

# The effectiveness of SMS as verification of flood early warning messages from users' perception

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**Abstract**—the aim of this paper is to research the effectiveness of SMS verification by understanding the correlation between notification and verification of flood early warning messages. This study contributes to the design of the dissemination techniques for SMS as an early warning messages. The metrics used in this study are using user perceptions of tasks, which include the ease of use (EOU) perception for using SMS and confidence with SMS skills perception, as well as, the users' positive perceptions, which include users' perception of usefulness and satisfaction perception towards using SMS as an early warning messages for floods. Experiments and surveys were conducted in flood-prone areas in Semarang, Indonesia. The results showed that the correlation is in users' perceptions of tasks for the confidence with skill.

**Keywords**—notification, verification, early warning messages, users' perception, short messaging services (SMS), flood.

## I. INTRODUCTION

Short messaging services(SMS) as notification early warning messages have been commonly used in many countries such as Australia, Bangladesh, Malaysia and Indonesia[1-4].

Prior studies have investigated the effectiveness SMS as a notification in terms of early warning messages because SMS can use local language to disseminate the warning information[5]. Other research suggested SMS is effective as early warning messages due to SMS being accessible from all types of mobile phone[6]. As for the cost, SMS as early warning messages is effective because SMS is not expensive [7]. With the spread of Internet infrastructure, some people think that social media and messenger apps such as Twitter or Facebook can be used for early warning messages, but Twitter is used as a source to support information from the authorities which is different from early warning messages[8]. Furthermore, our first study in the flood disaster prone area in Semarang, shows that 72.6% of respondents own and use a basic mobile phone and only 27.4% own a smartphone[9]. Hence this study selected SMS to be used as early warning messages.

Nevertheless, the dissemination techniques of SMS for early warning messages has never been explored. The problem that arises from using SMS notification as early warning messages, from the user's perspective, is the information in

notifications becomes ambiguous information. The ambiguous information is caused by a multiplication of information from family, friends or neighbors[10]. Moreover, there are hoax messages from irresponsible people who spread the hoax information with the aim to panic people[11]. To address the problem it is suggested for the authorities to provide verification messages with a pull messaging services method[12].

Prior research in the study of SMS notification and verification messaging for m-banking services in Bangladesh shows that by providing both of those services is satisfying to the user [13]. Other research on notification and verification messaging in m-learning for high school students in Australia shows that the notification messaging services are more important than the verification messaging services. Notification messaging services have the function to help students as a reminder to lecture and tutorial schedules and it helps the staff to handle students' questions about the lecture and tutorial schedules [14].

This paper's aim is to evaluate the effectiveness of SMS as verification early warning messages from the users' perception. The definition of the effectiveness of SMS as verification in early warning messages is that users are able or willing to use the system.

The method used was the examination of the correlation between notification and verification messages in SMS as early warning messages. The findings in this paper provide recommendations for authorities and information system designers for the design of the dissemination method for early warning messages.

This study used push messaging services for notification messages and pull messaging services as verification messages. A prototype for flood warning messages using SMS was developed using SMS gateway to give participants experience of notifications and verification messages.

## II. UNDERSTANDING THE INFORMATION SYSTEM DESIGN FROM THE USER PERSPECTIVE

### A. User performance as measurement

The performance measurements are based on the user's physical activity that can be observed directly such as measuring a user's time for completing the task in the system or counting a number of user errors for completing the task using the system. [15, 16]. Prior research suggests using five to eight participants for measuring the users' performance[17].

For conducting a user performance as measurement, it is suggested in the data collection to use video recording to observe the user performance. So, the use of laboratory is effective to measure the users performance because there was no interruptions [18].However, it becomes disadvantageous to use a laboratory setting for this study because the user can not feel the daily environment particularly in emergency conditions.

### B. User's perception as measurement

The user's perception is about the personal measurements and the result is in form of a user's opinion and judgments on technology [19]. It is important to assess technology using the user's perception because it can affect the information system behavior [20, 21]. Furthermore, by using user's perceptions it is beneficial to investigate the effectiveness of technology[22, 23].Using the user's perception as measurement, is essential to conduct the test in the field because the situations and conditions can influence the user's perception of the system [24].

The use of the users' perceptions as metric to evaluate SMS as early warning messages was used in our first study in profiling the users of SMS in emergency conditions and investigating the correlation between ease of use (EOU) and confidence with skill[9, 25].

## III. ELEMENTS FOR EVALUATION

To conduct an evaluation, it is essential to define metrics and analyze the impact of design solutions[26]. Users' perceptions on the technology usage in normal conditions and emergency situations are different [27].

As stated in section I, the definition of effectiveness for this research is the users' ability to use and their willingness to use the SMS verification system. Therefore, this study employed users' task perceptions and users' positive perceptions. The users' task perceptions present the effectiveness of the users' abilities to use the SMS verification. The users' positive perception shows the effectiveness of the users' willingness to use the SMS verification.

### A. Users' task perceptions

Users' task perceptions consist of the users' perceptions on EOU and confidence with skill for using SMS. Fig. 1 shows the variables for the users' task perceptions that were used to investigate the correlation between notification and verification messages using SMS as early warning messages.

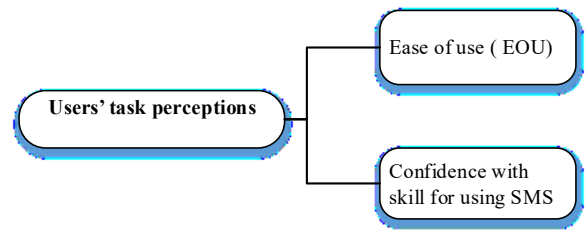


Fig. 1. Users' task perceptions for investigating the correlation between notification and verification messages

TABLE I. EOU FOR NOTIFICATION AND VERIFICATION MESSAGES.

It is easy to use and read in emergency situation
It needs a few steps to use it
I can receive messages successfully
I can identify the sender of messages

TABLE II. EOU FOR VERIFICATION MESSAGES

I can send the request for the verification messages successfully
I can receive verification messages successfully

TABLE III. CONFIDENCE WITH SKILL TO USE SMS AS EARLY WARNING MESSAGES

I easily to remember how to use SMS
I consider myself skillful at using sending and receiving SMS
I learned to use SMS quickly
I can identify an official or unofficial disaster early warning messages using SMS

The system should be easy to learn and the user should complete the task on the system [28, 29]. The survey question for this study on EOU was adapted from [30, 31].TABLE I and II show the questions for EOU.

For the verification messages via SMS, we added two questions to identify the EOU of SMS verification. See TABLE II.

Having confidence with skill is important for the users to think clearly about how to access information in an emergency condition [27]. The question for the confidence with skill was adapted from [31, 32] and used in our prior study [24,25] is shown in TABLE III.

### B. Users' positive perceptions

Fig. 2 shows the elements to assess the users' positive perceptions. The users' positive perceptions consist of usefulness and satisfaction.

The users' positive perceptions consist of usefulness and satisfaction.

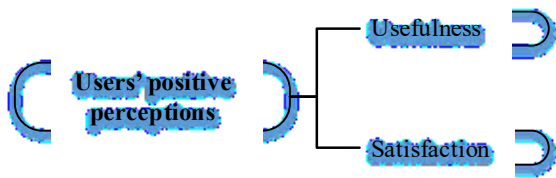


Fig. 2 Users positive perceptions to investigate the correlation between notification and verification messages

TABLE IV. USEFULNESS SMS NOTIFICATION AS DISASTER EARLY WARNING MESSAGES

SMS is useful to notify me about the disaster situations
SMS notification is usefulness to quick access information about the disaster situations
SMS notification is my preference to receive early warning messages.
SMS notification is usefulness to receive current disaster situations
SMS useful to receive about disaster situations compare to other application (Twitter or Facebook)

TABLE III. USEFULNESS OF SMS VERIFICATION AS DISASTER EARLY WARNING MESSAGES

It is usefulness to use SMS verification to confirm the information in SMS notification
The verification messages is useful to access current disaster situations
The verification messages is usefulness to confirm information compare to other application (Twitter or Facebook)

TABLE IVI. SATISFACTION SMS AS DISASTER EARLY WARNING MESSAGES

I am satisfied with SMS as early warning messages
I would recommend to use it to a friend
I prefer to use SMS as early warning messages compared to other application

Users' perceptions of usefulness is defined as the user's feeling of the benefit derived after using the system and the user's feeling that they must use the system to achieve their objective [28, 31]. When the users become the center for designing the system, it is essential to evaluate the system's usefulness[33, 34]. The questions for usefulness is adapted from [30, 31] and are shown in TABLE and TABLE III.

Users' perceptions of satisfaction can be assessed after the user has used the system. Satisfaction is defined as the user's positive attitude concerning the use of a system [35]. Moreover, satisfaction is attained when the users enjoy interacting with the system [31]. The question is adapted from [31] and used in our prior study [24,25] and is shown in TABLE IVI.

### C. A Likert scale

For scoring the users' perceptions, this study used a Likert scale with six options. The options are "Strongly agree", "Agree", "Somewhat Agree", "Somewhat Disagree", "Disagree" and "Strongly Disagree".

The Likert scale method is commonly used as a standard psychometric scale to measure responses from users [36]. This study used "Somewhat Agree" and "Somewhat Disagree" to avoid the participants selecting a "Neutral" option because this

study needs to have a clear understanding of the user's perception preference.

## IV. RESEARCH METHODOLOGY

Ethical approval for this survey was granted by the Flinders University Social and Behavioral Research Ethics Committee (Project No. 6817). Experiment and survey were conducted from November 2015 to February 2016.

### A. Participants

For this research, there were 100 participants who were willing to do the experiment and answer the survey. The participants were selected based on participants who owned mobile phones, could use SMS, lived in urban kampung flood prone areas and were aged over 19 years.

The area of urban kampung in Indonesia has a negative image such as having high density settlements, lacking basic infrastructure and being predominately populated by urban poor[37]. This type of area is commonly prone to flood disasters in the coastal city [38]. Using the actual users who will use the system is crucial to understand the effectiveness of the system [39].

### B. Hazard selection

It can be assumed that an early warning message is to inform the community about the current state of the disaster. The type of disaster that can use an early warning message is a monitorable disaster, before the real disaster strikes people living in disaster prone areas. Information in an early warning message of disaster comes from a monitoring tool that can detect future disasters [40, 41].

This study selected flood hazard because flood disaster is a common disaster that occurs in coastal cities in Indonesia (Jakarta and Semarang) [42, 43]. Moreover, early warning messages are commonly used to notify people who live in the flood-prone areas [44, 45]. A different condition will give a dissimilar result when assessing a technology from the users' perspective [46].

### C. SMS as early warning messages

The usage of SMS as a tool to disseminate early warning messages is due to the lack of Internet infrastructure in Indonesia for certain areas[47]. In addition, it should be noted that people who live in disaster prone areas usually live in poverty [48].

The study of profiles of SMS users in Bandar Harjo, Semarang shows the most of the participants in urban kampung Bandar Harjo, Semarang used and owned non-smartphones [9]. The Indonesian national data show that the numbers of people owning non-smartphones are greater than those owning a smartphone [49].

### D. Paper-based survey

To collect information about the users' perceptions, this study used a paper-based questionnaire for data collection. A questionnaire is a technique that has advantages, such as it is easy to receive many responses from wider range of participants, not time consuming and easy to scale the score [50, 51]. In terms of e-government services, using questionnaires to

collect information from users is an effective method [52]. The rationale for this study to choose SMS as the dissemination method is that the Internet is expensive for the target group and that more people owned and used non-smartphone devices.

#### E. Experiment

In order for participants to have perceptions about notification and verification messages, this study used SMS gateway to conduct the experiment. The benefit of using SMS gateways are they are fast and reliable for delivering bulk SMS messages and allow service providers to connect their computers with their clients' phones via SMS [53].

For receiving the notification messages and verification messages, the respondents used their own mobile phone. Respondents did not access the SMS gateway system. The respondents only experienced the process of the dissemination of SMS for notification and verification as early warning messages from their own mobile phone.

The experiment consisted of three sessions. The first session was notification messages session. Participants just received the messages. Participants did not need to reply to messages. The content of the notification message was that the height of the flood was already on the alert level in Bahasa Indonesia.

In the second session (verification messages session), participants were required to send short messages "info" using SMS to mobile number 628122xxxxx. The participant received information that was similar to the notification message. In the last session, the participants were answering the paper based survey.

#### F. Correlation analysis

To understand the effectiveness of SMS as verification messages in terms of early warning messages, this study used a correlation analysis. The correlation analysis shows the correlation between notification and verification messages using users' perceptions of task and positive perception research findings

### V. RESULTS

#### A. Prior statistical analysis result

Cronbach's Alpha ( $\alpha$ ) is a coefficient consistency (or reliability) instrument to measure internal responses in a survey or questionnaire[54]. This study uses Cronbach's Alpha ( $\alpha$ ) to show an internal consistency (reliability) for the question groups for EOU, confidence with skill, usefulness and satisfaction. The data can be used when a Cronbach's Alpha value is greater than 0.7[55]. Moreover, the Cronbach's Alpha is a valuable tool to investigate the internal consistency in Likert scale measurement [53].

The internal consistency, as shown in TABLE VI, for all responses for notification messaging services are excellent, and for verification messaging services all are excellent except EOU which is good. Based on these findings, we can use the data and continue with further data analysis.

TABLE VI. TABLE VALUES CRONBACH'S ALPHA

Users' perceptions	Notification messaging services			Verification messaging services		
	n	$\alpha$	consistency	n	$\alpha$	consistency
EOU	4	0.938	excellent	6	0.896	good
Confidence with skill	4	0.957	excellent	4	0.916	excellent
Usefulness	5	0.906	excellent	3	0.929	excellent
Satisfaction	3	0.948	excellent	3	0.938	excellent

Note:  $\alpha \geq 0.7$  is acceptable

TABLE VII. TEST OF NORMALITY

Users' perception	Notification			Verification		
	Kolmogorov-Smirnov <sup>a</sup>			Kolmogorov-Smirnov <sup>a</sup>		
	Statistic	df	Sig.	Statistic	df	Sig.
Ease of use (EOU)	0.153	100	0	0.210	100	0
Confidence with skill	0.137	100	0	0.195	100	0
Usefulness	0.163	100	0	0.156	100	0
Satisfaction	0.151	100	0	0.157	100	0

Note : sig < 0.01 not normally distributed

TABLE IX. CORRELATION BETWEEN USERS' PERCEPTIONS ON NOTIFICATION MESSAGES AND VERIFICATION MESSAGES

Notification \ Verification	EOU	Confidence with skill	Usefulness	Satisfaction
EOU	0.016	0.195	- 0.062	- 0.116
Confidence with skill	0.193	<b>0.326**</b>	0.037	- 0.028
Usefulness	- 0.024	0.101	0.009	- 0.138
Satisfaction	- 0.046	0.078	- 0.147	- 0.173

Note: \*\*. Correlation is significant at the 0.01 level (2-tailed).

For another preliminary analysis, this study tested normality. The Kolmogorov-Smirnov test is used for analysing the data normality distribution. TABLE VI shows the result of the data variables are not normally distributed ( $p < .01$ ) both for the notification messages and verification messages.

Therefore, nonparametric correlation (Spearman Rho) was used in the correlation analysis.

#### B. Result of Correlation between notification messages and verification messages for SMS as early warning messages

The null hypothesis for correlation between notification messages and verification was ( $H_0$ ) there will be no correlation between notification messages and verification messages.

TABLE shows the users' confidence with the skill for using SMS between the notification messaging services and the verification messaging services correlated with value 0.326. The strength of the correlation is medium and in the positive direction.

We reject the null hypothesis because there was a significant correlation in users' perceptions for the task in confidence with the skill for using SMS in notification and verification as early warning messages.

## VI. DISCUSSION

By using SMS as notification messages, it supports the users' confidence skill for using SMS verification. The data show that users who are confident in their ability to use SMS notification will feel confident too, in using SMS verification for early warning messages. The users' perceptions on confidence for using system is essential because it influences the success of the system [31]. Moreover, the user's confidence affects the user's intention to use the information technology system [32].

## VII. CONCLUSION

This study investigates the effectiveness of SMS as verification in early warning messages using users' perceptions.

The data analysis findings show that the users' perceptions on confidence with skill between SMS notification and SMS verification is correlated and in the positive direction. Factors that influence the use of SMS for verification and notification in early warning messages are the user's confidence with skill on tasks for using SMS, but did not affect the users' positive perceptions that represent the user's willingness to use SMS.

The practical contribution suggests the addition of SMS verification to the SMS notification service of early warning service messages is effective, based on the users' task perceptions. Furthermore, the finding of this study suggests that the authorities and information system designers for early warning messages should provide SMS verification services. The SMS verification messages would help the message receivers clarify the information in SMS notification as early warning messages.

The theoretical contribution of this paper is the user-centered method of evaluation for factors that influence effectiveness of communications systems in emergency situations. In such situations, received information must be acquired and analyzed quickly. Thus, assessing effectiveness from the user's perspective is essential for electronic public services.

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## REFERENCES

- [1.] Aloudat, A., and Michael, K. 'The application of location based services in national emergency warning systems: SMS, cell broadcast services and beyond', Proc. the 2010 National Security Science and Innovation Conference, Canberra : Australian Security Research Centre, pp 21-49, 2011
- [2.] Kushchu, I. 'Prospects of Using m-Technologies for Disaster Information Management in Bangladesh and other LDCs', 2005
- [3.] Ayobami, Akanmu Semiu and Rabi'u, Shamsudeen, *SMS as a Rural Disaster Notification System in Malaysia: A Feasibility Study*. Proceedings of 3rd International Conference on Communication and Media (i-COME), Penang, Malaysia, 2012. Available at: <https://ssrn.com/abstract=2167782>
- [4.] Anggunia, S. D., & Kumaralalita, L, *How Indonesians Use ICT and Social Media for Disaster Management*, 2016. Available at: <http://discover.isif.asia/2014/03/how-indonesians-use-ict-and-social-media-for-disaster-management/>.
- [5.] Jerry Velasquez, D., Cumiskey, L., Werner, M., Meijer, K., Fakhruddin, S., and Hassan, A., 'Improving the social performance of flash flood early warnings using mobile services', *International Journal of Disaster Resilience in the Built Environment*, 2015, Vol. 6, No 1, pp. 57-72. doi:[<http://dx.doi.org/10.1108/IJDRBE-08-2014-0062>]
- [6.] Aloudat, A., 'Location-based mobile phone service utilisation for emergency management in Australia', Ph.D. Dissertation, School of Information Systems and Technology, University of Wollongong, 2010
- [7.] Kesper, A., 'Warning Dissemination Technologies for Tsunami Early Warning in Local Communities', *German-Indonesian Cooperation for Tsunami Early Warning System*, 2007.
- [8.] Carley, K.M., Malik, M., Landwehr, P.M., Pfeffer, J., and Kowalchuck, M.: 'Crowd sourcing disaster management: The complex nature of Twitter usage in Padang Indonesia', *Safety science*, 2016, 90, pp. 48-61
- [9.] Nugraheni, D.M.K., and deVries, D., 'Users' perception of ease of use (EOU) and confidence with skill using SMS in emergency conditions'. Proc. 3<sup>rd</sup> International Conference on Human-Computer Interaction and User Experience in Indonesia, Jakarta, Indonesia, 2017. © ACM doi:[[10.1145/3077343.3077350](https://doi.org/10.1145/3077343.3077350)]
- [10.] Hellriegel, J., and Klaffit, M.: 'A Tool for the Simulation of Alert Message Propagation in the General Population', 2014
- [11.] Badan Nasional Penanggulangan Bencana (BNPB), *Jangan Sebar Info Bencana Hoax*, Available at: <http://www.solopos.com/2012/04/28/bnpb-jangan-sebar-info-bencana-hoax-181794>, 2015.
- [12.] Nugraheni, D.M.K., and deVries, D., 'Improving the Effectiveness of the Dissemination Method in Disaster Early Warning Message', Proc. International Conference on Information Technology & Society, Kuala Lumpur, Malaysia, 2015. Available at: <http://fstm.kuis.edu.my/icits/proceeding/fullpapers/IC-ITS%202015%20-%20IT%20028.pdf>
- [13.] Mousumi, F., and Jamil, S., 'Push Pull Services Offering SMS Based m-Banking System in Context of Bangladesh', *International Arab Journal of e-Technology*, Vol. 1, No. 3, pp. 79-88, 2010
- [14.] Richardson, J., and Lenarcic, J., 'SMS-push first and then students will pull administrative information in higher education?', 19th Australasian Conference on Information Systems, Melbourne, 2009, pp. 571-581
- [15.] Jokela, T., Koivumaa, J., Pirkola, J., Salminen, P., and Kantola, N., 'Methods for quantitative usability requirements: a case study on the development of the user interface of a mobile phone', *ACM Journal Personal and Ubiquitous Computing* archive, Vol. 10, No: 6, pp. 345-355. doi: [10.1007/s00779-005-0050-7]
- [16.] Peevers, G., Douglas, G., and Jack, M.A., 'A usability comparison of three alternative message formats for an SMS banking service', *ELSEVIER International Journal of Human-Computer Studies*, 2008, Vol. 66, no. 2, pp. 113-123, doi:[<https://doi.org/10.1016/j.ijhcs.2007.09.005>]
- [17.] Bevan, N., Barnum, C., Cockton, G., Nielsen, J., Spool, J., and Wixon, D., 'The magic number 5: is it enough for web testing?', *ACM CHI 2003*, Ft. Lauderdale, Florida, USA., 2003, pp. 698-699
- [18.] Kaikkonen, A., Kekäläinen, A., Cankar, M., Kallio, T., and Kankainen, A., Usability testing of mobile applications: A comparison between laboratory and field testing, *Journal of Usability studies*, 2005, Vol. 1, No : 1, pp. 4-16
- [19.] Nielsen, J., and Levy, J., 'Measuring usability: preference vs. performance', *ACM Communication*, 1994, Vol. 37, No. 4, pp. 66-75 doi:[[10.1145/175276.175282](https://doi.org/10.1145/175276.175282)]
- [20.] Chowdhury, G.G., and Chowdhury, S., 'Information users and usability in the digital age' (Facet Publishing, 2011)
- [21.] Wilson, T.D., 'Human information behavior', *Informing science*, 2000, Vol. 3, No. 2, pp. 49-56
- [22.] de Róiste, M., 'Bringing in the users: The role for usability evaluation in eGovernment', *ELSEVIER Government Information Quarterly*, 2013, Vol. 30, No.4, pp. 441-449, doi:[<http://dx.doi.org/10.1016/j.giq.2013.05.007>]

- [23.] Jadhav, D., Bhutkar, G., and Mehta, V., 'Usability evaluation of messenger applications for Android phones using cognitive walkthrough'. Proceedings of the 11<sup>th</sup> Asia Pacific Conference on Computer Human Interaction, Bangalore, India, 2013,doi:[ 10.1145/2525194.2525202]
- [24.] Roto, V., Oulasvirta, A., Haikarainen, T., Kuorelahti, J., Lehmuskallio, H., and Nyyssonen, T., 'Examining mobile phone use in the wild with quasi-experimentation', Helsinki Institute for Information Technology (HIIT), Technical Report, 2004, Vol. 1, pp. 2004
- [25.] Nugraheni, D.M.K., and deVries, D., 'Profile of a typical mobile SMS user in emergency situations (empirical study in an urban flood prone area)', Proc. 2<sup>nd</sup> International Conference on Science in Information Technology (ICISITech), Balikpapan, Indonesia, 2016, pp. 97-102. © IEEE. doi: [10.1109/ICISITech.2016.7852615]
- [26.] Good, M., Spine, T.M., Whiteside, J., and George, P., 'User-derived impact analysis as a tool for usability engineering', SIGCHI Bull., 1986, Vol. 17, No.4, pp. 241-246,doi:[ 10.1145/22339.22378]
- [27.] Parker, D.J., Priest, S.J., and Tapsell, S.M., 'Understanding and enhancing the public's behavioural response to flood warning information', Meteorological Applications, 2009, Vol.16, No. 1, pp. 103-114, © Wiley InterScience,doi:[ 10.1002/met.119]
- [28.] Nielsen, J., 'The usability engineering life cycle', Computer, 1992, Vol.25, No.3, pp. 12-22, doi:[ 10.1109/2.121503]
- [29.] Shackel, B., 'Usability – Context, framework, definition, design and evaluation', Interacting with Computers, 2009, 21, (5–6), pp. 339-346
- [30.] Legris, P., Ingham, J., and Colletette, P., 'Why do people use information technology? A critical review of the technology acceptance model', ELSEVIER Information & Management, 2003, Vol. 40, No. 3, pp. 191-204, doi: [http://dx.doi.org/10.1016/S0378-7206(01)00143-4]
- [31.] Lund, A.M., 'Measuring Usability with the USE Questionnaire', 2001
- [32.] Parasuraman, A., 'Technology Readiness Index (TRI) a multiple-item scale to measure readiness to embrace new technologies', Journal of service research, 2000, Vol. 2, No.4, pp. 307-320
- [33.] Mao, J.-Y., Vredenburg, K., Smith, P.W., and Carey, T., 'The state of user-centered design practice', Communications ACM, 2005, Vol.48, No. 3, pp. 105-109,doi:[ 10.1145/1047671.1047677]
- [34.] Adams, D.A., Nelson, R.R., and Todd, P.A., 'Perceived usefulness, ease of use, and usage of information technology: a replication', MIS quarterly, 1992, pp. 227-247
- [35.] Bevan, N., 'Quality in use: Meeting user needs for quality', Journal of Systems and Software, 1999, Vol.49, No.1, pp. 89-96,doi:[ http://dx.doi.org/10.1016/S0164-1212(99)00070-9]
- [36.] Li, Q., 'A novel Likert scale based on fuzzy sets theory', Expert Systems with Applications, 2013, Vol. 40, No. 5, pp. 1609-1618, doi:[ http://dx.doi.org/10.1016/j.eswa.2012.09.015]
- [37.] Funo, S., Yamamoto, N., and Silas, J., 'Typology of kampung houses and their transformation process', Journal of Asian architecture and building engineering, 2002, Vol. 1, No. 2, pp. 193-200
- [38.] Harwitasari, D., and Van Ast, J., 'Climate change adaptation in practice: people's responses to tidal flooding in Semarang, Indonesia', Journal of flood risk management, 2011, Vol. 4, No.3, pp. 216-233
- [39.] Sohaib, O., and Khan, K., 'Integrating usability engineering and agile software development: A literature review', International Conference On Computer Design And Applications 2010,doi: [10.1109/ICDA.2010.5540916]
- [40.] Australian, 'Australian Emergency Manual Series Manual Flood Warning', Attorney-General's Department,Australia, 2009
- [41.] Meissen, U., and Voisard, A., 'Increasing the effectiveness of early warning via context-aware alerting', Proc.5<sup>th</sup> International ISCRAM Conference – Washington, DC, USA, 2008, pp. 431-440
- [42.] Rukmana, Deden, Flood Governance in Jakarta, The Role of CBOs in mitigating Annual Floods, 2016, Available at : <http://indonesiurbanstudies.blogspot.com.au/2016/01/flood-governance-in-jakarta-role-of.html>
- [43.] Marfai, M.A., King, L., Sartohadi, J., Sudrajat, S., Budiani, S.R., and Yulianto, F., 'The impact of tidal flooding on a coastal community in Semarang, Indonesia', The Environmentalist, 2008, Vol. 28, No. 3, pp. 237-248
- [44.] Windarto, J., 'Flood Early Warning System Develop at Garang River Semarang using Information Technology base on SMS and Web', International Journal of Geomatics And Geosciences, 2010, Vol.1, No.1, pp. 14
- [45.] Khalid, M.S.B., and Shafiai, S.B., 'Flood Disaster Management in Malaysia: An Evaluation of the Effectiveness Flood Delivery System', International Journal of Social Science and Humanity, 2015, Vol.5, No.4, pp. 399-402
- [46.] Maguire, M., 'Context of use within usability activities', International Journal of Human-Computer Studies, 2001, Vol.55, No.4, pp. 453-483, doi: [10.1006/ijhc.2001.0486]
- [47.] Purbo, O.W., 'Struggle in Narrowing the Indonesian Digital Divide', Divide', STKIP Surya, Indonesia, 2016, Available: <http://onnocenter.or.id/pustaka/docs/ANU-conference-paper/OWP-20160606-struggle-in-narrowing-indonesian-digital-divide.pdf>
- [48.] Velasquez . J. D., Cumiskey, L., Werner, M., Meijer, K., Fakhruddin, S., and Hassan, A., 'Improving the social performance of flash flood early warnings using mobile services', International Journal of Disaster Resilience in the Built Environment, 2015, Vol.6, No.1, pp. 57-72
- [49.] Poushter, J, *Smartphone Ownership and Internet Usage Continues to Climb in Emerging Economies But advanced economies still have higher rates of technology use*, 2016., Available at : <http://www.pewglobal.org/2016/02/22/smartphone-ownership-and-internet-usage-continues-to-climb-in-emerging-economies/>
- [50.] Humayoun, S.R., 'Incorporating usability evaluation in software development environments', Ph.D. dissertation KI-Künstliche Intelligenz, Dipartimento di Informatica e Sistemistica "Antonio Ruberti", Roma University 2012,
- [51.] Zaharias, P., and Poylymenakou, A., 'Developing a usability evaluation method for e-learning applications: Beyond functional usability', Taylor & Francis Intl. Journal of Human-Computer Interaction, 2009, Vol. 25, No. 1, pp. 75-98, doi: [10.1080/10447310802546716]
- [52.] Hamborg, K.-C., Vehse, B., and Bludau, H.-B., 'Questionnaire based usability evaluation of hospital information systems', Electronic journal of information systems evaluation, 2004, Vol. 7, No. 1, pp. 21-30
- [53.] Katankar, V.K., and Thakare, V., 'Short message service using SMS gateway', International Journal on Computer Science and Engineering, 2010, Vol. 2, No.04, pp. 1487-1491
- [54.] Gliem, R.R., and Gliem, J.A., 'Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales', Midwest Research-to-Practice Conference in Adult, Continuing, and Community Education, 2003.
- [55.] Tavakol, M., and Dennick, R., 'Making sense of Cronbach's alpha', International Journal of Medical Education, 2011, pp. 53-55, doi:[10.5116/ijme.4dfb.8dfd]