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E-aedes framework based on Geographical Information System: Stakeholder Perceptions

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Effective and efficient information management can be achieved through the use of information technology. The emergence of the dengue virus is related to the uncontrolled breeding of the Aedes mosquito, also related to low levels of environmental hygiene. Control and prevention of the breeding of Aedes mosquitoes have been carried out in recent years, and still focused on eradication of the cases of Dengue Hemorrhagic Fever and Dengue Hemorrhagic Fever (DD & DDB). To prevent DD & DDB cases, the prevention action in decreasing number of DD & DDB is a major factor in controlling the spread of the disease and the breeding of Aedes mosquitoes. Accurate information is needed to provide a fast and accurate location notification of potential breeding areas for Aedes mosquitoes. This study aims to develop a framework for developing the Aedes (e-Aedes) mosquito warning system based on GIS (Geographic Information System), to identify a high-risk area for the Aedes mosquito breeding in residential area of Malaysia. Here, the expert interviews were conducted to confirm the initial framework of the study. This study chose qualitative and quantitative models as the research methodology. Thus, this study aimed to identify the awareness of community on DD &DDB issue. In order to achieve this study; we chose qualitative and quantitative models as the research methodology. This framework is verified through readiness, effectiveness and efficiency. The research results show a positive result, especially for effectiveness and efficiency which is can provide high reliability. This is shown from positive acceptance of respondents (the community) towards the framework of developing a GIS-based Aedes mosquito warning system (e-Aedes).

Keywords: Aedes mosquitoes, Geographic Information System, Mapping, Information Technology

1. INTRODUCTION

The current trend of increasing urbanization is one of the factors for environmental disruption and global disease burden experienced by developing countries, especially those living in urban areas in tropical and sub-tropical countries which generally lack resources and infrastructure [1]. The Aedes mosquito tends to dominate in densely populated urban areas and is usually found breeding in water reservoirs and all kinds of abandoned containers or jars filled with fresh water, rock pools and organic matter that can hold water [2]. Control and prevention that has been done to the community is by spraying and cleaning the places that are vectors of Aedes mosquito breeding [3]. Geographic Information System (GIS) is a useful technology for controlling and monitoring the breeding of Aedes mosquitoes. The - system has the ability to retrieve manage, display and analyze data in a geographical context [4]. Geographic Information System (GIS) is a technology in mapping to support dengue fever transmission and Aedes mosquito breeding [5]. GIS is used for monitoring, monitoring, mapping and identifying areas where dengue outbreaks are most likely to occur. Various studies have been conducted on the knowledge, attitudes and practices of dengue infection. A good dengue fever prevention program demands full involvement from the community [6, 7, 8]. Based on its various functions and benefits, GIS is one of the warning systems for use in the field of health, especially in the process of prevention and control of dengue fever diseases. GIS is used to analyze and integrate various types of data such as demographics, topography, and weather and so on. Space is an important element in providing distribution for dengue fever disease

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prevention and control activities [9]. The spread of dengue fever diseases is related to the elements of space and time such as environment, land use change, distribution and movement of population, social, economic and political. In this study, the control and prevention measures of dengue fever outbreaks are carried out when a case occurs, the information space regarding the transmission of disease and breeding of Aedes mosquitoes is important to be taken into account in carrying out preventive activities [10]. The information obtained is analyzed to increase the success of dengue fever disease prevention activities before a case occurs worse. The study emphasizes the importance of the local community taking steps to prevent the cause of dengue fever disease from increasing case [11, 12, 13].

Thus, a Study on the Evaluation of Space Risk Factors for the Occurrence of dengue fever Diseases using Geographic Information System (GIS) Applications [14]. Worked to develop a space model that can predict the risk of Dengue Fever and Dengue Fever based on physical environmental factors, land use, rainfall, temperature and Geographic Information System (GIS) applications using logistical regression methods. The results of this study are a risk map of dengue fever incidents in the incident area. This study also focuses on the use of spatial analysis in the process of planning and implementation of activities to prevent and control dengue fever. The GIS method in general plays a role in collecting, storing, analyzing and displaying information according to the purpose and objectives of the data in order to deliver early warnings. A previous study has used GIS using Aedes albopictus mosquito distribution analysis in northern Japan [15, 16]. GIS is used to analyze weather data and temperature distribution mapping in the study area. The results of this study found that areas that have the potential to spread mosquitoes and their breeding will be identified by the mapping done.

The emergence of mosquitoes in floodwaters, especially *Aedes sticticus* and *Aedes vexans mosquitoes*, causes major disruption and reduces the quality of life of the population in an area and can have a negative impact on the socio-economic conditions of the region. Beginning in 1998, studies showed that the distribution of this species spans 11 counties, with the highest abundance in the east-west belt in Central Sweden. It uses climate data from current climate scenarios and predicts, the distribution of *Aedes sticticus* expectations for 2020, 2050, and 2080 can be modeled using Geographic Information Systems (GIS) [16]. The expected modeling model from this study uses climate change scenarios for risk assessment and an easy-to-use early warning system for viewing *Aedes sticticus* vectors. Therefore, this study will discuss the development framework of Aedes mosquito early warning system (e-Aedes) based on mapping to identify areas and determine the level of risk of Aedes mosquito breeding. This framework focuses on early warning information and early signs of reproduction as well as the transmission of Aedes mosquitoes and dengue outbreaks.

2. METHODOLOGY

The conceptual framework of the Aedes mosquito early warning system (e-Aedes) involves three main components consisting of the Aedes mosquito breeding factor component, the early warning system criteria and the GIS criteria. Based on these three components, the effectiveness and efficiency factors become a measure in the development of the research framework. The process of the initial research framework shows the factors that need to be analyzed so that the information provided is accessible and easy to understand.

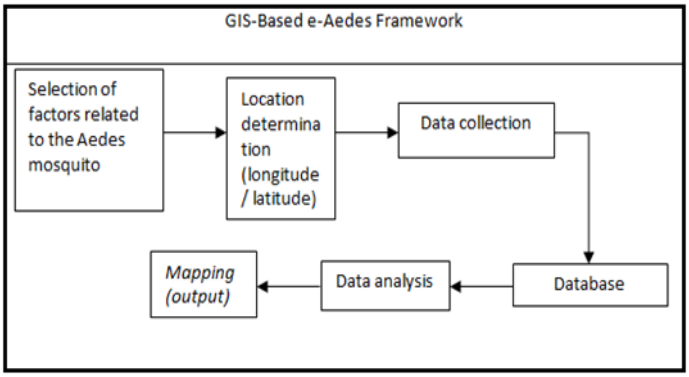

Figure 1. Conceptual framework of study for Aedes mosquito early warning system (e-Aedes).

Empirical study is the phase of data collection in setting the initial instrument of study. This empirical evidence is needed so that actual data can be collected based on the actual situation. This phase consists of the initial instrument model of the e-Aedes study. The initial instrument of the study was used to find out all the information needs about the Aedes mosquito warning system (e-Aedes) and also to assess the level of effectiveness and efficiency as well as the public's knowledge of the Aedes mosquito outbreak. There are two research instruments have been built, the first research instrument is the interview. This first questionnaire was prepared in the study to find out the level of expert knowledge of Aedes early warning system (e-Aedes). At the beginning of the study, several interviews were conducted; interview sessions were conducted with field experts and had information on Aedes mosquito research. Here, the interviews were conducted in two mode such as formally or informally. These interviews are conducted before a more in-depth study is done either until the data is collected. The second questionnaire was conducted on the final study, namely the evaluation of the efficiency and effectiveness of the e-Aedes system model. Questionnaires were distributed to residents in areas that have been determined according to the scope of the study to measure

the level of effectiveness after using the GIS-based Aedes mosquito system (e-Aedes) model.

3. RESULT AND DISCUSSION

In order to achieve the result, we proposed a new causal design. Here, causal design is a research that is useful for analyzing the relationship between one variable and another. Furthermore, this design is using a quantitative approach based on primary data collection from a survey method by distributing questionnaires to 140 respondents. This study we use Structural Equation Modeling (SEM) to determine the relationship and influence between variables. The Structural Equation Modeling (SEM) is an analytical technique that allows testing a series of relationships simultaneously over conceptual framework model (see Figure 1).

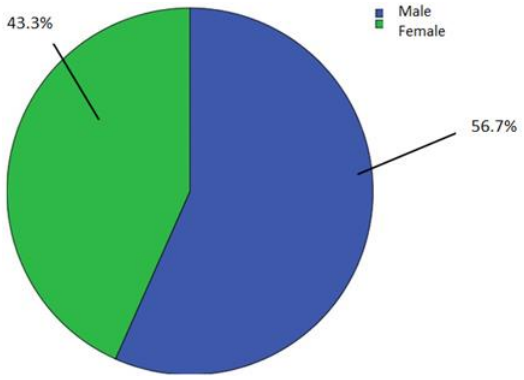

Figure 2. The distribution of the number of respondents by gender

The percentage of respondents following the highest qualification shows that the respondents in the master's degree is 63.3%, followed by bachelor's degree of 23.3% and doctor of philosophy as much as 13.3%. Figure 3 shows the distribution of respondents following the approval level.

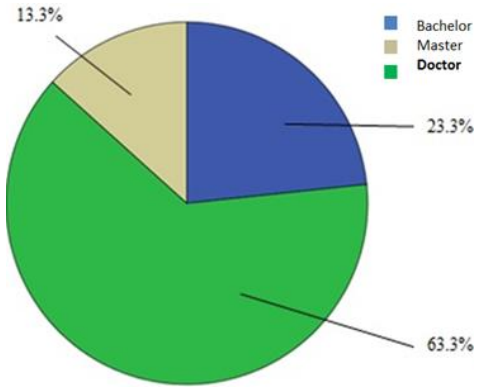

Figure 3. Distribution of number of respondents according to the highest approval

A. Readiness to Use GIS-Based e-Aedes System for Higher Gender and Approval

Table I shows the average respondents based on gender on readiness to use the GIS-based e-Aedes system framework in the study. As many as 77.7% of male respondents have readiness to use this system, as well as female respondents who are ready for the system which is 70.7%. Only 12% were unprepared for the use of GIS-based e-Aedes system in male respondents and 6.1% in female respondents. On average, respondents agree or have the willingness to use a GIS-based e-Aedes system.

Table I. Average analysis of gender respondents on system readiness

Group	Male	Female
Agree	77.5%	70.7%
Not sure	12.8%	23%
Disagree	10.5%	6.1%

Table II related to respondents based on the highest qualifications shows the average of the readiness to use the e-Aedes system framework based on GIS in the study. As many as 39.9% of undergraduate respondents have a willingness to use this system. Undergraduate respondents indicated that they were more prepared for the system at 84.1%, as well as the philosophical respondents showed that 85% were ready for the use of the GIS-based e-Aedes system. On average, undergraduate respondents are still less prepared compared to scholars and philosophers who are more willing (agree) in using the GIS-based e-Aedes system.

Table II. Average analysis of gender respondents on system readiness

Group	Bachelor	Master	Doctor of Philosophy
Agree	39.9%	84.1	85%
Not sure	25.6%	13.6	15%
Disagree	34.2%	2.1	-

Table III shows the median scores for availability from the GIS-based Aedes mosquito early warning system (e-Aedes). Variables A1, A4 and A5 have poor value with undergraduates as well as variables A1 towards women, meaning they are undergraduate respondents and a small proportion of women are still not very ready in the use of GIS-based e-Aedes system compared to other respondents. However, all of the level of availability for the gender factor and the highest approval indicates that the respondents are ready for the GIS-based e-Aedes system as shown in Figure 4.

Table III. Responder's median score on system readiness.

Group	A1	A2	A3	A4	A5
Male	5	6	5	5	5
Female	4	6	5	5	5
Bacehlor	3	6	5	4	4
Master	5	5	6	5	6
Doctor of Philosophy	5	6	5	5	5

Figure 4. shows a positive correlation between the willingness variables, indicating that all of these variables are positively correlated with one another. This correlation shows a logical situation in the real world. For example, the correlation between question A3 and question A5 (easy to mention if cases arise) is 0.827 very positive, indicating that the two questions are closely related.

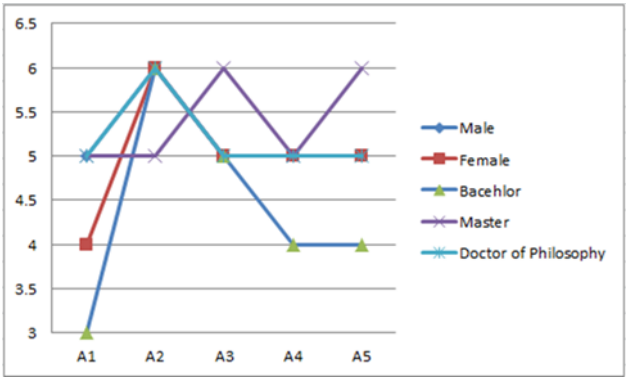

Figure 4. Respondent's median score on system awareness

4. CONCLUSIONS

To assess the readiness, effectiveness and efficiency of the GIS-based e-Aedes system, this research developed a questionnaire framework for the study respondents. The questionnaire was conducted on the final study which is the evaluation of the efficiency and effectiveness of the GIS-based e-Aedes system. Questionnaires were distributed to residents in areas that have been determined according to the scope of the study to measure the level of effectiveness and efficiency after using the prototype framework of the Aedes mosquito system (e-Aedes) based on GIS. The results of the study found that this study showed positive results, especially for effectiveness and efficiency. Scores obtained to assess readiness, effectiveness and good efficiency, and then indicate high reliability. This shows a positive acceptance from respondents (society) to the development framework of Aedes mosquito warning system (e-Aedes) based on geographic information system (GIS).

References

[1] S. J. Aston. **(2017)**. "Pneumonia in the developing world: Characteristic features and approach to management," Respirology, vol. 22, no. 7, pp. 1276–1287, Oct. 2017, doi: 10.1111/resp.13112.

[2] R. Ramasamy, S. N. Surendran, P. J. Jude, S. Dharshini, and M. Vinobaba. **(2011)**. "Larval Development of Aedes aegypti and Aedes albopictus in Peri-Urban Brackish Water and Its Implications for Transmission of Arboviral Diseases," PLoS Negl. Trop. Dis., vol. 5, no. 11, p. e1369, Nov., doi: 10.1371/journal.pntd.0001369.

[3] D. Roiz et al. **(2018)**. "Integrated Aedes management for the control of Aedes-borne diseases," PLoS Negl. Trop. Dis., vol. 12, no. 12, p. e0006845, Dec., doi: 10.1371/journal.pntd.0006845.

[4] J.-P. Gómez-Barrón, M.-Á. Manso-Callejo, R. Alcarria, and T. Iturrioz. **(2016)**. "Volunteered Geographic Information System Design: Project and Participation Guidelines," ISPRS Int. J. Geo-Information, vol. 5, no. 7, p. 108, Jul., doi: 10.3390/ijgi5070108.

[5] L. Lounibos, S. J.-B. invasions, and undefined. **(2018)**. "Where vectors collide: the importance of mechanisms shaping the realized niche for modeling ranges of invasive Aedes mosquitoes," Springer, Accessed: Jan. 01,. [Online]. Available: *https://link.springer.com/article/10.1007/s10530-018-1674-7*.

[6] C. Lorenz, M. Castro, P. Trindade. **(2020)**. M. N.-S. reports, and undefined, "Predicting Aedes aegypti infestation using landscape and thermal features," nature.com, Accessed: Jan. 01, 2021. [Online]. Available: *https://www.nature.com/articles/s41598-020-78755-8*.

[7] M. Ribeiro Heinisch Silva. **(2018)**. "Seasonal and spatial distribution of Aedes aegypti and Aedes albopictus in a municipal urban park in São Paulo, SP, Brazil," Acta Trop., vol. 189, pp. 104–113, 2018, doi: 10.1016/j.actatropica..09.011.

[8] K. Bashar, S. Mahmud, E. Tusty. **(2020)**. A. Z.-P. H. in Practice, and undefined, "Knowledge and beliefs of the city dwellers regarding dengue transmission and their relationship with prevention practices in Dhaka city, Bangladesh," Elsevier, Accessed: Jan. 01, 2021. [Online]. Available: *https://www.sciencedirect.com/science/article/pii/S2666535220300501*.

[9] H. W. Traduzido and C. Moreno. **(2014)**. Mosquitos Geneticamente Modificados: Preocupações Atuais.

[10] V. Corbel. **(2019)**. "Second WIN International Conference on 'integrated approaches and innovative tools for combating insecticide resistance in vectors of arboviruses', October 2018, Singapore," Parasites and Vectors, vol. 12, no. 1, Jul., doi: 10.1186/s13071-019-3591-8.

[11] A. Waldetensai. **(2021)**. "Aedes Mosquitoes distribution and risk of Yellow Fever transmission in Gurage Zone, Southwest Ethiopia." Accessed: Jan. 01, [Online]. Available: *https://ejphn.ephi.gov.et/*.

[12] S. Brugueras, B. Martinez, J. de la P.-E. **(2020)**. "Environmental drivers, climate change and emergent diseases transmitted by mosquitoes and their vectors in southern Europe: A systematic review," Elsevier, Accessed: Jan. 01, 2021. [Online]. Available: *https://www.sciencedirect.com/science/article/pii/S001393512030935X*.

[13] I. Dusfour. **(2019)**. "Management of insecticide resistance in the major Aedes vectors of arboviruses: Advances and challenges," PLoS Neglected Tropical Diseases, vol. 13, no. 10. Public Library of Science, , doi: 10.1371/journal.pntd.0007615.

[14] Y. Kusuma, A. G. **(2020)**. "Dengue awareness, preventive behaviours and Aedes breeding opportunities among slums and slum-like pockets in Delhi, India: a formative assessment," academic.oup.com, Accessed: Jan. 01, 2021. [Online]. Available: *https://academic.oup.com/trstmh/advance-article-abstract/doi/10.1093/trstmh/traa103/5917442*.

[15] K. Hirabayashi, N. Nihei. **(2020)**. "Elevational Distribution of the Asian Tiger Mosquito, Aedes albopictus, in the Inland Mountain Area of Nagano and Yamanashi Prefectures, Japan," meridian.allenpress.com, Accessed: Jan. 01, 2021. [Online]. Available: *https://meridian.allenpress.com/jamca/article/36/1/1/438762*.

[16] I. Dusfour, J. Vontas, J. David, D. W. **(2019)**. tropical diseases, , "Management of insecticide resistance in the major Aedes vectors of arboviruses: Advances and challenges," journals.plos.org, Accessed: Jan. 01, 2021. [Online]. Available: *https://journals.plos.org/plosntds/article?id=10.1371/journal.pntd.0007615*.

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