

Evaluation and Improvement of E-toll Card System at Toll Gate

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Abstract—The research was conducted to the manager or operator of toll road and e-toll users to find out what problems happened in transactions with e-toll cards. The purpose of the E-Toll Card is to simplify transactions and to unravel the traffic jam at the Suramadu toll gate. The methods used were the critical incident technique (CIT) and importance performance analysis (IPA). The research result in Suramadu toll road is 7 attributes that need to be improved. Evaluation and improvement of toll road usage system resulted that queue of vehicles at Suramadu toll gate was caused by the lack of socialization, lack of signs along Suramadu road access and lack of toll gate on Suramadu toll road. The toll road management is also required to provide a place for top up e-toll cards around Suramadu access. The toll road management also opens the e-toll card complaint system to the complaints of e-toll card users with the online system and also to reduce transaction errors on toll roads.

Keywords— *e-toll, IPA, CIT, improvement*

I. INTRODUCTION

As of 31 October 2017, PT Jasa Marga (Persero) applies 100 percent of non-cash payments in all toll roads in operation. This is performed in accordance with Decree of the Minister of Public Works and Public Housing No.16/PRT/M/2017 on non-cash toll transactions. Although the implementation of 100 percent use of non-cash transactions with e-toll cards, in some toll gate segments seem to make a long queue. The use of non-cash transactions actually makes the traffic jam at the toll gate because there are still many toll users that do not really understand how to use e-Toll Card [1]. However, it is believed that the application of this system provides convenience but needs socialization and customization of the e-Toll Card users. Although such payment system is considered to be very effective, many toll users assume that this method of payment will create traffic jam. Previously in the non-cash transactions, Jasa Marga targeted the transaction duration for 4 seconds this is certainly faster than the cash transactions that take approximately 8 to 9 seconds [2].

The use of e-toll cards is an innovation of payment systems technology aimed at reducing traffic jam and accelerating toll road services. A survey of consumer outlook on e-toll cards as a solution that positively impacts the environment. The existence of a large positive support from the consumer needs to be responded well by e-toll card service providers [3]. Problems that occur in the implementation of the e-toll system include (1) E-toll still cannot fully function as expected. E-toll is expected to reduce traffic jam even sometimes cause traffic jam. (2) The operator of the e-toll is less spry in managing the e-toll system problems. (3) Weak e-toll card marketing

education due to low understanding of e-toll cards to support sustainable environmental capacity.

The level of user acceptance of the e-toll card application can be measured by theoretical approach that can describe the acceptability and usage level of a technology that is the integration of Technology Acceptance Model (TAM) and Theory of Planned Behavior (TPB). The integration of TAM and TPB affects attitudes in the acceptance of technology. TAM is a conceptual model used to predict the adoption of a technology that includes perceived usefulness, perceived ease of use, attitude and intention to use [4]; [5]. TPB predicts certain behaviors that can be planned and deliberate. TPB is influenced by three factors: behavioral belief, normative belief, and control belief. The goal is to know the comprehensive view of user acceptance of e-toll card services and provide an understanding of e-toll card users intent.

Suramadu National Bridge that connects between Java and Madura Island makes it easier for people who are in Java to visit the island of Madura without having to board a crossing ship. As a toll road access, the Suramadu toll road, as of October 31, 2017, the toll payment must be non-cash. In anticipating the impact of government regulations on non-cash payment is the occurrence of traffic jam on the Suramadu toll road. The reason is the lack of socialization on the application of non-cash toll payment. Many drivers do not have electronic toll cards (e-toll). Another traffic trigger is lack of signs on the highway access of Suramadu to classify cars, trucks, and buses. Not infrequently the wrong trucks and buses take the right lane which is the direction towards automatic toll gate (GTO). When that happens, the bus and truck must be transferred first. In addition, many drivers whose e-toll balance is not sufficient, so they top up in front of the toll gate.

II. RESEARCH METHODS

This research is expected to produce the best proposal for e-toll card system in Suramadu Bridge. The method used was the critical incident technique (CIT). CIT is a procedure of collecting information through direct observation of incidents that are deemed to have the special and systematic meaning defined as criteria. So, it can be said that the focus of CIT is recording and analyzing incidents. The parties involved in CIT are those who are either directly or indirectly involved in critical incidents. Critical Incident itself means corrective action or that causes far from expected results [6].

Furthermore, there was questionnaire by using Likert scale to be processed further. The questionnaire consisted of 3 parts. Part A to process the data influence diagram. Part B to obtain performance data and section C to obtain data of interest. In

this study, it was used non-probability sampling technique with accidental sampling method. According to Malhotra, it is required as many as 110 data to be able to meet the adequacy of data which is the minimum number of attributes multiplied by 5 (five). The number of data obtained was 184 data which means it was already meet the criteria [7].

The next step was to test the validity of the data influence diagram, performance data, and interest data. Validity test was performed by using product moment with SPSS software. If the value of $R_{calc} > R_{table}$ then the data is declared valid. After doing the validation for all questionnaire data then the reliability test was performed to determine whether the data can be trusted (reliable) and satisfied. The next step was grouping to control input which will become the factor by using correlation analysis. Correlation analysis is a statistical method used to measure the magnitude of the linear relationship between two or more variables. If the value of correlation is positive, then the relationship between two variables is unidirectional. Conversely, if the correlation is negative, then the relationship between the two variables is opposite. The steps taken to perform this correlation analysis are the same as doing validation with Pearson correlations [8].

The next step was system evaluation with the method of importance performance analysis (IPA) to measure the level of someone's satisfaction over the performance of others. Person satisfaction is measured by comparing the level of expectations with the performance of other parties. IPA is used by companies to measure customer satisfaction. The company compares the expectations of consumers with the performance that has been done. If the level of expectations is higher than the performance of the company means that the consumer has

not reached satisfaction, and vice versa. Respondents are asked to assess the level of importance and performance of the company, then the average value of importance and performance are analyzed on the Importance Performance Matrix, in which the x axis represents perception whereas the y-axis represents expectations [9].

After finding the problematic attribute, there was the searching of the root of the problem by using why-why analysis. Why-Why Analysis is a root cause analysis tool for problem-solving. This tool helps identify the root cause or cause of a discrepancy in the process or product. Why-Why Analysis or 5 Why's Analysis is commonly used in conjunction with the Fishbone Diagram and use iteration techniques by asking WHY and repeated a few times until it finds the root of the problem, and then performs an improvement [10].

III. RESULTS OF RESEARCH

A. Preliminary Research

The preliminary research was conducted by interviewing the toll road operators and e-toll users to find out what problems happened on transactions with e-toll cards. The results of interview with toll operators were informed that the problem that often occurs at toll gates is that e-toll card users often do not check the remaining balance of their e-toll card at the time on GTO, so that becomes a problem in the toll gate because toll road operators do not provide alternatives payment system other than e-toll card. The frequency of the occurrence of errors in one day can reach 40-50 times. The hope from toll road managers is toll road users can conduct fast, precise, and correct transactions.

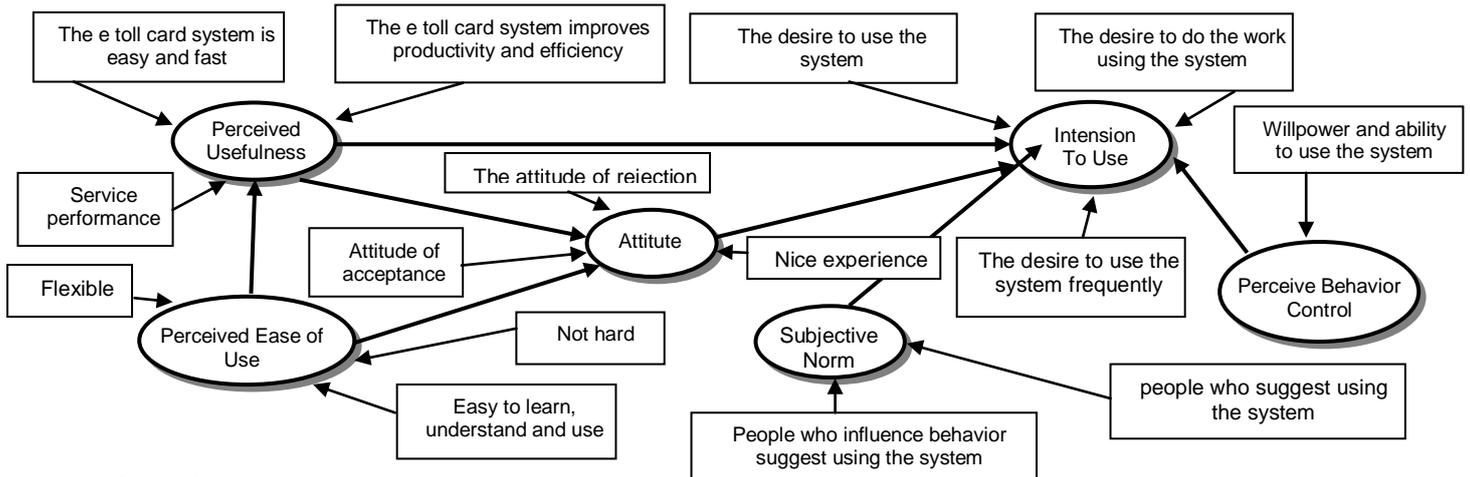


Fig. 1. Influence diagram

Interview of toll road users was performed in the toll rest area. Based on interview with toll users, e-toll cards have practical and efficient advantages. However, some e-toll card users also stated that this e-toll card system caused quite a long queue at the toll gates and top-up system which made it difficult because it should come to the publishing bank or should top up in indomaret or alfamart. Another problem that arises is the lack of readiness of the toll road operator in the presence of e-toll cards in each toll gate and the lack of spry of operator if e-toll card users have problem with the equipment

or e-toll card they own, which often causes queue at the toll gate. Based on the results of interview, it can be arranged influence diagram as Figure 1.

B. Identification of Attributes

The method used was the critical incident technique method. The e-toll card user was asked for one or more critical incidents that he/she has encountered while using the e-toll card. Questions asked based on control input. Interview results are interpreted to be attributes in Table 1.

TABLE I. ATTRIBUTES OF RESEARCH

No.	Attributes	No.	Attributes
1.	The e-toll card system is faster	12.	The e-toll card system is easy to use
2.	The e-toll card system is easier	13.	User acceptance attitude towards e-toll card system
3.	The e-toll card system improves performance	14.	The attitude of rejection of the e-toll card system
4.	The e-toll card system increases productivity	15.	Nice experience in using e-toll card system
5.	The e-toll card system enhances effectiveness	16.	People who influence behavior suggest using the e-toll card system
6.	The e-toll card system is very useful	17.	People who suggest using the e-toll card system
7.	The e-toll card system is easy to learn	18.	Willingness to use e-toll card system
8.	The e-toll card system is easy to implement	19.	Ability to use e-toll card system
9.	The e-toll card system is easy to understand	20.	The desire to use the e-toll card system
10.	The e-toll card system is flexible	21.	The desire to pass the highway by using e-toll card system
11.	The e-toll card system is free from difficulties	22.	The desire to use the e-toll card system frequently

C. Correlation Analysis

After validating the questionnaire data, the next step was performed correlation analysis. This analysis serves to determine whether the attributes obtained from CIT are included in the control input or not. Correlation analysis is also performed on influence diagram in order to know correlation between variables. The following is the result of attribute correlation analysis on control input.

Table 2 shows that the sig value. is under 5% which means the attribute is valid. Attributes 28 through 32 had correlation to control input. Of all the attributes that have been obtained in CIT, all attributes had correlation with control input. Attributes that have a low correlation, can be eliminated. Attributes that had low correlation were attributes 11 and 14. The attributes that could be eliminated were attributes 11 and 14.

TABLE II. ATTRIBUTES CORRELATION OF E-TOLL CARD

Atribut	Pearson Correlation	Atribut	Pearson Correlation
Control Input Perceived Usefulness		Control Input Attitude	
1. The e-toll card system is faster	0,606 ^{**}	13. User acceptance attitude towards e-toll card system	0,444 ^{**}
2. The e-toll card system is easier	0,598 ^{**}	14. The attitude of rejection of the e-toll card system	0,257 ^{**}
3. The e-toll card system improves performance	0,352 ^{**}	15. Nice experience in using e-toll card system	0,953 ^{**}
4. The e-toll card system increases productivity	0,606 ^{**}	Control Input Subjective Norm	
5. The e-toll card system enhances effectiveness	0,598 ^{**}	16. People who influence behavior suggest using the e-toll card	0,509 ^{**}
6. The e-toll card system is very useful	0,352 ^{**}	17. People who suggest using the e-toll card system	0,460 ^{**}
The e-toll card system is easy to learn		Control Input Perceive Behavior Control	
7. The e-toll card system is easy to learn	0,606 ^{**}	18. Willingness to use e-toll card system.	0,532 ^{**}
8. The e-toll card system is easy to implement	0,598 ^{**}	19. Ability to use e-toll card system	0,541 ^{**}
9. The e-toll card system is easy to understand	0,352 ^{**}	Control Input Intension to Use	
10. The e-toll card system is flexible	0,551 ^{**}	20. The desire to use the e-toll card system	0,396 ^{**}
11. The e-toll card system is free from difficulties	0,250 ^{**}	21. The desire to pass the highway by using e-toll card system	0,402 ^{**}
12. The e-toll card system is easy to use	0,321 ^{**}	22. The desire to use the e-toll card system frequently	0,487 ^{**}

D. Importance Performance Analysis (IPA)

In this technique, respondents were asked to assess the level of importance and performance of the firm, then the average value of importance and performance was analyzed on the Importance-Performance Matrix, where the X axis represents perception whereas Y axis represents expectations.

Based on Table 3, it can be seen that all attributes have a negative value which means that each attribute has not met customer expectations. After knowing that these attributes are included in the factors. The next step was to evaluate the current system by using the IPA method. This method can find out the improvement priorities for the attribute. The method was performed by using the results of questionnaire data part B (performance) and C (importance).

Based on Figure 2, quadrant A shows the factors or attributes that are considered important by the customer but not implemented properly by the company. The factors or attributes included in this quadrant are:

- (1) The e-toll card system is faster.
- (4) The e-toll card system increases productivity
- (5) The e-toll card system enhances effectiveness.
- (12) The e-toll card system is easy to use
- (13) User acceptance attitude towards e-toll card system
- (19) Ability to use e-toll card system
- (22) The desire to use the e-toll card system frequently.

Thus, these attributes become the company's top priority scale to be improved.

TABLE III. CUSTOMER SATISFACTION SCORE BASED ON RANK

No	Pernyataan	Score		Gap
		Perc.	Exp.	
1	The e-toll card system is faster	2.69	3.57	-0.88
2	The e-toll card system is easier	2.69	3.47	-0.78
3	The e-toll card system improves performance	2.87	3.44	-0.57
4	The e-toll card system increases productivity	2.88	3.56	-0.68
5	The e-toll card system enhances effectiveness	3.01	3.5	-0.49
6	The e-toll card system is very useful	3.07	3.48	-0.41
7	The e-toll card system is easy to learn	3.04	3.44	-0.4
8	The e-toll card system is easy to implement	2.99	3.45	-0.46
9	The e-toll card system is easy to understand	3.09	3.45	-0.36
10	The e-toll card system is flexible	3.06	3.41	-0.35
11	The e-toll card system is free from difficulties	3.04	3.48	-0.44
12	The e-toll card system is easy to use	3.07	3.51	-0.44
13	User acceptance attitude towards e-toll card	3.08	3.51	-0.43
14	The attitude of rejection of the e-toll card system	3.04	3.47	-0.43
15	Nice experience in using e-toll card system	3.09	3.41	-0.32
16	People who influence behavior suggest e-toll card	3.13	3.44	-0.31
17	People who suggest using the e-toll card system	3.13	3.44	-0.31
18	Willingness to use e-toll card system	3.15	3.45	-0.3
19	Ability to use e-toll card system	3.02	3.57	-0.55
20	The desire to use the e-toll card system	3.17	3.57	-0.4
21	The desire to pass the highway by e-toll card	3.23	3.47	-0.24
22	The desire to use the e-toll card system frequently	3.0	3.54	-0.54

	systems other than e-toll cards. Some toll users want to preempt the queue
Difficult top-up system	Users must come to the issuing bank or must top up in indomaret or alfamart. Lack of user knowledge in checking balances.
Lack of toll road user knowledge	New technologies require socialization and information on how to use. Users do not know the benefits of e toll card.
Transaction error	The absence of a complaint system against transactions error, such as the withdrawal of 2 tariffs on a transaction and e-toll machine error to read the type or class of vehicle.

The volume of vehicles passing through Suramadu is categorized in large quantities every day. Often seen a long queue, especially in rush hour during the morning and late afternoon and on weekends. At the Suramadu Toll Gate, there are sides of Surabaya and Madura are 4 Entrance toll gates that serve cars both from Surabaya and Madura which are operated for 24 hours. This amount is deemed appropriate to be added considering the number of queues. The proposed suggestion is to increase the number of toll gates with an open-close system. The toll gate is opened in a long queue condition and closed at a quiet queue. Socialization of the importance of the queue also needs to be done so that toll road users do not each other to grab when entering the Suramadu toll gate. Readiness of toll officers should also be upgraded as soon as queues occur in the Suramadu toll road by promptly performing problem analysis and resolving queues quickly [11].

The toll road management also provides top-up e-toll cards services around Suramadu that can serve all e-toll card operators. Toll road operators can work with bank or alfamart and indomaret to open top-up e-toll services around Surabaya and Madura sides in Suramadu entrance. This service also needs to be equipped with signs about the use of e-toll cards before entering the Suramadu area, so that the toll road users anticipate their readiness if they will enter the Suramadu toll road. The operator also should realize the checking of toll balances and complaints system by online system through HP, so that e-toll card service becomes easier, faster, and efficient [12].

The purpose of the E-Toll Card is to simplify transactions and to unravel the traffic jam at the Suramadu toll gate. The lack of socialization from related parties to all groups or communities is still confused with the E-Toll card program at the Suramadu toll gate. Lack of socialization and also services that still cause traffic jam. Although there has been socialization related to E-Toll card, but the method of socialization that is performed by related parties is only applied at the toll gate Suramadu. It would be better to use the door to door method. There are still many people who are less aware or even do not know the function of e-Toll. Not only that, the readiness of the issuer e-toll card bank. Not to mention for top-up issues, because some users complained that they are still in difficulties when they want to add balance [13].

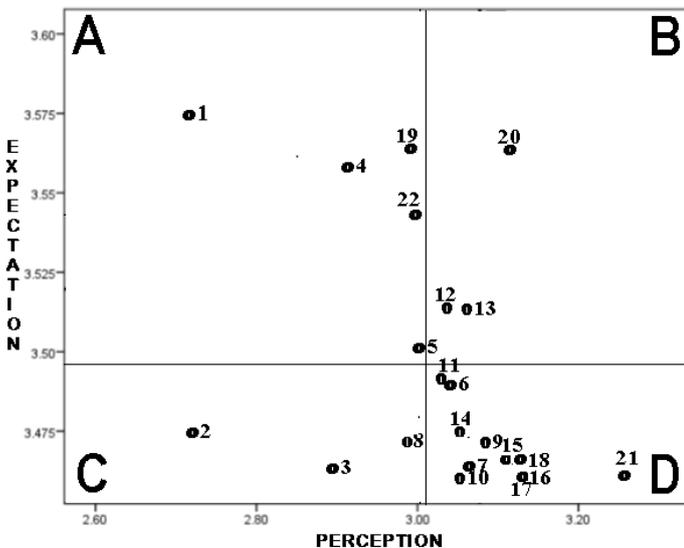


Fig. 2. Cartesian Diagram

E. Why-why Analysis

To find the root of the problem can be performed by using why-why analysis. The procedure of Why-why analysis was to interview 5 Suramadu e-toll cards (problem owner). Five e-toll card users were between 25-45 years old. The five users routinely use e-toll cards. After finding the root of each problem, then it can be given a proposal for each problem.

TABLE IV. WHY-WHY ANALYSIS

Problem	Root of Problem
Quite long queue at the toll booth	The lack of readiness of toll road operators and the lack of spry of e-toll card operators which have problems with tools and e-toll cards. Toll road operators do not provide alternative payment

The main disadvantage of this e-toll card system is that users have to trust e-toll card operators and e-toll machines operated by toll managers in Indonesia. To reduce the weaknesses and suspicions of e-toll card users, e-toll card operators need to disclose information, especially in checking e-toll card balances. For example with e money application, by attaching e-toll cards on NFC Smartphone. Either before or after the use of the balance. In addition, to know the available balance, e-toll card users can also ensure no fraud committed by irresponsible person [14].

IV. CONCLUSION

E-toll card is an innovation of payment systems technology aimed at reducing traffic jam and accelerating toll road services. The results of this research in the Suramadu toll road that there are 7 attributes that need to be improved, (1) the faster e-toll card system, (2) e-toll card system increases productivity, (3) e-toll card system enhances effectiveness, (4) The e-toll card system is easy to use, (5) User acceptance attitude towards e-toll card system, (6) Ability to use e-toll card system, (7) Desire to use e-toll card system frequently. The suggestion given is the addition of the number of toll gates with open-close system where the toll gate is opened at the time of long queue and closed back when the queue is in minimal situation. The management of toll road must conduct socialization, especially around the Suramadu toll road on Surabaya and Madura. This is expected to raise awareness and remind people about the importance of e-toll cards. Suramadu toll road managers also prioritize information disclosure, especially the checking of e-toll card balance to reduce suspicion of e-toll card users.

ACKNOWLEDGMENT

This work was supported by the Grant of international publication on DIPA 2018 - University of Trunojoyo Madura. (SP DIPA-042.01.2.401029/2018).

REFERENCES

- [1] Gravelle, Kelly, and Frances E. Lindsay Jr. "Method of enrolling in an electronic toll or payment collection system." U.S. Patent No. 7,347,368. 25 Mar. 2008.
- [2] Wibowo, A., & Kochendörfer, B. "Financial risk analysis of project finance in Indonesian toll roads". *Journal of Construction Engineering and Management*, 131(9), 2005, pp. 963-972.
- [3] Miliyani, L., Purwanegara, M. S., & Indriani, M. T. D. "Adoption Behavior of E-Money Usage". *Information Management and Business Review*, 5(7), 2013. Pp. 369.
- [4] Venkatesh, V. "Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model". *Information systems research*, 11(4), 2000, pp. 342-365.
- [5] Montano, D. E., & Kasprzyk, D. "Theory of reasoned action, theory of planned behavior, and the integrated behavioral model". *Health behavior: Theory, research and practice*, 2015, pp. 95-124.
- [6] Urquhart, C., Light, A., Thomas, R., Barker, A., Yeoman, A., Cooper, J., & Spink, S. "Critical incident technique and explicitation interviewing in studies of information behavior". *Library & Information Science Research*, 25(1), 2003, pp. 63-88.
- [7] Malhotra, N. K., Agarwal, J., & Peterson, M.. "Methodological issues in cross-cultural marketing research: A state-of-the-art review". *International marketing review*, 13(5), 1996, pp. 7-43.
- [8] Sedgwick, S. *Hegel's Critique of Kant*. Oxford University Press on Demand, 2012.
- [9] Matzler, K., Bailom, F., Hinterhuber, H. H., Renzl, B., & Pichler, J. "The asymmetric relationship between attribute-level performance and overall customer satisfaction: a reconsideration of the importance-performance analysis". *Industrial marketing management*, 33(4), 2004, pp. 271-277.
- [10] Behrend, T. S., Sharek, D. J., Meade, A. W., & Wiebe, E. N. "The viability of crowdsourcing for survey research. *Behavior research methods*", 43(3), 2011, pp. 800.
- [11] Wibowo, A., Permana, A., Kochendörfer, B., Kiong, R. T. L., Jacob, D., & Neunzehn, D. "Modeling contingent liabilities arising from government guarantees in Indonesian BOT/PPP toll roads". *Journal of construction engineering and management*, 138(12), 2012, pp. 1403-1410.
- [12] Miliyani, L., Purwanegara, M. S., & Indriani, M. T. D. "Adoption Behavior of E-Money Usage. *Information Management and Business Review*, 5(7), 2013, pp. 369.
- [13] Khatimah, H., & Halim, F. "Consumers' intention to use e-money in Indonesia based on Unified Theory of Acceptance and Use of Technology (UTAUT)". *American-Eurasian Journal of Sustainable Agriculture*, 8(12), 2014, pp. 34-40.
- [14] Nasution, S. M., Husni, E. M., & Wuryandari, A. I. "Prototype of train ticketing application using Near Field Communication (NFC) technology on Android device. In *System Engineering and Technology (ICSET)*", 2012 International Conference on (pp. 1-6). IEEE.