E-Atlas of Health in Selangor, Malaysia

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Abstract. Electronic atlas (e-atlas) of health is a multimedia website system, containing a compilation of health and disease maps. Selangor is one of the states with a high rate of physical development and having major disease burdens. Empowering local communities on wellbeing education through a digital network is one of the effective ways to reduce the incidence of diseases and health issues. This paper aimed to design and develop an e-atlas of health according to the local user requirement. A collection of hardcopy health maps from student’s Cartography projects, Adobe Illustrator and ArcGIS Online were utilized to create the system according to the waterfall model. The finding of the user requirement has indicated the existing websites has general information on health but the e-atlas elements of health are not fully established particularly in Selangor. Thus, this proposed interactive mapping system has demonstrated several sub-menus regarding the health aspects such as waterborne diseases, vector-borne disease, health care facilities, and others. General info on the Selangor wellbeing features with good cartographic elements have been also incorporated. Eighty-five per cent of respondents gave the positives feedback, but they are hoping that this community services system could be applied practically in the future.

1. Introduction
The World Health Organization (WHO) defines health is an integral part of physical, mental, and social well-being, not merely a lack of disease or disease. In Malaysia, with a large population of more than 30 million people, this Southeast Asian nation has proved to be vulnerable to a wide range of outbreaks and diseases. Cardiovascular disease, for instance, is the major cause of death at 36%, impacting all generations [8]. The better health care system can control health and disease issues in a particular area through a systematic information system. Health care is a way of preserving or enhancing our health to ensure that our wellbeing is well managed.

The WHO [7] has recognized the capability of the information and communications technology (ICT) or system as a control tool for disease outbreak plan and health education platform. Health technology is a field of organised expertise and skills in the form of devices, medications, vaccines, procedures, and systems designed to address a health and disease problem and improve quality of
life. Acknowledging health innovations provide health care professionals with resources that are invaluable for efficient and comprehensive prevention, diagnosis, recovery, and rehabilitation, and attainment of internationally agreed with health-related development goals.

ICT or Web technology can facilitate the growth of peoples and health practitioners to obtain general info on health issues [2][10][11][12]. For example, the new information technology can assist the growth of indigenous peoples and help to share data on their health even though some scientists are not convinced that ICTs are directly involved in indigenous populations, particularly in the fight against health issues and poverty [2]. Furthermore, the effectiveness of mobile health (M-health) programs in Africa has been also demonstrated at numerous levels, including specialist advice in remote areas, drug procurement and inventory management and national health support policies [4].

Similarly, the innovation in modern Cartography and GIS technology for health and disease application can enhance the existing health care education and wellbeing promotion methods through electronic atlas. Atlases of health are cartographic map collections relating to conditions, infrastructure or services offered in health and health care. Maps are commonly used to display information about geographical areas visually, while a geographical information system (GIS) is a framework for gathering, managing, analysing, and mapping data. GIS can reveal deeper insights into epidemiological problems into data, such as patterns, relationships, and situations in helping users make smarter decisions. Combinations mapping and GIS cartography may produce an effective e-atlas of health that support health decision-makers to boost their services to local communities. In Malaysia, particularly in Selangor, the local researchers have demonstrated the capacities of Cartography and GIS modernizations for disease mapping and health control programme [13-20].

Atlas in health consists of spatial basic functions such as data collection [5], information database and access, and web application [3]. Development of the health atlas for the Ministry of Health and the Community in Mexico by [6] is an appropriate example for creating a decent community health awareness using digital health atlas. This GIS cartography web-based platform allows people to connect with medical and specific data, regions, and classes according to their data needs, and produces thematic maps such as the entire state's population or a specific community. In Malaysia, although the Department of Survey and Mapping Malaysia [9] produced a National Atlas of Malaysia, it was still not specifically stated the aspects of health or wellbeing theme. Therefore, this study aimed to develop an electronic atlas for health and disease information in Selangor, Malaysia towards health awareness among the local communities.

2. Materials and Methods

The waterfall model was selected as the main method used in this study, addressing the life cycle for a standard web-multimedia system design and development. It is a universal process which helps to coordinate all the steps involved in system development to achieve the objectives of the study. These processes were started with preliminary studies and then is followed by user requirements assessment, data collection, system design and system testing and evaluation.

2.1. Preliminary Study

Selangor Darul Ehsan is the main area of the study. Selangor situated on the western coast of Malaysia's peninsula, with Shah Alam as its capital city. Selangor consists of nine districts: Langat, Hulu Selangor, Klang, Gombak, Hulu, Kuala Langat, Sabak Bernam and Sepang, Kuala Selangor, and Petaling. This important task has reviewed the previous websites that provided the e-health in Malaysia. Reading articles, journals, and previous papers are also conducted to obtain an early idea and to investigate any related problems. It was found that there are many websites about health care in the country with certain advantages and disadvantages in terms of mapping or GIS elements and applications.

In general, every website of health is focused on the service of the facilities they can be provided to the users. But these websites have not demonstrated the specific websites for disease map collection or an atlas in Selangor. Table 1 is the existing health websites that have been studied to understand
the function of the system for future improvements.

### Table 1. Selected existing websites of health in Malaysia

| Website                        | URL Address                                                                 |
|--------------------------------|-----------------------------------------------------------------------------|
| Kementerian Kesihatan Malaysia | https://www.moh.gov.my/index.php/pages/view/1732                           |
| MySejahtera                    | https://mysejahtera.malaysia.gov.my/intro_en/                                |
| Malaysia MedicalResources      | http://elder.medicine.com.my/                                               |
| Sime Darby Health care         | https://www.ramsaysimedarby.com/Healthline                                 |
| National Institute of Health   | https://www.healthline.com/ https://www.nih.gov/health-information          |
| World Health Organization      | https://www.who.int/malaysia/emergencies                                    |
| Malaysia Health care           | https://www.thrive-malaysia.com/about-metastatic-breast-cancer              |
|                                | https://www.mhtc.org.my/discover-malaysia-                                 |
| Sunway Medical Centre          | https://www.sunwaymedical.com/                                              |
| UNAIDS                         | https://www.aidsdatahub.org/                                                |

#### 2.2. Data Collection

The data used for this study are the location of the health care centres or hospitals. In this study, there are 11 government hospitals and more than 30 private hospitals in Selangor. The collection of the student’s thematic maps related to health and disease were also used in this study. The software applications utilised in this project include Adobe Illustrator, Adobe Photoshop, Adobe Animate, ArcGIS and Visual Studio. The target users of this website were the public users who are looking for information about the disease hotspots in the area in the state.

Nowadays, people prefer to look for knowledge using the digital, platform such as a computer and smartphone. This system was also attached with mobile phone and open source. Open-source data are widely available, including basic information on the health and health of ArcGIS Online [1], OpenStreetMap and other Selangor Health Websites.

#### 2.3. User Requirements

The next step was user requirements through the questionnaire for requiring a response from the potential user on the proposed website of e-atlas. A questionnaire selection was generated based on the ‘WH’ question to obtain information about client requirements the most important question is to give the respondents the option to respond to it more easily. Besides, the questionnaire encourages the respondents to express their opinions on the answer column if they have their own needs or requirements that could be included on this website.

The questionnaire was divided into four sections with fourteen questions. The sections cover the protection of data, the information system used, geographical details in education, and the last parts is opinions referring to e-health. The effectiveness of the website program following the respondents is another question included in this section. The following criteria are used to determine the effectiveness of the website:

- User friendly system
- Multimedia system
- Insightful information
- Good cartographic map design.

#### 2.4. System Design and Development

This system development is specifically designed to create a health interface template so that patients can effectively use it. Four process design stages were required to create an effective, simple, and user-friendly system. Firstly, Navigation design used to ensure the design can help the user without any complex trouble. A standard navigation design is also established in a user-friendly way and it is therefore can help the user to easy understanding the system functions as shown in Figure 1. For example, the homepage will allow the user to access the system for getting the idea of the website
system implementation. In the Home, it displays the general content about health and related information on the state public health.

Secondly, Interactions control on this site is designed to achieve the internet for providing the community with health information. Two types of interaction controls are site access controls and map interaction controls on this system. The user-based interaction with multi-page content is site access controls. Layout Design is another process included in the system which is to show events on each window or each web page. The process of creating display events helps to develop the concept of map contents and map interactions. Lastly, the development of Storyboard that is created by navigation design, interaction control, and display events. The storyboard is another task created in the system based on the result of the questionnaire from the respondent's opinions.

![Figure 1. Proposed main menus and navigation design of e-health atlas.](image)

Before conducting the development of the system using ArcGIS Online according to the proposed storyboard. The data processing of thematic mapping was performed using ArcGIS desktop and Adobe Illustrator. In ArcGIS, there are eleven types of diseases and two types of facilities extracted from the student cartographic maps project. Every data of health care centre was in the excel format and imported to the software by their coordinates. The map was displayed in the shapefile for easy editing and modification of cartographic map design.

![Figure 2. Creating symbols of the health features in Adobe Illustrator](image)

In Adobe Illustrator (AI), the symbol of every layer of the map was standardized to insert into the map design of Cartography. The type of health care was created with suitable icons or symbols for the symbolization and generalisation. A line and eclipse were also built for a gridding and drawing the
icons. Every category of health or disease layer were created in a different colour of the symbol as displayed in Figure 2.

The web-based mapping of e-health map when then developed using ArcGIS Online. The map design such as classification and symbology are recreated in this online platform as well. This proposed mapping service or e-atlas comprises ten different types of the base map that can be used to design a map and street base map. Multimedia elements such as text, sound, image, video, and animation were also generated and arranged on this page for an interactive presentation and to ensure the interplay between users via the Internet.

2.5. System Testing

When the development phase was completed, the proposed e-atlas of Selangor health information system was evaluated by selected respondents to make sure the objective is achieved and approved by the user in Selangor and for improvement. The questionnaires test and analysis of the system was carried out using a google form. The testing process and the evaluation of the system consist of the requirements, technical design, product, and testing cases. Thirty respondents gave their response randomly on the testing of the system for evaluation. The procedures of system testing implementation are listed below:

- On several occasions random respondents is selected.
- The system is briefly explained to every respondent.
- The link for the website is shared with the respondent.
- The respondent will explore the website system themselves.
- After that, the exploration of the system is done by the respondent. At the last page of the website has a link for feedback.
- Click the link to get the feedback form.
- Then the respondent can evaluate the system based on their experience testing on the system.

3. Results and Discussion

3.1. Review on the Existing Health Websites in Malaysia

It was found that there are many websites on health care established in Malaysia, but most of the websites are only focused on the service of the facilities that they can be provided to the user. Several websites information on health care in the country is only focused on the main topic, including dengue or popular health information. These websites emphasize on the design of websites, especially the design of homepages, types of tourist pages, functions on the buttons, textual information, tourism maps and multimedia elements on the websites.

| No. | Website Name                        | Text/image | Map | Audio | Video | Animation |
|-----|-------------------------------------|------------|-----|-------|-------|-----------|
| 1   | Kementerian Kesihatan               |            |     |       |       |           |
| 2   | MySejahtera                         |            |     |       |       |           |
| 3   | Malaysia Medical Resources          | No map     |     |       |       |           |
| 4   | SiSme Darby Health Care             | No map     |     |       |       |           |
| 5   | Healthline                          | No map     |     |       |       |           |
| 6   | National Institute of Health        | Google     |     |       |       |           |
| 7   | World Health Organization           | No map     |     |       |       |           |
| 8   | Thriev                             | No map     |     |       |       |           |
| 9   | Malaysia Healthcare                 | No map     |     |       |       |           |
| 10  | Sunway Medical Centre               | Interactive|     |       |       |           |
| 11  | UNAIDS                              | No map     |     |       |       |           |

*Figure 3. Multimedia elements and maps in the existing local health websites*
In terms of health map contents, many websites only use Google Map to view health care site locations. These maps are not hypothetical, because it only shows the position with current Google Map symbols. Figure 3 illustrates that analysis of the existing websites that focus on 5 categories that are text, image, audio, video, and animation. All the elements are multimedia that attract public users.

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From the eleven websites that no one has all the categories. This element is important to investigate to make sure the site is still run. There are five elements of the map in the cartography that is map title, legend, north arrow, scale, and symbol. The elements help the user to an easy understanding and a guide to the user that do not have cartography knowledge to use the map. The websites do not also have a completed cartography map layout except the UNAIDS but it still trying to fulfill the proper layout requirement.

3.2. User Requirements on the E-Atlas of Health

The first objective of the study is related to the existing system and user requirement on the proposed system of e-health atlas. It involved 118 respondents that have volunteered to participate in this study. The demographic section, covering the aspects of the group of age, occupation, and background study to know whether the existing system is a good website or not. The respondent’s answers are very important to improve from the existing website and their expectation in the proposed or new system. The most age group that participated in this questionnaire is among 18 to 24 years old with 58.5% especially from students (66.9%, and the rest from the users aged more than 24 years old either in employed or unemployed people. Most of the participant for this survey were mostly among the bachelor’s degree holders.

Figure 4. Function limitation of the existing local health websites

Therefore, referring to the respondent opinion on the proposed system as shown in Figure 5, 61% (72 people) respondents agreed that the developments of new health information need to be developed and considering the elements of a geographical information system, cartographic and multimedia elements in the system websites. The respondent also wants to know more information about the health compared to the existing website systems that mostly explained only a particular disease. Thus, system improvement is done by putting more than one health information to increase their awareness of health. The other suggestions are that the system should provide the clearer map
and to insert in the proposed health system information is the location of the patient, but the authors change to the location of the hospital and clinic because to locate patient need a big data.

![Figure 5. Respondents opinion on the development of e-atlas](image)

3.3. System Features and Functions of the E-Atlas

Overall, the main menus and functions of the system are displayed in Figure 6. Figure 7 shows the home of the health information system of Selangor. This page displays the layout of the cover of the system. The first page is having an image of the symbolic electronic health atlas of Selangor. To attract the user, we must attract the with the first expression of the system. The home page is the introduction of the system to attract the user to use the website. For every one that uses this website, the first that shown is the “HOME.

There are eight buttons under the title. The button represents how many this system page. Every button has its function to use by the user. The button helps the user as a guide to explore the website system. The buttons system is home, an atlas map, human borne, waterborne, airborne borne, vector-borne, facilities and info as shown in Figure 7.

The atlas map page explains the information about the map information and all type of data in one map as indicated in Figure 8. It can see there are so crowded but do not worry if we zoom and pan, and the difference because this system is an interactive map. If the user confuses about the logo on the map, they can look at the legend. Multimedia is also on every health category page to know more about the health.

![Figure 6. System module structure in e-atlas](image)

The system also provides information on the main types of disease such as waterborne, foodborne, vector-borne, and other diseases. There are four types of health under the human borne that is HIV, AIDS, thalassemia, and obesity. These four-health problems are using the same colour to shows that there are under the same category that is a black colour symbol. Waterborne disease is an infection
caused by drinking water polluted by human or animal faeces containing pathogenic microorganisms, including typhoid, leptospirosis, and food poisoning.

Figure 7. Homepage of e-atlas

Figure 8. Health elements in e-atlas

Airborne diseases include any that are caused via transmission through the air, while vector-borne disease that transmits to humans and other species by blood-feeding arthropods such as ticks, mosquitoes, and fleas such as Lyme disease, Dengue fever, West Nile virus and malaria. The other menus in the system include Health Facilities, General Info on the Health and Disease Situation in the state and related the health organisations links. There are also have the feedback link at the end of the website where the user can give feedback or suggestion for improving this system. These basic functions have directly demonstrated the mapping and GIS capabilities for allowing people communicate with health and general data, regions and classes based on their data requirements, and create thematic maps[3][5].

Besides this, the proposed system is compatible with the Smartphone as shown in Figure 9. Two types of the most popular system smartphone in the world thats is the iPhone Operating System (IOS) and Android Operating System. The website of the electronic health system is tested for the compatibility with a smartphone to improve the reachability where it does not stand alone just can use at the computer only but also can "on-the-go". These functions could be beneficial to the local
policy decision-makers [4][9] for better health information sharing or delivery system among local communities [6].

![Figure 9. E-atlas via smartphone platform](image)

3.4. System Testing of E-Atlas Performances

System testing and evaluation are conducted to make sure the system could be practically applied by the users. If the system has a problem or cannot satisfy the user expectation, the authors need to improve and test the system again until the system is accepted accordingly. All aspects including screen visualization and presentation, GIS elements, e-atlas or maps, health information, interactivity elements, and multimedia elements are tested.

![Figure 10. The respondent’s satisfaction on the e-atlas application](image)

More than 85% of respondents agreed with the functions and features established in the system such as user friendly, completed health information, GIS elements, map contents, multimedia elements, system speed, system quality, and system attraction. Similarly, the respondents also strongly satisfied with the overall performance of the system (Figure 10). However, the system needs to be improved in terms of information provided in the menus because few of the user did not capture or familiar with the overall idea or input presented in the proposed system of the e-atlas.

4. Conclusion

Selangor is one of the places in Malaysia with a fast rate of physical growth and has a significant health population challenge. Empowering local populations on health literacy through digital tools is one of the strategies used to monitor and mitigate the possibility of disease epidemics. An e-health atlas is built in the state to create awareness among the locals about the health care concern via ICT and GIS Cartography innovation. Existing hardcopy health maps could be combined and managed in this digital form for better health information sharing or delivery system among the local communities. The e-health atlas is an innovative map collection website that has much information about the health,
health care, and disease epidemiology for society applications. This creative website comprises significant sub-menus regarding the health and disease aspects towards creating awareness among the people since the user can easily access it anywhere and at any time they want. Most of the respondents gave the positive feedbacks on this invention due to its practical and helpful characteristics that are better than existing websites.

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