for organizations. Therefore, a growing interest in EC focuses on strategy to improve business. Several paradigms have arisen from the EC field in recent years which try to support different business activities, such as Business to Consumer and Consumer to Consumer.

2.2 Electronic Ticket

An electronic ticket commonly known as e-ticket is a digital ticket. The requirements related to privacy and security can vary among different applications of electronic ticket. In some cases, security is critical, such as on electronic ticket falsification on air travel. Privacy requirements as the anonymity of the users are mandatory in other cases [3].

An electronic ticket system is designed to enable fare collection in as simple, efficient and secure way [10-11]. The customer receives an electronic ticket medium (mobile device ticket, smart card) which is the storage location for electronic tickets. The main objective of electronic ticket is to reduce operational expenditure and improve the service quality for customer. This strategy has been run smoothly for airline, so that it is practical and feasible as well to be implemented within other transportation mode such as bus, train, etc. [12-13]. For example, Matsuo and Ogata proposed an electronic ticket Scheme for intelligent transport system which is suitable for payment intelligent transport system [14]. Some studies built a communication channel with the verification system [15-18].

3. Electronic Ticket Verification Methods

In this study, four electronic ticket verification methods including QR code, QR code with digital certificates, RFID card, and credit card are proposed and presented in following subsections.

3.1 QR Code

The procedure and scenario of QR code for electronic ticket transactions are designed and presented in Figure 1 and following subsections.

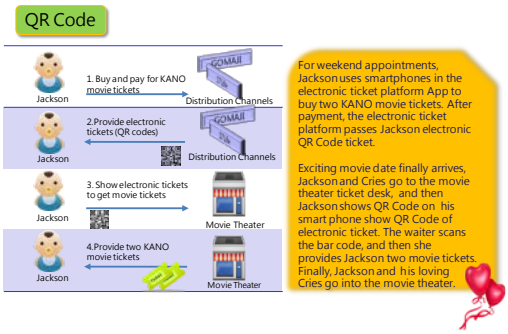

Fig. 1 The procedure and scenario of QR code for electronic ticket transactions.

3.1.1 The Procedure of QR Code

There are four steps of QR code for electronic ticket transactions.

Step 1: Buy and pay for KANO movie tickets.
Step 2: Provide electronic tickets (QR codes).
Step 3: Show electronic ticket to get movie tickets.
Step 4: Provide two KANO movie tickets.

3.1.2 The Scenario of QR Code

This section designs a case study of QR code for electronic ticket transactions.

For weekend appointments, Jackson uses smartphones in the electronic ticket platform App to buy two KANO movie tickets. After payment, the electronic ticket platform passes Jackson electronic QR Code ticket. Exciting movie date finally arrives, Jackson and Cries go to the movie theater ticket desk, and then Jackson shows QR Code on his smart phone show QR Code of electronic ticket. The

waiter scans the bar code, and then she provides Jackson two movie tickets. Finally, Jackson and his loving Cries go into the movie theater.

3.2 QR code with Digital Certificates

The procedure and scenario of QR code with digital certificates for electronic ticket transactions are designed and presented in Figure 2 and following subsections.

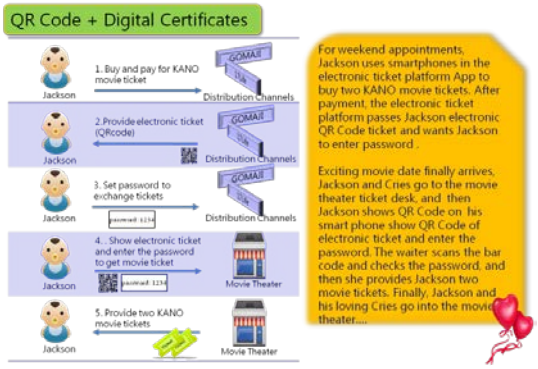

Fig. 2 The procedure and scenario of QR code with digital certificates for electronic ticket transactions.

3.2.1 The Procedure of QR Code with Digital Certificates

There are five steps of QR code for electronic ticket transactions.

Step 1: Buy and pay for KANO movie tickets.
Step 2: Provide electronic tickets (QR codes).
Step 3: Set password to exchange tickets.
Step4: Show electronic tickets and enter the password to get movie tickets.
Step 5: Provide two KANO movie tickets.

3.2.2 The Scenario of QR Code with Digital Certificates

This section designs a case study of QR code for electronic ticket transactions.
For weekend appointments, Jackson uses smartphones in the electronic ticket platform App to buy two KANO movie tickets. After payment, the electronic ticket platform passes Jackson electronic QR Code ticket and wants Jackson to enter password. Exciting movie date finally arrives, Jackson and Cries go to the movie theater ticket desk, and then Jackson shows QR Code on his smart phone show QR Code of electronic ticket and enter the password. The waiter scans the bar code and checks the password, and then she provides Jackson two movie tickets. Finally, Jackson and his loving Cries go into the movie theater.

3.3 RFID Card

The procedure and scenario of RFID card for electronic ticket transactions are designed and presented in Figure 3 and following subsections.

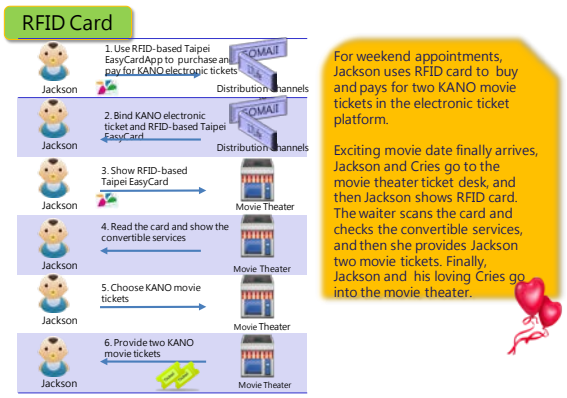

Fig. 3 The procedure and scenario of RFID card for electronic ticket transactions.

3.3.1 The Procedure of RFID card

There are six steps of RFID card for electronic ticket transactions.

Step1:Use RFID-based Taipei EasyCard App to purchase and pay for KANO electronic tickets.
Step2:Bind KANO electronic tickets and RFID-based Taipei EasyCard.
Step 3:Show RFID-based Taipei EasyCard.
Step4:Read the card and show the convertible services.
Step 5: Choose KANO movie tickets.
Step 6: Provide two KANO movie tickets.

3.3.2 The Scenario of RFID card

This section designs a case study of RFID card for electronic ticket transactions.
For weekend appointments, Jackson uses RFID card to buy and pays for two KANO movie tickets in the electronic ticket platform. Exciting movie date finally arrives, Jackson and Cries go to the movie theater ticket desk, and then Jackson shows RFID card. The waiter scans the card and checks the convertible services, and then she provides Jackson two movie tickets. Finally, Jackson and his loving Cries go into the movie theater.

3.4 Credit Card

The procedure and scenario of credit card for electronic ticket transactions are designed and presented in Figure 4 and following subsections.

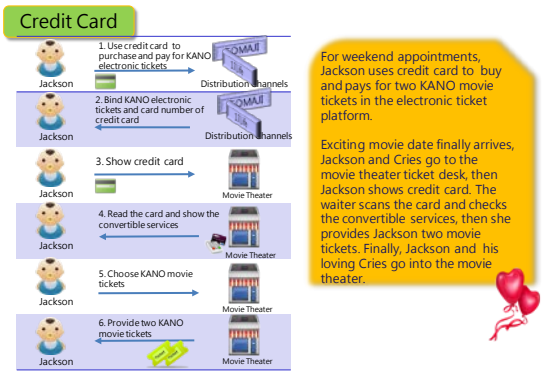

Fig. 4 The procedure and scenario of credit card for electronic ticket transactions.

3.4.1 The Procedure of Credit card

There are six steps of credit card for electronic ticket transactions.

Step1: Use credit card to purchase and pay for KANO electronic tickets.

Step2: Bind KANO electronic tickets and card number of credit card.

Step 3: Show credit card.

Step4: Read the card and show the convertible services.

Step 5: Choose KANO movie tickets.

Step 6: Provide two KANO movie tickets.

3.4.2 The Scenario of Credit card

This section designs a case study of credit card for electronic ticket transactions.

For weekend appointments, Jackson uses credit card to buy and pays for two KANO movie tickets in the electronic ticket platform. Exciting movie date finally arrives, Jackson and Cries go to the movie theater ticket desk, then Jackson shows credit card. The waiter scans the card and checks the convertible services, then she provides Jackson two movie tickets. Finally, Jackson and his loving Cries go into the movie theater.

3.5 Summary

The characteristics and comparisons of the proposed electronic ticket verification methods are summarized in Table 1.

Table 1: The characteristics and comparisons of the proposed electronic ticket verification methods

Payment Tools	QR Code	QR Code + Digital Certificates	RFID Card	Credit Card
Transmission Rate	Slower (5 mins)	Slower (5 mins, w/o digital certification time)	Faster (1 min)	Medium (3 mins)
Data Security	Less safe	Safer than QR Code	Safer with higher encrypted data	Safer with higher encrypted data
Requirements	Smartphone or papers	Smartphone or papers	RFID Card	Credit Card
Strength	➢ Convenience of use	➢ Convenience of use ➢ Safer than QR Code	➢ Write off faster: You can move at high speed read ➢ The more data security and correctness	➢ The more information on the safety and correctness
Limitations	➢ Scanning takes longer to write off ➢ When dirty or damaged bar code cannot be read ➢ Low security	➢ Scanning takes longer to write off ➢ When dirty or damaged bar code cannot be read ➢ Verification password is required	➢ The need for RFID-based cards (such as Taipei Easy Card)	➢ Need to have a credit card
Case	Taiwan High Speed Rail T Express	Reference [19]	RFID-based Taipei EasyCard	None

4. Implementation and Evaluation

This study implemented the proposed methods and selected people to use these method for evaluation. The experimental environments and analyses are presented as follow.

4.1 Statistics Models and Experimental Environments

This study proposes statistics models to evaluate the relations between the user acceptances of electronic ticket verification methods (i.e., QR code, QR code with digital certificates, RFID card, and credit card) and uses profiles

(e.g., sex, age, education, experience of electronic ticket transaction)(shown in Figure 5). In experiments, 186 questionnaires are collected and analyzed for evaluation. Each person fills in his/her questionnaire and select one or more electronic ticket verification methods which are accepted by him/her. The distributions of uses profiles are shown in Figures 5-8, and the user acceptance rate of each method are shown in Table 2.

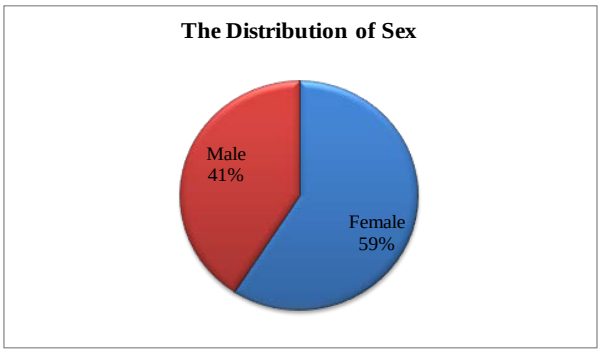

Fig. 5 The distribution of sex.

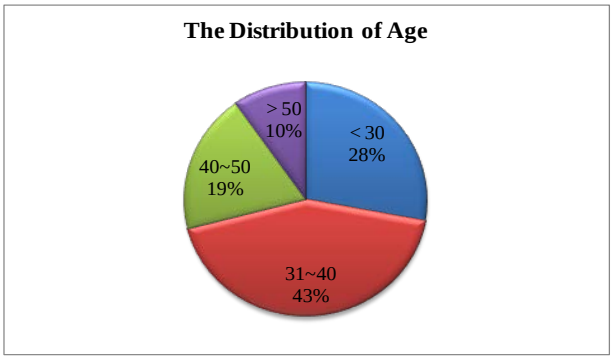

Fig. 6 The distribution of age.

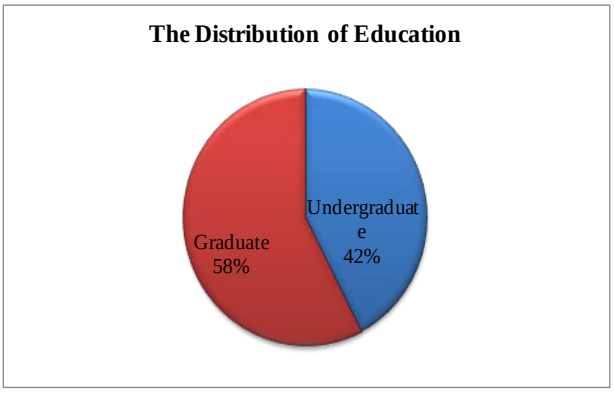

Fig. 7 The distribution of education.

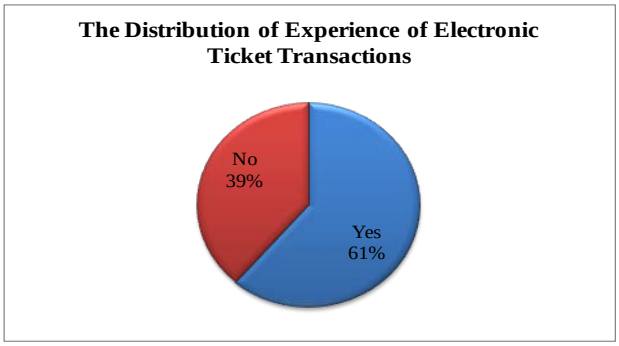

Fig. 8 The distribution of experience of electronic ticket transaction.

Table 2: The user acceptance rate of each method

Method	User Acceptance Rate
QR Code	40.32%
QR Code with Digital Certificates	25.27%
RFID Card	45.16%
Credit Card	45.70%

4.2 The Analysis of Sex and Electronic Ticket Verification Method

For the analysis of sex and electronic ticket verification method, Table 3 shows the counts of the user acceptance with different sexes for each method. Then expect counts of the user acceptance with different sexes are calculated and showed in Table 4 when the relation between sex and the acceptances of electronic ticket verification method is independent. Finally, the chi-square test [20] is used to verify the this relation, and the results show that there are no significant differences ($\chi^2 = 3.66 < 7.815 = \chi^2_{3,\alpha=0.05}$) in this test (shown in Table 5). Therefore, the factor of sex would not influence the selection of electronic ticket verification method.

Table 3: The counts of the user acceptance with different sexes for each method

	QR Code	QR Code with Digital Certificates	RFID Card	Credit Card	Summary
Female	42	33	47	46	168
Male	33	14	37	39	123
Summary	75	47	84	85	291

Table 4: The expect counts of the user acceptance with different sexes for each method

	QR Code	QR Code with Digital Certificates	RFID Card	Credit Card	Summary
Female	43	27	48	49	168
Male	32	20	36	36	123
Summary	75	47	84	85	291

Table 5: The chi-square test results of sex

	QR Code	QR Code with Digital Certificates	RFID Card	Credit Card	Summary
Female	0.04	1.27	0.05	0.19	1.55
Male	0.05	1.73	0.06	0.26	2.11
Summary	0.09	3.00	0.11	0.46	3.66

4.3 The Analysis of Age and Electronic Ticket Verification Method

For the analysis of age and electronic ticket verification method, Table 6 shows the counts of the user acceptance with different ages for each method. Then expect counts of the user acceptance with different ages are calculated and showed in Table 7 when the relation between age and the acceptances of electronic ticket verification method is independent. Finally, the chi-square test [20] is used to verify the this relation, and the results show that there are no significant differences ($\chi^2 = 2.38 < 16.919 = \chi^2_{9,\alpha=0.05}$) in this test (shown in Table 8). Therefore, the factor of age would not influence the selection of electronic ticket verification method.

Table 6: The counts of the user acceptance with different ages for each method

	QR Code	QR Code with Digital Certificates	RFID Card	Credit Card	Summary
< 30	21	10	23	19	73
31~40	33	21	33	40	127
40~50	15	11	18	17	61
> 50	6	5	10	9	30
Summary	75	47	84	85	291

Table 7: The expect counts of the user acceptance with different ages for each method

	QR Code	QR Code with Digital Certificates	RFID Card	Credit Card	Summary
< 30	19	12	21	21	73
31~40	33	21	37	37	127
40~50	16	10	18	18	61
> 50	8	5	9	9	30
Summary	75	47	84	85	291

Table 8: The chi-square test results of age

	QR Code	QR Code with Digital Certificates	RFID Card	Credit Card	Summary
< 30	0.25	0.27	0.18	0.25	0.96
31~40	0.00	0.01	0.37	0.23	0.61
40~50	0.03	0.13	0.01	0.04	0.21
> 50	0.39	0.00	0.21	0.01	0.61
Summary	0.68	0.42	0.76	0.52	2.38

4.4 The Analysis of Education and Electronic Ticket Verification Method

For the analysis of education and electronic ticket verification method, Table 9 shows the counts of the user acceptance with different educations for each method. Then expect counts of the user acceptance with different educations are calculated and showed in Table 10 when the relation between education and the acceptances of electronic ticket verification method is independent. Finally, the chi-square test [20] is used to verify the this relation, and the results show that there are no significant differences ($\chi^2 = 1.16 < 7.815 = \chi^2_{3,\alpha=0.05}$) in this test (shown in Table 11). Therefore, the factor of education would not influence the selection of electronic ticket verification method.

Table 9: The counts of the user acceptance with different educations for each method

	QR Code	QR Code with Digital Certificates	RFID Card	Credit Card	Summary
Undergraduate	31	23	34	34	122
Graduate	44	24	50	51	169
Summary	75	47	84	85	291

Table 10: The expect counts of the user acceptance with different educations for each method

	QR Code	QR Code with Digital Certificates	RFID Card	Credit Card	Summary
Undergraduate	31	20	35	36	122
Graduate	44	27	49	49	169
Summary	75	47	84	85	291

Table 11: The chi-square test results of education

	QR Code	QR Code with Digital Certificates	RFID Card	Credit Card	Summary
Undergraduate	0.01	0.55	0.04	0.08	0.67
Graduate	0.00	0.40	0.03	0.05	0.49
Summary	0.01	0.95	0.07	0.13	1.16

4.5 The Analysis of Experience of Electronic Ticket Transaction and Electronic Ticket Verification Method

For the analysis of experience of electronic ticket transaction and electronic ticket verification method, Table 12 shows the counts of the user acceptance with different experiences of electronic ticket transaction for each method. Then expect counts of the user acceptance with different experiences of electronic ticket transaction are calculated and showed in Table 13 when the relation between experience of electronic ticket transaction and the

acceptances of electronic ticket verification method is independent. Finally, the chi-square test [20] is used to verify the this relation, and the results show that there are no significant differences ($\chi^2 = 0.87 < 7.815 = \chi^2_{3,\alpha=0.05}$) in this test (shown in Table 14). Therefore, the factor of experience of electronic ticket transaction would not influence the selection of electronic ticket verification method.

Table 12: The counts of the user acceptance with different experiences of electronic ticket transaction for each method

	QR Code	QR Code with Digital Certificates	RFID Card	Credit Card	Summary
Yes	44	27	54	50	175
No	31	20	30	35	116
Summary	75	47	84	85	291

Table 13: The expect counts of the user acceptance with different experiences of electronic ticket transaction for each method

	QR Code	QR Code with Digital Certificates	RFID Card	Credit Card	Summary
Yes	45	28	51	51	175
No	30	19	33	34	116
Summary	75	47	84	85	291

Table 14: The chi-square test results of experience of electronic ticket transaction

	QR Code	QR Code with Digital Certificates	RFID Card	Credit Card	Summary
Yes	0.03	0.06	0.24	0.02	0.35
No	0.04	0.09	0.36	0.04	0.53
Summary	0.07	0.14	0.60	0.06	0.87

5. Conclusions and Future Work

ICT and EC are flourishing dramatically, and using electronic ticket is possible to reduce the costs of ticket management for companies and users. However, due to the ease of copy of electronic contents and privacy issues, the security issue is important in the real application of the electronic ticketing systems. Therefore, this study proposes four electronic ticket verification methods which include QR code, QR code with digital certificates, RFID card, and credit card to provide safe and convenient transactions. Then this study proposes statistics models to evaluate the relations between the user acceptances of electronic ticket verification methods and uses profiles (e.g., sex, age, education, experience of electronic ticket transaction). In experiments, 186 questionnaires are collected and analyzed for evaluation. The practical results show that RFID card and credit card are popular for users. Furthermore, no significant differences are in these relations. Therefore, EC transactions can be designed with RFID card and credit card to verify electronic ticket in the future.

References

[1] C. Coursaris, K. Hassanein, "Understanding M-Commerce", Quarterly Journal of Electronic Commerce, vol. 3, no. 3, pp. 247-271, 2002.

[2] B. Bhasker, "Electronic Commerce - Framework, Technologies and Applications", McGraw-Hill Publishing Company, Inc., USA, 2013.

[3] M. Mut-Puigserver, M.M. Payeras-Capellà, J.L. Ferrer-Gomila, A. Vives-Guasch, J. Castellà-Roca, "A Survey of Electronic Ticketing Applied to Transport", Computers & Security, vol. 31, no. 8, pp. 925-939, 2012

[4] E.M. Awad, "Electronic Commerce: From Vision to Fulfillment", Pearson/Prentice Hall, Inc., USA, 2002.

[5] J. Gordijn, H. Akkermans, H. van Vliet, "Value Based Requirements Creation for Electronic Commerce Applications", Proceedings of the 33rd Annual Hawaii International Conference on System Sciences, Los Alamitos, CA, USA, 2000.

[6] G. Saloner, A.M. Spence, "Creating and Capturing Value: Perspectives and Cases on Electronic Commerce", John Wiley & Sons Ltd., UK, 2002.

[7] E. Turban, J. Lee, D. King, H.M. Chung, "Electronic Commerce - A Managerial Perspective", Pearson/Prentice Hall, Inc., USA, 2002

[8] E. Hartonoa, C.W. Holsapple, K.Y. Kim, K.S. Na, J.T. Simpson, "Measuring Perceived Security in B2C Electronic Commerce Website Usage: A respecification and Validation", Decision Support Systems, vol. 62, no. 1, pp. 11-21, 2014.

[9] J. Wu, L. Li, L. Xu, , "A Randomized Pricing Decision Support System in Electronic Commerce", Decision Support Systems, vol. 58, no. 1, pp. 43-52, 2014.

[10] L. Finzgar, M. Trebar, "Use of NFC and QR Code Identification in an Electronic Ticket System for Public Transport", Proceedings of 2011 19th International Conference on Software, Telecommunications and Computer Networks, Split, Croatia, 2011

[11] J.C. Ferreira, P. Filipe, C. Gomes, G. Cunha, J. Silva, "Taas - Ticketing as a Service", Proceedings of the 3rd International Conference on Cloud Computing, Aachen-Germany, 2013.

[12] S.M. Nasution, E. Husni, A. Wuryandari, "Prototype of Train Ticketing Application Using Near Field Communication (NFC) Technology on Android Device", Proceedings of 2012 International Conference on System Engineering and Technology, Bandung, India, 2012.

[13] Z.M. Alfawaer, M. Awni, S. Al-Zoubi, "Mobile E-Ticketing Reservation System for Amman International Stadium in Jordan. Jordan", International Journal of Academic Research, vol. 3, no. 1, pp. 848, 2011.

[14] S. Matsuo, W. Ogata, "Electronic Ticket Scheme for ITS", IEICE Transactions on Fundamentals of Electronics Communications and Computer Sciences, vol. E86A, no.1, pp.142-150, 2003.

[15] D. Haneberg, "Electronic Ticketing: Risks in E-commerce Applications", Digital Excellence, pp.55-66, 2008.

[16] K. Kuramitsu, T. Murakami, H. Matsuda, K. Sakamura, “TTP: Secure ACID Transfer protocol for Electronic Ticket Between Personal Tamper-proof Devices”, Proceedings of the 24th Annual International Computer Software and Applications Conference, Taipei, Taiwan, 2000.
[17] K. Kuramitsu, K. Sakamura, “Electronic Tickets on Contactless Smartcard Database”, Lecture Notes in Computer Science, vol. 2453, no. 1, pp. 392–402, 2002.
[18] S. Birzhandi, N. Pour Moallem, S.J. Ghoreishi, “Evaluation of E-trust Building Structures Interact with Transportation”, Proceedings of 2014 8th International Conference on e-Commerce in Developing Countries: With Focus on e-Trust, Mashhad, Iran, 2014.
[19] D. Conde-Lagoa, E. Costa-Montenegro, F.J. Gonzalez-Castao, F. Gil-Castiñeira, “Secure eTickets Based on QR-Codes with User-encrypted Content”, Proceedings of 2010 Digest of Technical Papers International Conference on Consumer Electronics, Las Vegas, NV, USA, 2010.
[20] C.H. Chen, H.C. Chang, C.Y. Su, C.C. Lo, H.F. Lin, “Traffic Speed Estimation Based on Normal Location Updates and Call Arrivals from Cellular Networks”, Simulation Modelling Practice and Theory, vol. 35, no. 1, pp. 26-33, 2013.

Shu-Ping Lu received a M.S. degree from Department of Electronic and Computer Engineering at National Taiwan University of Science and Technology, Taiwan, in 2008. She is currently serving as a researcher in Service System Technology Center of Industrial Technology Research Institute. Her interests include web services, information and communication technology, intelligent transportation system, and image processing.

Chih-Wei Chao received a M.S. degree from Graduate Institute of Industrial Management at National Cheng Kung University. He is currently serving as a project manager in Service System Technology Center of Industrial Technology Research Institute. His recent research interests are in web services and software engineering.

Chi-Hua Chen received his B. S. degree from Department of Management Information Systems of National Pingtung University of Science and Technology in 2007, a M. S. degree from Institute of Information Management of National Chiao Tung University (NCTU) in 2009, and a Ph.D. degree from Department of Information Management and Finance of NCTU in 2013. He is an associate researcher for Internet of Things Laboratory of Chunghwa Telecommunication Laboratories. He has published over 100 journal articles, conference articles, and patents. He served as the Guest Editor-in-Chief of Special Issue on "Cloud Computing Technology and Applications" for IEEE Multidisciplinary Engineering Education Magazine; furthermore, he is serving as an Editor-in-Chief for IEEE Technology and Engineering Education and the Guest Editor of Special Issue on "Information Management and Applications of Intelligent Transportation System" for Mathematical Problems in Engineering. He also is currently serving as a member of editorial board of several international journals. His recent research interests are in Cloud Computing, Cellular Network, Data Mining, Intelligent Transportation System, Network Security, Healthcare System, Augmented Reality, E-Learning System, and Digital Marketing.