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GEOGRAPHICAL INFORMATION SYSTEM (GISy) IMPLEMENTATION WITHOUT GEOGRAPHICAL INFORMATION SCIENCE (GISc) FUNDAMENTAL

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ABSTRACT

This article reviews the use of Geographical Information System (GIS) has been primarily applied in spatial decision making from simple to complex geospatial problems. GIS is usually referred to as a computer system used explicitly to store, manage, analyze, manipulate, and visualize geospatial data. GIS can produce meaningful information for a better understanding of solving related geographic/spatial problems. With the technology, hardware, and software assistance, GIS is at its progressive pace even though GIS starts with a simple and straightforward question of geographic features/event location. This rapid development has made GIS and spatial data becoming a critical commodity today. However, without the basic knowledge and GIS understanding, the actual GIS capabilities, such as understanding geographical concepts, managing geographic phenomena, and solving geographical problems, become limited. To become worse, GIS is was seen as a tool to facilitate map display and simple spatial analysis. Furthermore, the market's professional training emphasizes simple GIS components such as hardware, software, geospatial data mapping, extracting geographical data from tables (tabular data), simple queries or display, and spatial data editing mastered using GIS manuals in training. Thus, this article highlights the impact of implementing GIS without sufficient GIS fundamental knowledge, resulting in complicated spatial decision planning issues.

Key words : GIS fundamental, GIS, spatial data, spatial thinking.

1. INTRODUCTION

The use of GIS applications in the smartphone is so deeply ingrained in our daily lives, especially on location-based services for searching nearby routes [1], ironically, GIS seems awkward, and GIS awareness is still low for certain people [2]. Practically, GIS has long been adopted based on mapping concepts and overlay concepts before becoming a computerized information system in 1960 [3]. The core concept of overlay has contributed significantly to geographer's understanding of the geography phenomenon, issues, or problems; however, producing analog maps is very complicated, and limited spatial analysis can be carried out without computers[4]. Due to these shortcomings, GIS was introduced to produce a digital map. GIS is renowned as a computer system with capabilities in managing, analyzing, measuring, and displaying geographical data digitally as a reference for managing geographic resources before spreading to other applications. To put it briefly, GIS has accounted for almost a large part of human life on geospatial decision making. These phenomena are not surprising because most of the earth surface event involves geography features embedded with spatial data. GIS can help users view data in a geospatial context to understand better how the data relate to each other based on their position because most of the global issues involve geographic data**.**

2. THE DEVELOPMENT OF GIS

Although GIS is recognized as a newcomer, GIS is rooted in the geographic area [5]. GIS was initially intended to manage geographic data (spatial data) that became the pulse and driving force of the GIS system. Promising GIS acceptance has led to the rapid GIS expansion in line with computer, information systems development, modern lifestyle, and high demand for geospatial data and information. This rapid development has made GIS and spatial data become an essential commodity today.

In early development, despite GIS has proven its capabilities as a geospatial information system, there was a debate among academics questioning the fundamental issues in the legitimacy of GIS process, database structure, information accuracy, and reliability [6] until GIS was

slammed as " non-intellectual expertise" [7]. Simultaneously, GIS as a tool for mapping and science in solving geographic problems being questioned [8]. Concerns continue to emerge on the possibility GIS will disappear if GIS development focused on technology and applications without considering the GIS fundamental. Thus, [9] has taken a wise step to support GISystem by stressing the fundamental research and issue of GIS management, known as Geographic Information Science (GIScience) [10]. Despite the various reactions, GIScience's contribution to spatial data handling theories, geostatistical measurement theory, and scientific analyses in GIS has been acknowledged [11]. However, in 1990, GIS was welcome by professional users rather than public users because of data constraints, costs, and data management skills, processing, and spatial data analysis. In early 2000, GIS evolved as a service (GIServices). GIServices usually serve GIS design and development, digitizing and mapping, data acquisition, spatial analysis, and modeling services.

Nevertheless, with Information technology, GIServices is synonymous with website services to provide direct access to spatial data, databases, and processing tools more quickly, easily, and faster. GIS has evolved from simple software (GISystem) to one discipline (GIScience) to one career and service (Figure 1). Unlike other software, GIS software can store both attribute and spatial data. With these advantages and varieties, GIS can diversify the use of stored spatial data and managed efficiently in the geospatial database [12] until GIS evolves from easy software that can answer the simple question "what is where?" This ability refers to query analysis [13].

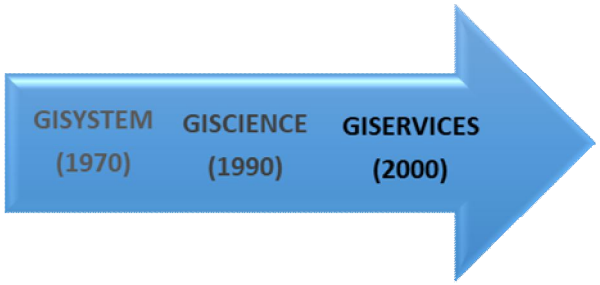


Figure 1 Evolution of GIS

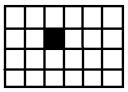
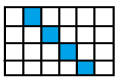
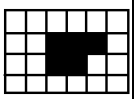
From a simple format (x, y coordinate) in vector format, now GIS has changed and improved sophisticated as GIS can store raster format obtained from aerial images and satellite images. These situations have enabled GIS to raster data analysis, known as surface analysis. Vector analysis involving a single layer or multiple data layers, and the surface analysis has been a backbone to GIS, whereas data spatial becomes the GIS pulse.

3. PULSE AND BACKBONE OF GIS

Geographical features refer to all the earth features, either natural or human-made features, whether tangible features such as rivers, cities, or intangible features such as contour lines and political support areas in an election [14]. Any geographical features in the relevant forms may refer to spatial features or spatial data as these features occupy space in a particular location in the earth.

Spatial data or geospatial data is often defined equally, whereas geographic data is mainly from spatial data. Generally, spatial data brings information that answers questions about location, shape, size, direction, spatial elements, and the relationship between objects. Based on the map scale used, all geographical features essentially represent the map with a point, line, or area symbol depending on the geographical features' nature. Features such as a well, a gas station, and a bungalow, which only occupy a small space, are represented as a point symbol. Line symbols usually use to represent narrow and elongated features such as roads, railways, and waterlines. Lastly, the polygons symbol represents the features that occupy relatively large or wide areas such as lakes or forests. In line with this, GIS represents a point symbol with a dot, a line symbol with lines, and a polygon symbol with an area. The river can be represented with long and narrow blue or light blue lines and distinguishes from other rivers by name labeling. River's name (Sungai Kim Kim) is part of the attribute data. In GIS, these attribute data are stored in the form of characters and alphabet in databases. Spatial data relating to this river can be stored in the form of vectors (coordinates x, y) or raster (grid cell) (Table 1). However, the vector symbol's representation of line feature varies according to the map scale, where the number of coordinates of x, y represents the details of the rivers that meander less when the scale of the map is smaller.

Table 1 Data Spatial Display on Map

Data Display	Point feature	Line feature	Polygon feature
Vector			
Raster			

Spatial data is the GIS pulse because, without spatial data, GIS cannot represent any geographical features on the map or screen. No spatial data means no analysis can be carried out no matter how simple the analysis, such as query analysis [15]. Whereas GIS analysis is the GIS backbone because no matter how much data collection and advanced technology are, no information can be generated without an analysis function. No information produce means that the information system (tool) is useless. User needs to have basic GIS

knowledge before deciding on GIS, as mentioned in the following paragraphs.

4. BASIC USE OF GIS

Application or development of GIS does not happen by chance only. There is a need for observations and studies to understand event details before the GIS use's suitability can be determined. In this way, we can estimate the relevant and necessary data, related analysis, and expected outcomes. However, it all starts with studying the related event with the use of spatial thinking to understand the geographical concept, geography phenomenon, and geographical problems:

4.1 Geography Concept

The concept refers to an idea for people to imagine, understand, and communicate. For example, when someone understands the vehicle concept, he can already imagine a car, lorry, van, or motorcycle used for transporting people or goods, the appearance, and vehicle condition. With this understanding, one can make a self-analysis of consumer preference in buying a car compared to a motorcycle even though they have to apply for a loan and be stuck in traffic jams. Apart from transportation, there is also geographical concept like "desertification", "minority culture", "food sovereignty " and various concepts to give an idea or deliver the meaning of particular activity, process, or understanding. These concepts are named geographical concepts because all of these concepts take place on the earth's surface. Geographical concepts have spatial components. Thus, the geography concept provides a framework for geographers to interpret and represent the phenomena and problems information that happens in our real-world [16].

4.2 Geography Phenomena

Without the basic concept, a phenomenon might not understand appropriately due to a lack of proper foundation in approaching a phenomenon. Usually, a phenomenon closely related to the basic geography concept. The geographical phenomenon will be investigated and view from a geographical perspective for a better understanding. Understanding a geographical phenomenon becomes a necessity in our lives, especially at the top-level (decision-makers). Any change in occurrence or phenomena (naturally happens or human activity factor) can affect human life regardless of the event's scale. The phenomenon is often seasonal or something extraordinary or prominent in general. In a scientific context, phenomena are observable events that can be explained scientifically. A social phenomenon rather strange is called the bystander effect, where when others present, people unwillingly offer assistance for those in an emergency. Another awkward cultural phenomenon is same-sex marriage (SSM), increasingly accepted legally in twenty-six countries of the country in the 21st century [17]. These phenomena have received different respond and become one of the social, religious, and political issues. These phenomena are part of the geographical phenomena that can be the subject that might demand GIS use. Today, online entrepreneurship has become phenomenal compared to last thirty years ago as our community still not familiar with purchasing via the internet.

From geographical and GIS perspectives, geographical phenomena can be interpreted as facts, events, or conditions observed in nature.

4.3 Geography Problem

Geography is concerned with global issues, including biological, physical, cultural, and social issues, including how these interactions impact the earth. Thus, geography problems can include issues and contemporary events such as floods, human abuse, migration, genocide, and others. With the fundamental of geospatial knowledge, the primary data needed to solve geographical problems can be identifying. The knowledge needs to consider data type, how data collection, processed, stored, analyzed, and displayed by the GIS software. For example, data is required to handle forest fires. Most likely, in conducting analysis, the data needed such as fire incident location, an area involved, and period of fire, the firefight direction, fire height, the spatial extent of the fire, and distance of fires from source water, settlement areas, and more. Location, area, time, direction, height, spatial extent, and distance are part of the primary data or spatial elements needed to understand and analyze forest fires. In fact, before deciding GIS to deal with geographic issues, understanding geographic phenomena and geographical concepts, the spatial elements need to be refined as described below:

4.4 Spatial Element

Even though spatial data is essential, reliance on spatial data alone does not highlight the GIS system's capabilities or a GIS system user's competence. The ability to diversify spatial data use and exploit spatial data, and process GIS analysis are more significant than just having an enormous spatial data volume. However, all this is unlikely to be achieved if the spatial elements of geographical features are not covered and refined since spatial elements are the fundamental blocks for geometric constructions, which are very useful for spatial data representations. More importantly, spatial elements are the basic blocks for the GIS analysis construction. Spatial elements described below:

4.4.1 Location

The location explains the positioning of an object such as a river and a piece of land. Locations are usually given in the form of longitude and latitude to represent the placement of an entity. The absolute location is the actual location of

placing something on the earth and is usually expressed in coordinates (latitude and longitude). The street address may also indicate location. Relative location describes a place or site's placement, such as ten miles from home and five minutes from town.

4.4.2 Distance (Length, Width, Height, Depth)

Space between two locations simply defines distance, but if these two locations overlap in one place, the distance will not exist (small scale). In general, distance refers to the measurement of the chosen path length between two points. From a space perspective, distance is expressed in the absolute and relative distance. Absolute distance refers to distance measures in standard measurement terms such as Kuala Lumpur City Centre (KLCC) to Kuala Lumpur International Airport (KLIA) via Lebuhraya Kuala Lumpur–Putrajaya is 55.9 kilometer. Whereas it takes around 49 minutes and cost about Ringgit Malaysia 78 - 98 using Grab service depends on traffic, speed, weather, and usually refers to the relative distance that measures cost or time.

Elements closely related to distance elements are length, width, depth, and height. Distance and length sometimes give misconception of terms because both terms refer to the space between two locations. Length can refer to distance but distance not necessarily be referred to as length. The length refers to two points connected physically, such as the bridge's length, whereas distance can refer to both physically connected or not connected features.

Width is a distance measure from one point to another along the direction perpendicular to the direction of length. The width of an area can give an estimate of how spacious it is. The mine's width is calculated from one endpoint to the other endpoint, where the area is covered with water. Other spatial elements related to distance are height and depth. Height refers to the distance from one level to another higher vertically, such as the hill's height measured from the sea level to the hill's highest point. In contrast, depth is the distance from one level to another lower-level measured vertically. For example, a water storage tank's depth referred to the vertical distance from the water's surface to the storage tank floor.

4.4.3 Area, including Spatial Extent

If several points (minimum 3 points) connect and form close form, area information can be generated. For example, the lake area is referenced by the lake space's size covered or filled with water. The spatial extent referred to the extent of a geographic phenomenon or problem's impact, such as how volcanic lava may hit an area, as far as the oil spill in the sea.

4.4.4 Directions, including orientation, patterns

Directions are used to describe the way the position of an object. Depending on an object's position (relative direction), directions can change according to an object's movement, such as the river direction will change based on driving direction. If a driver from the Johor, the river will be on the right side of the driver. However, if the driver is the opposite, the river will be on the driver's left side. Four cardinal directions are the north, east, south, and west, usually used in a geographical context.

Orientation can be referenced to the tendency of movement direction or arrangement [18]. For example, along the countryside streets, it is common to view the shophouses are built. These shophouses are arranged in one direction of linear and elongated (Figure 2a). Another row of shophouses behind these shophouses will form a row of shophouses in parallel (Figure 2b). Another row of shophouses can be constructed perpendicular to the original storehouse's direction (Figure 2c). If this construction is repeated several times, it will result in a shophouse area pattern, as illustrated in Figure 2. The pattern is a specific set of repeated symbols (iterative) on the sidelines and in a specific direction at a particular space.

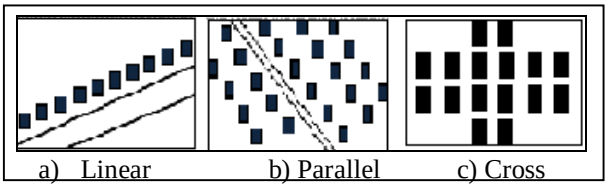


Figure 2 The Orientation of Shop Houses

The pattern is formed in the presence of the same features or activity in specific quantities in a particular area or events repeatedly, such as limestone cave distribution in Malaysia and criminal case pattern by a 24 gang in Penang, Malaysia. Usually, patterns are categorized into three types, namely the distribution of random, clustered, or dispersed.

4.4.5 Network

Networks often apply to the features that interconnect with each other, such as roads, business branches, computer hardware, and social connections. The network is formed when more than two entities or objects (nodes) are connected. Networks consist of a link that connects nodes. The road connecting two cities is known as a link. The intersection between two roads is known as a node.

4.4.6 Time

Every problem, issue, phenomenon, or activity is related to time. Some events happen for a long time, such as the civil war in Somalia, which lasted from 1988 [19]. Instead, the earthquake took only 30 seconds but has killed 19 lives in 2015 [20]. Time refers to a moment as in general use at night, when it rains, and interprets various other contexts, such as periods of ten years, intervals such as per hour or, frequencies such as once a month. Time used to show seasons like spring, flood season, wedding season, and fruit season. Time is a

fundamental element of the space-time cluster analysis as well as time series analysis in GIS.

This fundamental knowledge of GIS covers spatial thinking that consists of spatial concept, spatial representation, and spatial reasoning as described below.

4.5 Spatial Thinking

GIS and geography are often associated same thinking skill, namely spatial thinking, which is a collection of cognitive skills [21]. Spatial thinking involves identifying, analyzing, and understanding the geographic relationship in data, concepts, phenomena, problems, or issues through location, scale, pattern, and trends. In other words, spatial thinking involves the way individuals think in spatial perspective based on their knowledge and ultimately produce new information to increase their knowledge or solve problems. According to The National Research Council (NRC) of United States, spatial thinking can conceptualize in three critical elements:

4.5.1 Space Concept

Space concept is the building blocks of spatial thinking**.** Space can be comprehended by understanding the different ways of understanding and calculating distance, the base of coordinate systems, and the two or three-dimensional nature of the space itself. Space represents an absolute location in the form of latitude and longitude in contrast to a relative location in terms of time and cost.

4.5.2 Spatial Representation

Spatial representations show how individual represent the relationship between object and space in their mind and translated into a map, a table, a drawing, or a figure (GIS representation). The spatial representation can show an image (points, lines, or polygons) and relationship when data are represented in different grid systems and map projections[22].

4.5.3 Spatial Reasoning

Spatial reasoning involves the process of reasoning, explaining, describing the reasons behind a conclusion based on the relevance of space between objects, problems, issues, phenomena, which eventually lead to new knowledge gain. For example, the justification on the shortest distance route may base on time or distance.

Various parties have welcomed this spatial thinking because, without spatial thinking, the world's complex issues will not be dealt with effectively. Tools or software can help solve problems; however, spatial thinking is the core of understanding the problem.

5. APPLICATIONS WITH AND WITHOUT GIS

5.1 Natural resource

GIS has permeated nature resource management, especially in forest management. Due to the increasing demand for timber, wood products and fulfilling society's demand to preserve the forest for the next generation, managing forests becomes more challenging. These situations ordinarily require extensive data volumes for analysis, usually carried out manually in most countries [23]. This task is very pricey and requires many workers, yet it has constrained the decision-making efficiencies and viability [24].

Selective Management System (SMS) has been recognized as the most sustainable method in managing and preserving the forest. This system involved pre-felling study, mark for felling, survey in checking illegal felling, treatment, replacement and will be repeated for another 25-30 years. However, with the low number of skillful workforce in implementing and monitoring this system, illegal logging is still rampant [25]. Other activities such as treatment and replacement still need to enhance to prevent deforestation where land frequently being clean for agriculture or development purposes [26]. The advance of spatial technologies, including Remote Sensing, Global Positioning Systems, and GIS, enables collecting large volumes of data for more accurate decision-making. These technologies can easily give valuable tree location information, forest area mapping, or monitoring wildlife habitat distribution, biodiversity loss prediction, and forest cover change modeling. For example, harvesting activities need to decide the tree's felling direction and possible route quickly carried out by analyzing GIS tools. Therefore, GIS has become a critical tool to assist forest managers in preserving our forest.

Water resource management always gets attention from all over the world because people might live for a while without food but rarely can survive without water. Due to several parties (federal government, state holder, water policy, and legal experts) involve in water management, managing water becomes complex. Many issues and challenges, such as increasing water supply-demand, water availability, and water pollution, should be addressed[27]. The community has a water crisis due to management rather than the fundamental issue of shortage [28]. Most of the decision-making in past management focuses more on short-term economic goals than long-term environmental goals. The water management system is designed and developed based on climate trend observation, prediction of analysis, and hydrology data assumption [29]. However, with current issues and challenges, the past method's assumption, no longer acceptable, depends heavily on the past method's assumption. There are computer and simulation models with interactive visualization for decision-making support systems to manage water resources [30].

Excellent understanding and knowledge of geospatial data and information, including water sources, water valves, rainfall, soil type, terrain surface, drainage basins, contour line, human activities, watershed, and others are required, so database for storing abundant of different type of data needed. Based on this requirement, GIS manages to penetrate water management because GIS has geodatabase capability to store different data types typically needed for hydrology modeling. The stored data in GIS software can help hydrologists analyze and visualize water distribution and related activities near water sources to decide water status and quality. Besides, the GIS modeling tool has changed engineer ways in modeling water resources by allowing automation of simulation model in less time and less human error but producing a more significant quality model for better understanding of spatial aspects in water distribution.

5.2 Social Application

Although GIS is well known for traditional disciplines such as physical geography and environmental science, social science disciplines also adopt GIS for phenomena and problems directly related to geography. For example, homeless problems are highlighted as a social problem due to mental health, family breakdown, addiction issues, physical disabilities, and poor health [31] can be tackled more efficiently and accurately by GIS. Before GIS use, various parties from government, non-government organizations, and volunteers cooperate to survey and collect data of homeless people. After a long collaboration to get data, the left stack of data sheets needs to be processed and usually presented in numbers [32].

However, with GIS, this collected data can be visualized and understand in interactive ways. Based on the homeless location, GIS can display distribution, patterns, and trends. The public can better understand this issue through the information displayed, homeless hotspot, homeless populations per capita, and supply other related information [33]. With a combination of other primary data such as demography land use, related authorities can plan for more effective programs, identifying the location for a new shelter, create awareness, and supply aid.

Another social application is the education sector, which significantly influences the introduction of Information Communication Technology (I.T.). The teaching method has been changed from the conventional teaching method 'chalk and talks' to the sophisticated approach of information technology and computer tool in teaching [34]. Rather than static documents, visualization on screen can be more interactive to the student. However, especially in Malaysia, I.T.'s teaching subject still varies, and some subjects remain less favored by students [35]. Geography subject is the subjects still in memorizing facts nature without technical skills. This subject becomes less attractive to students because it lacks integration with technology, whereas the nature of geography needs skill in drawing, recognizing locations, visualization, and reasoning. Photocopy maps have become a trend among students, whereas map-making is the basis for this subject [36]. This trend has reduced the emphasis on mapping skills and spatial thinking. Following this problem, GIS was introduced as an effective teaching tool and an information system to solve various problems related to space, geography, and other subjects such as science, mathematics, arts, environmental studies, biology, physic, and others [37]. GIS is a system used for mapping and a geographic inquiry-driven data analysis, identifying patterns of behavior, and results in displays [37]. GIS can stimulate students to think critically and develop higher-order thinking when students use actual data to relate with real events for analyzing, exploring, and interpreting the relationship between human activities, land use, road, forest, building, and others. For example, the student can explore and investigate the relationship between human activities, factories, and rivers. After observing and finding river pollution information, they can relate to polluted rivers caused by nearby human activities' irresponsible behavior. This finding will encourage them to think critically about what will happen to the river and other natural sources if this situation happens for a long time. This knowledge will create awareness among the young generation and teach them to appreciate and learn about our world in the "big picture".

6. GI-SYSTEM WITHOUT A GI-SCIENCE FUNDAMENTAL

GIS technologies have advanced our way by replacing paper with digital maps in most vehicles' smartphones and navigation systems. Being general-purpose software, GIS is open to anyone [38]. Novice users can easily experience GIS use via web-based mapping and analysis by following the GIS manual without GIS fundamentals or geography. Most organizations and governments have attempted to provide their spatial data and information to the public via online services. The situation has contributed to this phenome (GIS used by novice users) with short GIS professional training in the market. Besides, we have no idea how real-life experiences can help (for the person who is not from a geography and GIS background) in understanding the concept, phenomena, and problems in the "big picture". Without GIS fundamental knowledge, someone may not fully understand why a city is represented as a point on one map and as a polygon purely because he lacks scale knowledge, the fundamentals of spatial representation. Furthermore, it would be challenging for some people to reason why spatial data need to be georeferenced if they lack knowledge of space concept, location, orientation, projection, and coordinate system. These concepts are developed based on spatial thinking. People must think spatially to use this GIS effectively, manipulate data and create information for a wise and precise decision either for daily tasks or for organization and government (GIS participatory).

Besides, reading, understanding, and interpreting maps and spatial data has become crucial for everybody today. Employers may look for an employee proficient with technical skill in handling software and seek an employee who knows to understand and view problems from the spatial perspective to solve any geographic problem and issue from the grassroots.

The proficient user in handling software will have difficulties thinking out of the box as they are too dependent on the software. The user will face difficulty solving the problem and understanding the problem from a space perspective, resulting from minimum knowledge of GIS fundamentals, including spatial thinking skills. It is evident here, although any technology used to solve problems involving space but without the basic understanding of GIS, the results obtained and conveyed possibly not interpreted to cover the whole angle [37]. Without GIS fundamental, someone may not fulfill society's need nowadays, as society needs someone who always considers space in mind to support producing information as most of the problem happens in a particular space. Therefore, we need to utilize space as an organizing idea or concept to understand better and solve particular problems.

Undoubtedly, the problem may arise when a nonprofessional mapmaker is producing a map without basic spatial and map representation knowledge. The map may be unable to achieve the primary function of map production to deliver truthful and reliable information. For example, the choice of color for geographic symbol might confuse when the user represents forest with his preference color rather than the standard color for forest symbol (green). If the user uses black color for the forest, the reader might interpret the symbol as human-made/cultural features. This situation can lead to the question of map reliability.

One more highlight is that this article is spatializing intangible spatial data that people with common geography knowledge and GIS fundamental fail to do. The problem directly related to geographical features seems more relevant, not questionable, and GIS use can quickly be decided. However, the problem involves intangible as geographic features such as alcoholism and broken family may raise some question of how GIS can be used. Users might have difficulty identifying the geographic features and relationships involved in this problem and may only view it as a social problem. Therefore, they fail to recognize the intangible spatial data, such as a store location and store to the residence distance. Traditionally, most data seem more easily represented in tables or charts to show the problem's seriousness. Unfortunately, visible via table and chart such as pattern and relationship between features or object. With advanced technology and analytical tools, intangible spatial data is spatialized in graphical form simply for better understanding and analysis and graphic representation. It can show the distribution of this problem, the relationship that particular area with alcoholism problem, and decide which area needs more urgent action.

Despite growing recognition, a survey shows that young Amerika in the United states abilities has common geographic understanding using spatial thinking skills during the survey [39]. Malaysia is no exception [40], and the proof proposes that most students are not capable spatial thinkers [41]. For students who use GIS, the most troublesome is applying spatial thinking despite their ability to create maps [42]. This not means they can interpret maps effectively or utilize them to interpret issues or generalize to understand the issues or problems [43]. Whereas in higher education, students are more interested in securing essential and related skills, mainly technical parts and technologies, for better job opportunities. When users depend too much on technology, users fail to think and let technology think. In a simple situation, GPS is used to reach a particular location in town. When reaching a particular location, users might have no idea and feel lost even if they are in their neighborhood. This situation has shown a proto-spatial thinking lifestyle that the vast availability of GIS tools and limited spatial thinking apply to use these technologies effectively [44]. If lifestyles are continuously happening without any approach to overcome this lifestyle, we will only produce young generations who know how to produce a result without reasoning.

7. CONCLUSION

Nowadays, GIS technology has become more prevalent in dealing with problems closely related to spatial data, and it already becomes a common phenomenon, with novice users using GIS software and analysis tools. However, not everyone has fundamental knowledge to understand the problem from spatial perspective and grassroots. Using GIS without fundamental knowledge will produce ineffective analysis, and the user will more depending on the GIS manual and software. Therefore, it becomes a huge loss when a problem can be simplified by the tool, but a problem cannot be understood deeply, and eventually, the solution suggested are not comprehensive and holistic. Therefore, awareness fundamental of GIS knowledge, including spatial thinking covering almost fundamental GIS topics (spatial concept, spatial representation, and spatial reasoning), should be formally and widely promoted to help us understand any issues, problems, or phenomena not just purely depending on the tool.

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