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CONCEPTUAL STRUCTURAL MODEL OF THE GEOINFORMATION FACTORS EFFECTS ON NATURAL DISASTER MANAGEMENT IN UAE

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Abstract

Recent developments in the UAE have proceeded toward the concept of disaster resilience. However, preparations for any impending disaster have been slow and, due to the country's recent legal establishment as a nation, disaster preparation has featured on the national agenda only very recently. In light of the new nuclear development in the UAE energy sector, it is important to understand the vulnerabilities of the sector as a means of preparedness for future natural or man-made hazards. Therefore, the paper is prepared to discuss the conceptual model of the geoformation factors' effects on natural disaster management in the UAE. The study will contribute to the knowledge of disaster management far as geoformation is concerned in the UAE.

Keywords: Disasters Management, Geographic Information System, Conceptual Structural Model, UAE

1. INTRODUCTION

The increasing frequency and intensity of disasters have resulted in severe disruptions to communities and built environment facilities around the world. There is an evident increase in human and property losses from disaster events over the past few decades. In the period between 2000-2011, 2.7 billion people have been affected by disasters, 1.1 million of which were fatalities, and the financial cost of disaster impact was estimated at $1.3 trillion (Wex et al., 2014). Evidence suggests that disaster risks are rising at a rate faster than affected communities can build resilience (Al Khaili and Pathirage, 2014). Fast-growing cities and urban areas of the world increase disaster vulnerability due to economic growth and fast population expansion. Cities, where more than 50% of the global population resides and where much of the economic assets can be found (Haworth, 2016), are very much the epicenter of destruction and loss brought about by natural and man-made disasters.

Growing urbanization results in increased built environment facilities such as buildings and infrastructure, and thus a greater exposure of potential human populations and services to natural or man-made hazards (Johnson, & Munshi-South, et al., 2017). The need to address the disaster vulnerability of built environment facilities such as infrastructure is becoming increasingly important. How these facilities are designed and built, and where they are located, is critical to their ability to withstand different types of

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natural or man-made hazards. The energy sector is a strategic component of any modern society. As the demand for electricity and energy grows, so does the complexity of the system and the need to protect it. The significant increase in consumer demand and population in both developed and developing countries means that not only is society dependent upon the energy sector but also that more people and businesses require an increasing energy supply, to operate normally (Bie & Li, et al., 2017). Failure to protect the energy system and build resilience into the infrastructure could have severe effects, should these assets have been subjected to a natural or man-made disaster.

The disasters that have frequented the United Arab Emirates (UAE) or at least have the potential to do so, such as storms, earthquakes, tsunamis, terrorist attacks, are complex and diverse in origin as they are in effect. The energy sector dominates the UAE economy, especially in terms of its production and supply, and holds a very important global position in the world's economy. The protection of these systems and assets and within the energy sector especially, the safeguarding of oil and gas infrastructure from any natural or man-made hazards should become the top priority of the UAE (Ebinger et al., 2014). Recent developments in the UAE have progressed toward the concept of disaster resilience. However, preparations for any impending disaster have been slow and, due to the country's recent legal establishment as a nation, disaster preparation has featured on the national agenda only very recently. In light of the new nuclear development at Braga and other expansions in the UAE energy sector, it is important to understand the vulnerabilities of the sector as a means of preparedness for future natural or man-made hazards (Saleh et al., 2015). Therefore, this study explores the impact that geoformation has on tacking natural disasters in UAE.

The objective of this article is to suggest based on literature the disaster aspect, geoformation and its value of implementation, as well as the conceptual model in assessing disaster management performance. This is useful in formulating the action plan, strategies and identifies fields of focus in improving the disaster management practices in UAE. This article starts with an introduction to the need to improve disaster management in UAE. The second section explains the general review of disaster management and geographic information system this was followed by the discussion of the methods employed in this study and the proposed conceptual model. Finally, the conclusion and suggestions for future research are disclosed in the last section.

2.0 DISASTER MANAGEMENT

The Emirates and its archipelago that extends over the Arabian Gulf cover 83,600 sq km. The Emirati coastline extends for approximately 700km. The country shares land borders with Qatar to the west, Saudi Arabia to the south and west, and Oman to the east and south. Four-fifths of the UAE's landmass is desert. The littoral zone of the UAE is characterized by active coastal sabkhas, a phonetic translation of the Arabic word for a salt flat (Doherty et al, 2009). In 1980 the total population was 1 million. It increased to 8.4 million only 30 years later. By 2050 the UN expects this figure to reach 15.5 million

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(Pathirage & Al-Khaili, 2016). The overwhelming majority of the population lives in urban areas in coastal zones, which are also prone to several natural and manmade hazards.

Even before the coronavirus pandemic, the Council ranked the digital/tech sector as the most important business first mover in 2020 followed by acquiring the talent needed to enable technology transformation. But COVID-19 has elevated digital initiatives to digital demands, immediately prompting HR managers to work with CEOs to rethink capability needs as business models rapidly shift. The pandemic proved what many people knew before. Traditional work techniques are outdated (Engler, 2020).

Globalization requires favourable conditions a relatively free and non-discriminatory trade environment, low tariffs, efficient market processes, support institutions, and a relatively stable operating environment, at least one characterized by manageable risks rather than disruptive uncertainties environment. In addition, the recent wave of globalization requires efficient physical and digital infrastructure and sophisticated technologies to coordinate complex global supply chains and exploit opportunities for locational advantage. Any of these changes would alter the attractiveness of a global business strategy. The weakening of policy factors has become apparent in recent years. There are many conflicting arguments surrounding the root cause of these shifts in the U.S. focus on military primacy (Wertheim, 2020).

The truth is, COVID isn't telling us anything new about crisis management. Rather, it is a stark enlightener of known fission points in preparation and leadership. Successful crisis management is all about getting the right people into the right spaces so that the right decisions can be made to achieve unified strategic goals. This statement applies to organizations and countries and should be the ultimate goal of leaders facing a crisis. If we apply these lessons to our management techniques, we'll emerge stronger from this crisis it doesn't matter what the next crisis brings. Crisis management research is conducted before, during, and after a crisis. (Morris, 2020).

Possible since the beginning of the COVID-19 crisis, such as evolving health or digital work solutions. Its start-ups have weathered the crisis better than any other economic leader. Many entrepreneurs use the Bricoleur persona as they try to drive change and create opportunities with the support available. Bricoleurs demonstrated that crises can foster the development of new modifications and alternative products and services (Brem, 2020).

The UAE economy is dominated by the energy industry, particularly in terms of demand and distribution, and it occupies a critical global role in the global economy. The UAE’s prime concern ought to be the preservation of such infrastructure components, particularly in the energy industry, the shielding of oil and gas infrastructure from environmental and man-made risks (Copping et al., 2021). In the United Arab Emirates, recent advancements have evolved toward the paradigm of emergency preparedness. Nonetheless, preparedness for any coming disaster has indeed been delayed, and disaster preparedness has only lately been placed in the national conversation, owing to the state's recent legal creation as a sovereign. In anticipation of the recent nuclear power

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plant at Braga and other additions in the UAE's power sector, it's essential to comprehend the industry's vulnerability as a way of preparing for potential natural or man-made disasters (Alteneiji et al., 2020). As a result, the purpose of this study is to investigate the role of geoformation in dealing with natural disasters in the United Arab Emirates.

GEOGRAPHIC INFORMATION SYSTEMS: AN OVERVIEW

Although the United Nations designated the 1990s as the International Decade for Natural Disaster Reduction (IDNDR), there was a global failure to reduce natural disaster impacts during that time (Chou, & Liu, 2010). Ultimately contributing to this trend are environmental degradation, rapid urbanization, and social marginalization (Newbutt, & Yuill, 2016), particularly in developing countries. The increasing number of disasters suggests that vulnerability to natural hazards is also rising and so equates to changing the geography of risk. By way of elaboration, more people are living in low-lying coastal zones, seismically hazardous areas, and concentrated urban environments (Graber, & Dunaway, 2017). Vulnerable populations will be at increased risk, for example, as the geography and magnitude of hydro-meteorological hazards that are historically associated with some of the greatest disasters change with global climate (Erdelj et al., 2017).

Defining the geography of risk is of major concern in general and in particular in developing countries, where disasters jeopardize important social development goals such as addressing poverty, ensuring adequate food, water, and sanitation, and protecting the environment, (Oloruntoba et al., 2018). Because natural disasters have the greatest overall impact in developing countries (Oloruntoba et al., 2018), this is where geospatial information technologies (GIT) have the greatest potential to mitigate causalities. The purpose of this research is to examine the use of GIT for natural disaster management in the UAE, with an emphasis on how these technologies can be effectively utilized. Although natural disasters cannot entirely be prevented, disaster losses (including human, environmental, and infrastructure/personal property) can be minimized with effective disaster management in the process of mitigation, preparation, response, and recovery (Haworth et al., 2015).

The field of disaster management has greatly benefited from recent advancements in computers and related information technologies (Carley et al., 2016). Geospatial information technologies (GIT), including geographic information systems (GIS), remote sensing (RS), global positioning systems (GPS), and Internet GIS (IGIS) is currently being employed in a variety of ways to support all phases of disaster management. Since each phase is geographically related to where people, places, and things are spatially located (De Albuquerque et al., 2015), the entire disaster management process can be significantly enhanced through the effective use of GIT. Even though the natural processes (e.g., floods, earthquakes, landslides, etc.) that generate disasters might be fundamentally different, the techniques to assess and mitigate risk, evaluate preparedness, and assist response have much in common and can share and benefit

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from advances in geographic information science data acquisition and integration; issues of data ownership, access, and liability; and interoperability (Drexl, & Wiedemann et al., 2016). It is proposed that currently available free and open-source software (FOSS) can fulfil many GIT requirements needed to improve disaster management capacity at the local level. While FOSS can create additional challenges compared to commercial solutions (Camara&Onsrud, 2004), with a clear understanding of the barriers and benefits of FOSS from a developing world perspective, FOSS is a capable and effective alternative (Huang et al., 2015).

Simply put, natural hazards are unpredictable acts of nature, characterized by extremes in physical processes (Carley et al., 2016). Examples of natural hazards include earthquakes, tsunamis, hurricanes, typhoons, droughts, wildfires, tropical storms, and floods. The fundamental determinants of natural hazards are location, timing, magnitude, and frequency. The spatial scale and duration of natural hazards can vary greatly, which is important from a GIT perspective, and in particular from the perspective of data requirements. Landslides, for example, have a local impact, whereas major floods can affect a large region. Earthquakes occur with little warning and last only a few seconds to minutes, while drought may build up over months over large regions and last even longer. Thus, a distinction can be made between 'rapid-onset' natural hazards such as floods and earthquakes, or slower 'creeping crises' hazards like drought or disease (Akgün et al., 2015). However, slowly developing hazards have more in common with natural resource management, at least from a mitigation perspective.

Monllor, & Murphy, (2017) describes natural disasters as the disruptive and/or deadly and destructive outcome of triggering agents when they interact with and are exacerbated by, various forms of vulnerability. Simply put, when a hazard intersects the zone of human use there is a risk of disaster. The number of people affected by disasters resulting from natural hazard events of rapid-onset is increasing (Erdelj et al., 2016). In particular, hydro meteorological-related natural disasters (e.g., floods, landslides/avalanches, forest/ scrub fires, wind storms, and waves/surges) have more than doubled since 1996 and caused over 90 percent of deaths from natural disasters during the 1990s.

Large-scale disasters represent a complex and multidisciplinary problem for local disaster managers and related organizations, as well as international humanitarian/aid organizations (Frennesson et al., 2020). While many natural disasters are characterized by short reaction/response times, overwhelming damage to property and infrastructure, and a strain on the resources of the affected community, those less frequent large-scale natural disasters are much deadlier. Among the largest-scale globally predominant natural disasters with 50,000 victims or more, three hazard types can be singled out: earthquakes, tropical cyclones (with coastal inundation), and river floods (Ikeda & Palakhamarn, 2020). These types of natural hazards have caused the worst calamities both in the 20th century and the entire history of humanity, namely: the 1970 flood and cyclone in Bangladesh (300,000 victims), the 1976 earthquake in China (242,000 victims), and the 1931 flood in China (140,000 victims). The 2004 earthquake that occurred off the coast of Sumatra, Indonesia, and the resulting tsunami that devastated many countries

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surrounding the Indian Ocean also ranks among the deadliest natural disasters in history, with 283,000 reported fatalities (Erdelj et al., 2016).

4. RESEARCH METHOD

This study starts by exploring the information from several articles published related to natural disaster management from 2010 to 2021 to achieve the objective of this study. Initially, the review process is focused on identifying the main issues of natural disaster management, the framework of the geoformation factors effects on natural disaster management in UAE, elements of working GIS integrates these five key components: hardware, software, data, people, and methods, the method of analysis, findings, and limitations in natural disaster management practice. Keywords such as 'natural disaster management', 'hardware, software, data, people, and methods, have been used for identifying and selecting the references on various databases such as Scopus, SciVerse Science Direct, Emerald, IEEE Explore, Google Scholar, and so on. All articles are then filtered and sorted by relevance to natural disaster management. For the development of the conceptual model, National Emergency Crisis and Disasters Management Authority (NCEMA) in UAE had involved verifying the relevancy of the GIS component in disaster management.

The followings explain the components of a geographic information system for conceptual model development:

4.1 Hardware

A GIS's hardware is the machine on which it runs. GIS is now available on a variety of hardware platforms, ranging from centralized data centers to independent or interconnected personal computers (Bowlick et al., 2018). GIS software consists of a variety of hardware types, ranging from centralized computer servers to personal PCs, and in freestanding or networked configurations. End-user equipment like graphical gadgets, subversives, and scanning is referred to as hardware. A variety of processors are used for data representation and management. Web servers are now an integral feature of many systems' architectures as a result of the rise of the Internet and Web-based applications; as a result, most GISs use a 3-tier structure. It is made up of the computer network that will execute the GIS software. The hardware systems available ranged from 300MHz desktop computers to TeraFLOPS Super Computers. The computers are the heart of the GIS hardware, receiving data from scanning or digitizing boards. A scanner translates a physical image into a digital image that can be processed further. The scanner's outputs can be saved in a variety of formats, including TIFF, BMP, and JPG. A digitizing board is a flat board that is used to vectorize a set of mapping components. The most typical output signals for a GIS hardware configuration are printers and conspirators (Bowlick et al., 2018). However, in Table 1, there are a few items adopted from the previous studies to measure the hardware.

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Table 1: Hardware measurement items

H1	The user currently using any Web GIS platforms to share geospatial data
H2	Users think it is useful for your organization to have a Web GIS platforms to share geospatial data
H3	Users think opportunities will arise from open source geospatial platform
H4	Users think challenges lie ahead for open source geospatial hardware
H5	User organization (or the members that you represent) plan to use and/or contribute to the development of open source geospatial hardware
H6	Hardware helps in capturing data on natural disaster
H7	It provides an opportunity to get more information about the occurrence of the disaster
H8	It gives more accurate data than other technologies when it comes to disaster management
H9	It provides information on the big data about natural disaster

4.2 Software

GIS application supports the capabilities and equipment needed for storing, analyzing, and displaying geographic data (Jiang et al., 2018). The following are important software packages:

- A database management system (DBMS)
- Tools for the input and manipulation of geographic information
- Tools that support geographic query, analysis, and visualization
- A graphical user interface (GUI) for easy access to tools

Software is also a very dynamic component of the system. There are now many GIS software suites available. These technologies are available from a variety of embedded systems and have a variety of useful possibilities. GIS software includes features and functions for storing, analyzing, and displaying geographic data. ArcGIS, MapInfo, Global Mapper, AutoCAD Map, and other GIS tools are used. The software on offer is categorized as application-specific. Mapinfo is the best choice for low-cost GIS work on desktop Global mapping. It's simple to use and has a lot of GIS features. ArcGIS is the ideal solution if the user intends to conduct intensive GIS analysis, comprising simulation and report preparation. AutoCAD Map is a wonderful alternative for AutoCAD users who want to branch out into GIS. However, in Table 2, there are a few items adopted from the previous studies to measure the software.

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Table 2: Software measurement items

S1	The organization provide a server room/ data center space to keep a new server
S2	Organizations provide Internet connectivity to a new server
S3	Users think the development and use of open source geospatial software will evolve over the next decade
S4	Users think opportunities will arise from open source geospatial software
S5	Users think challenges lie ahead for open source geospatial software
S6	Software help in tacking disaster in UAE
S7	User organizations provide a medium scale server to build a geo-portal
S8	The software provides information to evade disaster
S9	Available software in UAE will help tremendously in disaster management
S10	Software maintenance is paramount to disaster management
S11	Organization (or the members that you represent) plan to use and/or contribute to the development of open source geospatial software

4.3 People

Even without a manager in managing the system by making methods for deploying it to real-world situations, GIS technology is of insufficient use. Users of GIS range from technical experts who create and manage the platform to all of those who utilize it to assist them in their daily tasks. Users are the outcome essential for a genuine GIS. Any individuals who would use GIS to promote initiative or intended outcomes, or an organization at large that would use GIS in service of its mission statement, is referred to as a user (Li et al., 2018). The individuals who utilize a GIS are the ones who give it its true power. Computers have grown considerably easier and somewhat more economical for businesses, institutions, and organizations during the last years. People in a variety of fields are now using GIS as a skill to assist them to execute their work more efficiently. GIS is used by authorities to fight crime, and by emergency, 911 managers to dispatch emergency crews to a potential victim. GIS is used by biologists to safeguard plant and animal species, and instructors use it to educate geographies, literature, and technological subjects. The range of GIS users in the twenty-first millennium is endless. The client is essential to a good GIS, regardless of the program. GIS programmers are frequently portrayed as persons who work with computers daily. Although this is partially true, a broader range of GIS users is frequently selected. Users are divided into three classes according to one classification method (USGS, 1988): System users; End Users;

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and Data Generators. However, in Table 3, there are a few items adopted from the previous studies to measure the people.

Table 3: People measurement items

P1	Networks contribute to the generation of shared awareness by enabling richness to be shared
P2	The Regional Operational Team consists of well-trained and skilled professionals
P3	People had not worked with the disaster forecast application before or had only had limited training
P4	The quality of communication has improved considerably as a result of the implementation of the disaster forecast application.
P5	Multi-disciplinary teams that collaborate on solving societal challenges require a common understanding of geospatial data
P6	Data and messages are exchanged between clients and services
P7	People perform tasks efficiently for disaster management
P8	People provide information about natural disaster
P9	People overcome obstacles when disaster strikes

4.4 Methods

An effective GIS follows a good vision and strategic principles, which are the patterns and operational processes that are specific to each company. Geographic Information System (GIS) - A system that allows users to share information in a structured way (Chu et al., 2018).

- Measure aspects of geographic phenomena and processes.
- To emphasize geographical patterns, organizations, and interactions, express these observations in the shape of a searchable database.
- By combining various sources, use these visualizations to generate more measures and identify new patterns.
- Transform such descriptions to fit into the various entity and link paradigms.

Such behaviors are reflective of the bigger framework (Institutions and Societies) where these individuals operate. GIS is a computer software program for organizing data with a spatial component. Its ability to incorporate principles and techniques from a wide variety of topics, including mapping, geographies, mapping, analytics, operational methodological approaches, and computation arithmetic, makes it a powerful platform for working with spatial datasets. This provides a unified evaluation by establishing a one-to-

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one relationship among geographic and non-spatial elements. The photogrammetry might be in the form of diagrams, aerial photographs, satellite pictures, planes table inspected graphs, and GPS-generated observations, all of which are effectively mapping databases. The non-spatial or characteristic statistics might be in the combination of language, figures, and symbols gathered from authorities such as censuses, supplementary investigations, and other resources.

A good GIS follows a well-designed roadmap along with business logic, which are the principles and operational processes that are specific to each corporation. For the construction of maps and their subsequent use in any enterprise, a variety of strategies are employed. The maps could be created to use an automatic pixel to the graphic converter or individually vectorised utilizing imported pictures. These computerized maps were created using either surveyed company maps or satellite images (Chu et al., 2018). Lastly, few studies use items to measure the methods, and Table 4 showed those items.

Table 4: Methods of measurement items

M1	The method is paramount in working with disaster management gadgets
M2	The method serves as a procedure for tackling disaster
M3	Do you think the method used for open geospatial data will evolve over the next decade
M4	The platform flexibility allows organizations to choose the best implementation method for them
M5	The implementation method an organization should use should be based completely on which one works best with its needs and existing IT infrastructure
M6	The method gives staff more understanding of solving disaster management
M7	The method gives staff the idea to manage more resources than in disaster management
M8	The method gives staff idea to use new tools in disaster management

4.5 Data

The information is maybe the most significant aspect of a GIS. Geospatial data works together to achieve information that can be analyzed in-house or bought from an infomercial network operator. A GIS will incorporate geographic information with some other information systems and could even manage geographic information using a database management system (DBMS), which is used by most organizations to integrate and coordinate their information. Vector and raster datasets are the two primary types of geospatial data (Goldthorpe et al., 2018).

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In GIS, vector data/layers are distinctive structures described by endpoints, arrows, and polygons. Lines are created by joining two or more points together, and polygonal is a private area of Lines. Geometries with a shared set of properties are represented as layers. The topological of entities inside a stratum is bilateral. Digitalized maps, attributes collected from picture inspections, and several other vector resources can be found.

Raster data is a two-dimensional continual matrix of pixels or the three-dimensional counterpart of hexagonal cell lines. Continuous and categorical raster data are theoretically separated. Every cell value in a categorized raster is associated with a classification in a different table. Instances Types of soil and vegetation Land appropriateness, for example. Continuous raster pictures, like the Digital Elevation Model, are used to depict continual occurrences in place, with each pixel representing an elevations measurement.

A GIS's data is among the most significant, and quite often very costly, aspects. In a GIS, all data is either geographic data or analytical. The location of anything is determined by geographical analysis. Attribute data describes what happens; it describes the nature or qualities of geographic data. A process known as digitizing is used to enter geospatial information, which is made up of geographical data and their associated attribute values, into a GIS. This procedure entails electronically capturing topographical elements like structures, highways, and district lines. Tracing the position, direction, or border of geospatial data on a computer monitor with scanning maps in the backdrop, or on a detailed map coupled with digitizing tablets, is the process of digitizing. Whether digitizing massive data like soil basins, torrents, or topography contouring, the procedure can be arduous and time-consuming.

Any data with a definite link to space, comprising information regarding objects and people which exist in nature, is the material that a GIS works with. Hard-copy data, such as classic topographical maps, contractor records, demographic data, topographical assessments, and fieldwork summaries, were once part of this. With advancements in geographical data gathering, segmentation, and precision, a growing number of service digital processing at various scales are now obtainable (Jiang et al., 2018). However, preparations for any impending disaster have been slow and, due to the country's recent legal establishment as a nation, disaster preparation has featured on the national agenda only very recently. In light of the new nuclear development at Braga and other expansions in the UAE energy sector, it is important to understand the vulnerabilities of the sector as a means of preparedness for future natural or man-made hazards (Saleh et al., 2015). However, in Table 5, there are few items adopted from the previous studies to measure the data

Table 5: Data measurement items

D1	Organizations often do use geospatial data
D2	Organizations often do acquire for free or purchase spatial data
D3	Users think challenges lie ahead for open source geospatial data

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D4	Users think the production and use of open geospatial data will evolve over the next decade
D5	Organization (or the members that you represent) plan to use and/or contribute to the production of open geospatial data
D6	Data provide information on disaster occurrence
D7	Data helps in analyzing disasters for good management
D8	Accurate data helps in forecasting disaster and lead to disaster management
D9	Data serves as the main source for disaster forecasting leading to disaster management

5. CONCEPTUAL STRUCTURAL MODEL

The fundamental objective of this study is to determine and establish the effects of geoformation on natural disaster management in the UAE. Figure 1 shows the GIS conceptual structural model for disaster management. It can be seen from Figure 1 that disaster management can be affected by two main factors: hard factor and soft factor. The hard factor represents hardware, software, and data while the soft factor refers to people (user) and method. The preceding literature review helped in the development of the conceptual model of this research work is also explained in earlier topics. The conceptual model developed was generated through theories and the literature review was based on PLS-SEM analysis, introducing variables and elements that have not been used in a study like this. Based on these grounds and agreed by NCEMA representatives, the relationship between the variables of the study is predicted to be positive.

There five hypotheses will be measured to validate the conceptual model in the future study as follows:

H_h: There is a positive relationship between Hardware and disaster management

H_s: There is a positive relationship between Software and disaster management

H_d: There is a positive relationship between Data and disaster management

H_p: There is a positive relationship between People and disaster management

H_m: There is a positive relationship between methods and disaster management

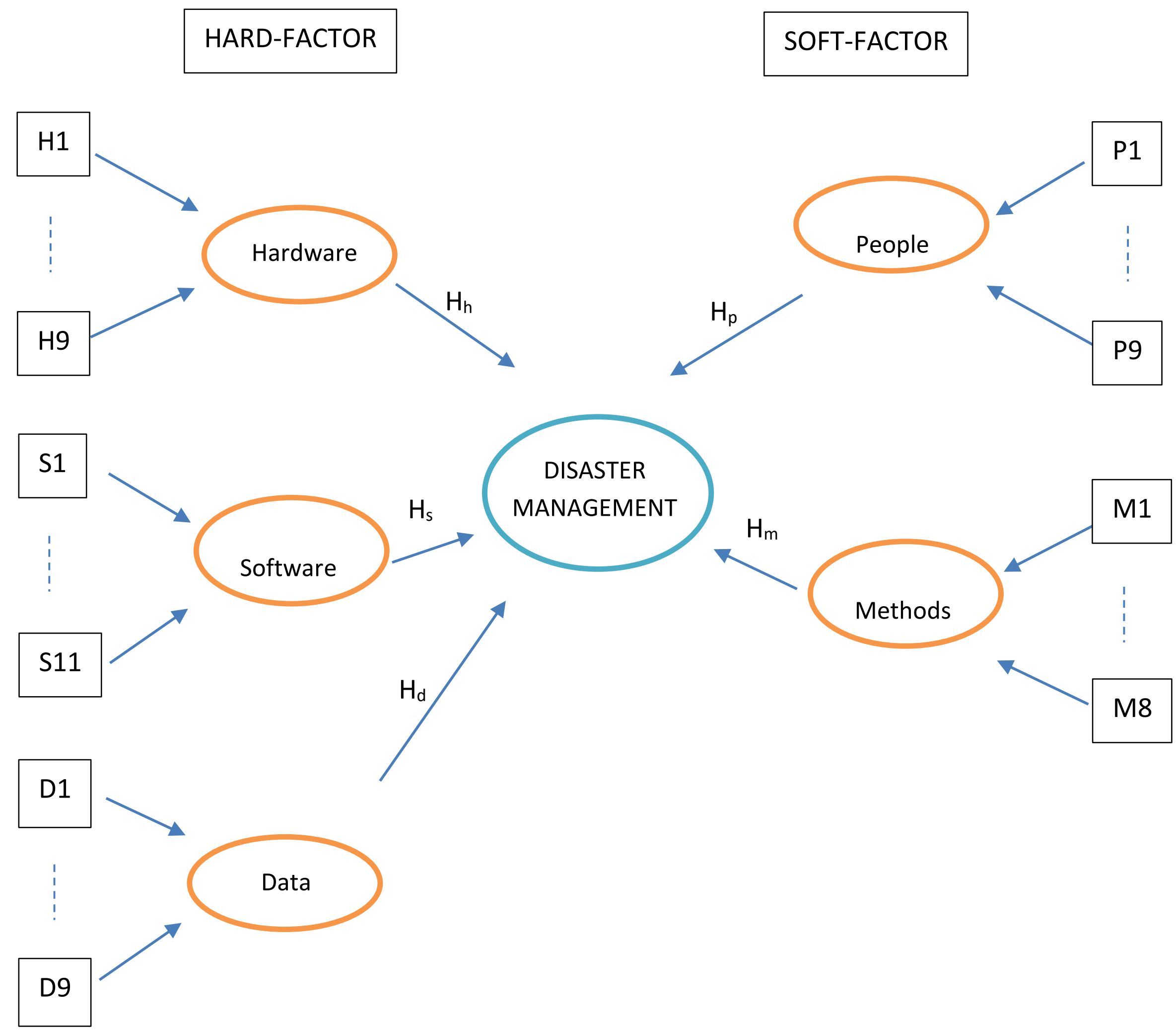

Figure 1: GIS conceptual structural model for disaster management

6 CONCLUSION AND FUTURE STUDY

The purpose of this study is to identify the potential effects of the implementation of GIS on disaster management in the UAE. Although the initial results indicate that both hard factor and soft factors adoption of GIS has a significant positive effect in improving the performance of disaster management (claimed by NCEMA), but there is no specific structural relationship study has been performed. Thus, the conceptual model is reliable to conduct and be tested in future studies using PLS-SEM. The future study can test all the hypotheses and identify which elements in the model are significant. In addition, nine elements for hardware, 11 for software, nine for data, nine for people, and eight for methods (in total is equal to 46 items) were considered as a comprehensive study of GIS implementation in disaster management.

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