APPLICATION OF GEOGRAPHICAL INFORMATION SYSTEMS IN DECISION MAKING OF IT INFRASTRUCTURE SUPPLY COMPANIES IN UGANDA

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Abstract

Ever growing technology has resulted into development of many powerful tools that ease the day to running of businesses both small and multipurpose ones. GIS one of most powerful tools handles a variety of operations in businesses that guide in effective decision making processes. This papers explored applications of GIS in decision making of information technology (IT) infrastructure supply companies. a proposed flow chart illustrating all necessary stages in data collection, processing and management towards making relevant business decisions has been developed and examples of GIS applications in line with business decision making have been cited, followed by the general conclusions.

Key words: GIS, Decision Making, IT Infrastructure, Supply Companies

Introduction

Effective running of any company to achieve its strategic goals and move towards its vision is based on major operations of data/information collection, management and analysis to obtain the guiding procedures to be undertaken while making final decisions towards achieving the expected outputs. Companies have to plan and manage their infrastructure needs to gain the greatest returns on their IS investments (pearson, 2016).

For a supply company to sustain its operations while achieving its targeted objectives, it should be in position to effectively satisfy the needs of its customers and attract larger market. It is of great important for a supply company to obtain relevant information from both its suppliers and customers and ensure effective handling and analysis for making best decisions necessary for its sustainable development and standing at above its competitors.

Improved techniques for advanced and faster handling of both customers' and suppliers' information play a great role towards effective and efficient decisions of handling complex activities and achieving results within the targeted work plan.

This paper intends to explore all applications of Geographical Information System that guide decision making for different operations involved in IT hardware and software supply companies in Uganda.

Companies dealing with supplying Information Technology infrastructure to other organizations, business and individuals, undergo a number of critical procedures to ensure providing their customers with best quality services and products within the shortest time possible. Additional dimensions like assessment of market location and size, tracing of competent suppliers, verifying the functionality of infrastructure among others, explain the operational complexity within the supply companies dealing in IT related supplies. Geographical information system (GIS) is a potential means of dealing with this complexity (Sonti SH, 2015) thus making decision making for supply businesses reliable, faster and perfect.

The ability to interpret geographic data and make decisions based on geographic information is essential for business decision makers (Michael A. Erskine, 2013**).** Geographical Information Systems (GIS) has potential to effectively collect/abstract, manage and analyze data and information, track the locations of best supplies and large market positions which gives the best guidelines for company managers and directors while making decisions for running the business.

With geographical information systems, companies are able to operate with minimal time usage, money and human resources while improving service delivery and meeting the expectations of their clients. The use of Geographical Information Systems (GIS) has flooded almost every field in the engineering, natural and social sciences, offering accurate, efficient, reproducible methods for collecting, viewing and analyzing spatial data (Sonti SH, 2015)

Approximately over 75 percent of all business data contains geographic information and 80 percent of all business decisions involve geographic data, Mennecke, B.E (as cited in Michael A. Erskine, etal 2013). The ability to interpret geographic data and make decisions based on geographic information is essential for business decision makers (Michael A. Erskine, etal 2013). This because Geographical Information Systems (GIS) are important to get, combine, analyze and transfer the spatial data (Gürder, 2012)

IT Infrastructure

IT infrastructure is a combined set of hardware, software, networks, facilities, etc. (including all of the information technology related equipment), used to develop, test, deliver, monitor, control or support IT services. Associated people, processes and documentation are not part of IT Infrastructure (Joe Roush, 2017)

The components of IT infrastructure consists of but not limited to;

- Hardware: Servers, computers, data centers, switches, hubs and routers, etc.
- Software: Enterprise resource planning (ERP), customer relationship management (CRM), productivity applications and more

- Network: Network enablement, internet connectivity, firewall and security
- Meatware: Human users, such as network administrators (NA), developers, designers and generic end users with access to any IT appliance or service are also part of an IT infrastructure, specifically with the advent of user-centric IT service development.

GIS is an information system consisting of four equally weighted components which are hardware, software, attribute data, and spatial data that digitally collect, organize, analyze, and visually presented spatial data as illustrated below (Gürder,2011(cited by Gürder, 2012)).
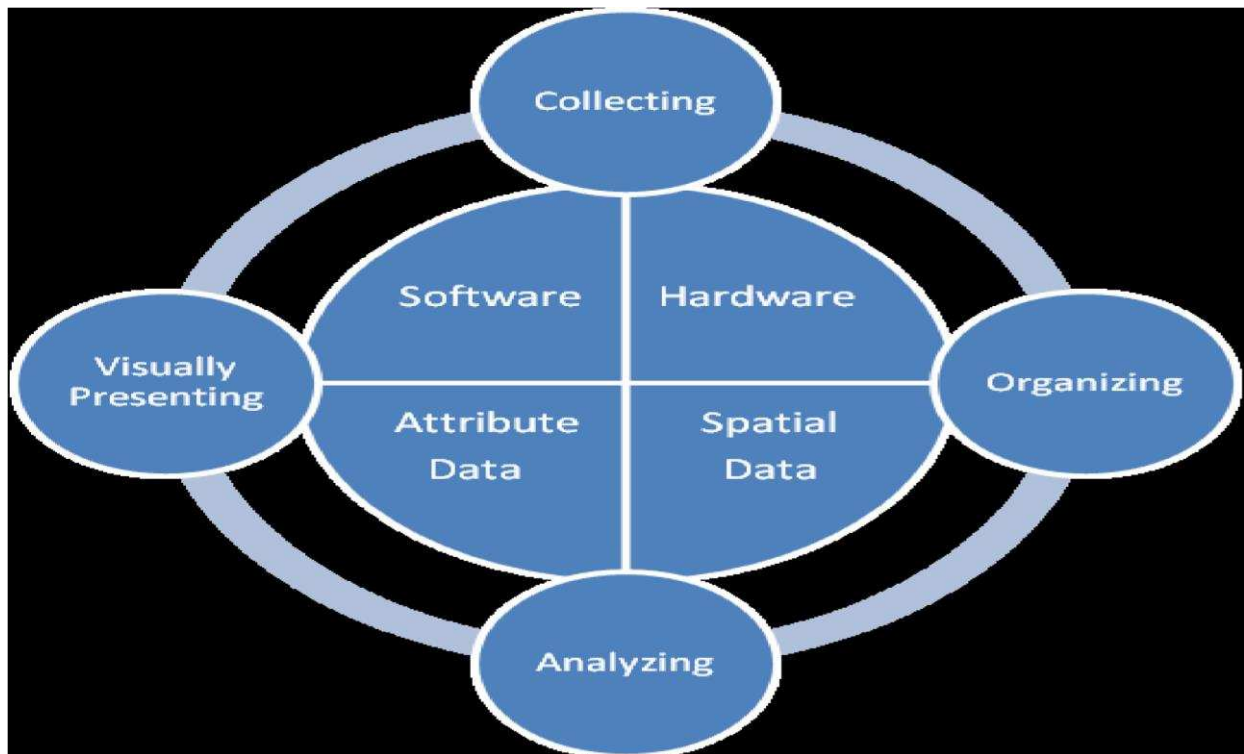
Figure 1

IT infrastructure plays a vital role in running a number of technology operations in almost all organizations to achieved improved working capacity. The practice of IT service management (ITSM) is widely adopted by IT infrastructure and operations (I&O) organizations around the globe to help deliver technology services better, faster, and cheaper (Stephen Mann, etal, 2013)

Decision Making

Managers and executives in companies that supply IT infrastructure, need decision support systems to enable them clearly understand the all the operational processes under which IT infrastructure go through from the manufactures through the warehouses and finally to the last user. These systems also enable the companies' decision makers (managers and executives) to identify and fill the existing gaps within the companies' processes. Decision support systems are also important in predicting the future market trends, operational costs and quality stands for the supplies.

In the current world, GIS is being incorporated with decision support systems to enhance communication texts and tables by the visual presentation of data and information, thereby

ensuring that accurate results are obtained quickly, which in turn leads to better and more informed decisions (Tarik Turk etal, 2014).

The spatial decision support system (SDSS) which contains three main parts i.e. Geographic Information System (GIS) and Remote Sensing (RS), Decision Support System (DSS) Models, Expert System (ES) and Artificial Intelligence(Christina Albert Rayed, 2012) can be used by decision makers to make critical decisions that are relevant and beneficial to the supply companies especially those specializing in IT infrastructure because IT infrastructure components are mainly technology- based, be it in manufacturing, transporting, handling, monitoring and utilization which can be effectively managed with application of Geographic Information Systems. An example of a model used in business for GIS-based decision making is shown in the figure below;
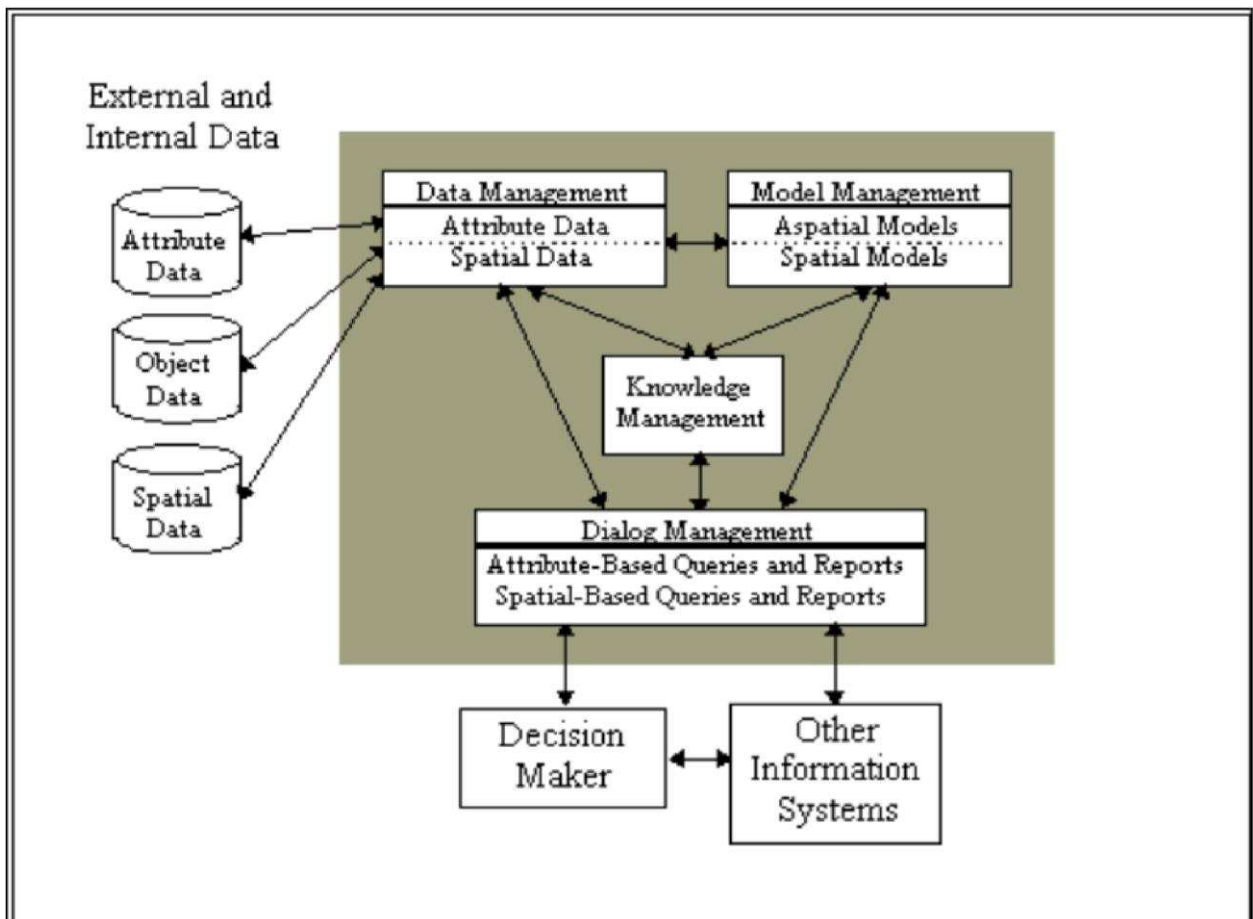

Figure 2: A conceptual model of a geographic information system used for decision support: source mennecke cited by Lotfy Azaz, (2011)

Geographical Information Systems (GIS)

Geographic Information System (**GIS**) is a system designed to capture, store, manipulate, analyze, manage, and present geographical data. (Luqman, etal 2015) defined GIS as an information system or technology which has strong capability to maintain and analyze geographic or spatial data. GIS is a system which consists of hardware, software, data and People capable to capture, store, update, manipulate, analyze and display spatial data (ESRI, Luqman, etal, 2015). GIS is an integrated collection of computer software and data used to view and manage information about geographic places, analyze spatial relationships, and model spatial (Ahmed Adel Ismael etal, 2014)

The ability of a GIS to aggregate and easily display layered themes of data on maps can greatly enhance constituent access and streamline operations by avoiding requests for printed map production (Tae Hwan Oh, Young B. Choiand Rajath Chouta, 2012). The strength of GIS lies in its ability to show relationships and patterns in data and in revealing previously uncovered trends (Dr. Stephen McElroy and Steven Owlett, 2012). GIS enables organizations to make better decisions that align with and support the strategic mission of the organization and work to find an effective balance among the competing constraints of benefits, risk and resources. (Matthew Lewin, 2017) .Below is a GIS

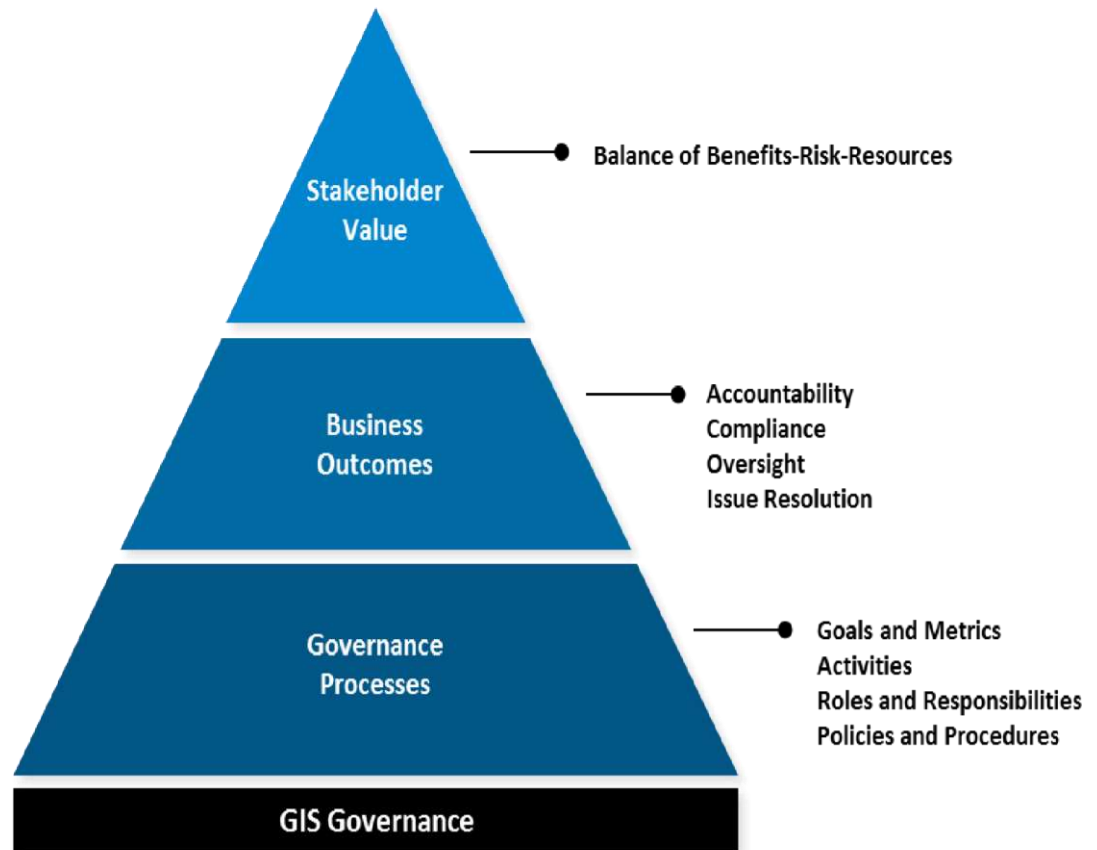Governance Value Pyramid for business risk management

Figure 3: Exhibit *- GIS Governance Value Pyramid. Source: Matthew Lewin, 2017*

(Xia, J. cited by Tarik Turk etal, 2014) listed advantages of GIS to a business as below;

- *GIS can categorize and place objects into individual themes and thus has the ability to treat these objects differently,*

- *GIS has the ability to perform spatial analysis,*

- *GIS has the ability to store data related to the visual presentation over the spatial database,*

- *GIS can be implemented online, thus control of the system can be easy and remotely conducted,*

- *The cost of the implementation of a GIS is considerably low.*

GIS Applications

Application of GIS is increasing day by day due to its predictive models which are providing functions for the data storage, manipulation, calculation, analysis and output processing (Tsanis, I.K. and Boyle, S cited by Luqman, M., Ahmad, 2015).

GIS is a solution that harnesses the power of geography to help organizations overcome their operational challenges and deliver improved profitability (Esri, 2012). GIS eases the process of decision making by enabling policy makers take fast and efficient decisions related to services and products selection, allocation and planning at the same time sufficiently manage any risk that may arise in business processes. Below is the illustration of change and risk management model. GIS is a critical tool that manages massive amounts of location-based data to produce information that helps executives to make better choices (Dr.StephenMcElroy and Steven Owlett, 2012)
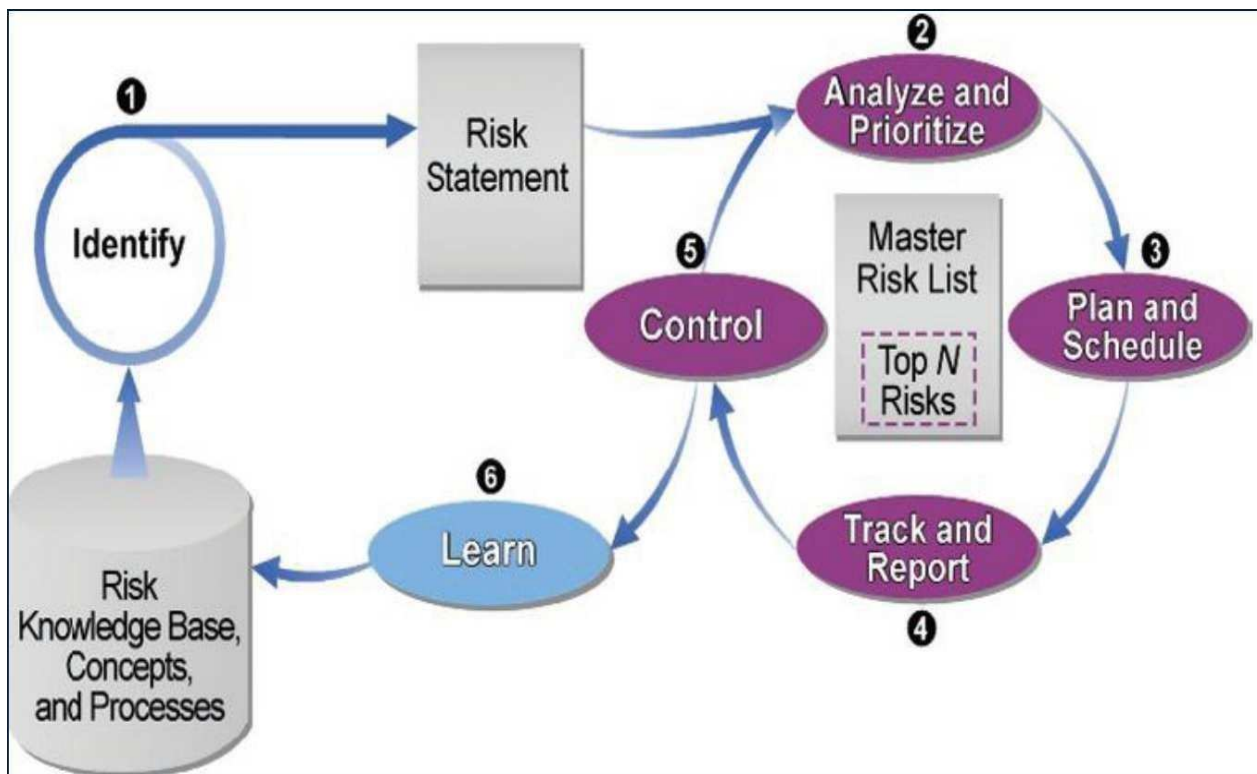
Figure 4:

GIS provides a supply company to with better flexibility for choosing the products and service according to the capital investment it can afford. It can also be used by the company for visually locating and mapping critical infrastructure (Tae Hwan Oh, Young B. Choiand Rajath Chouta, 2012) in that they are easily and clearly accessed by its customers

With help of GIS, a supply company for IT infrastructure can be able to determine density of hardware infrastructure, capacity and cost of available transport means from the suppliers to the business location. The costs of products are understood prior to transportation/ shipping from the manufacturer which enables company managers and executives to decide early enough on preferable prices to be set for their goods and services once they reach the warehouses which saves many companies from incurring unpreparedness losses.

GIS software guarantees the supply company the ability to handle large volume of spatial and non-spatial data (Aurora, Colo. 2012). This is very important in rendering effective

Source: Morgan Stanley, 2012 service delivery where variety of items are being handled concurrently with a large number of customers. IT infrastructure Supply Companies can be able to effectively handle a number of orders at the same time ensuring customer satisfaction.

Transportation and logistics can be properly planned and managed using the technology of geographic information systems (GIS). GIS helps transportation professionals to be cost-effective in managing physical assets and human resources, in the office and the field. (Esri, 2012). Therefore IT infrastructure to be transported either from suppliers or to be delivered to final customers can be properly planned prior to their movements to ensure safety and time management by the help of GIS software that calculate length of distance to be covered, identify airport or railway locations, determine the departure time, routes with favorable weather and all the accompanying costs. The IT infrastructure for the companies are tracked right away from the manufacturers to the warehouses and finally to the consumers in a standardized manner using GIS software.

GIS is also used to identify the best evacuation routes based on population, traffic patterns and road capacities (Tae Hwan Oh, Young B. Choiand Rajath Chouta, 2012) By utilizing GPS-enabled smartphones to track transportation routing and scheduling, and using high-resolution cameras to upload photos of road hazards in real-time, GIS technology provides company executives, dispatchers and customer service representatives with access to the most up-to-date information in user-friendly formats to ensure operations run smoothly (Aurora, Colo.2012). GIS uses GPS technology for location purposes and adds data in a

way that allows the user to make intelligent strategic and tactical decisions (SupplyChainBrain, 2014).

GIS helps companies Improve profitability and operational performance by sharing knowledge-based decision making across departments and increase market understanding based on a single, common view of business performance using geo extended workflow and business processes (Esri, 2012). IT infrastructure supply companies can be able to use GIS to monitor and control the operational performance of all their departments by developing a system under which all their information is shared and updated as well as accessing and analyzing information about their customers and suppliers, which is relevant for the achievement of their objectives.

With GIS, supply companies are able to attract and retain customers by fully capturing relevant data on them thereby understanding their location, tastes and preferences, purchasing power and favourable periods for high consumption. GIS can therefore help these companies to project the future market size of their products and services basing on the existing information hence the companies can be able to determine whether the business is steadily progressing or more efforts are needed to accelerate the business on the right track. Companies can also use Geographical Information Systems (GIS) techniques to construct a distribution network and appropriate placement of their warehouses within clusters of customers (Aurora, Colo.2012) as the one of the techniques towards achieving their goals as illustrated in the diagram below.

Figure 5: Source: Tae Hwan Oh, Young B. Choiand Rajath Chouta, 2012

By integrating data from geospatial content such as maps, images, applications and other geographic information commonly used for planning, deploying, operating and optimizing transportation and logistical systems (Aurora, Colo. 2012), GIS enables companies decision makers to take effective decisions that are beneficial and favourable to all sides i.e. the companies stakeholders and their clients as well.

ArcGIS one of GIS software has capacity to process raw data to be used for location and route analysis through a company's supply chain (Techane Bosona, etal, 2013). The brief description of approach used for location and route analyses is illustrated below
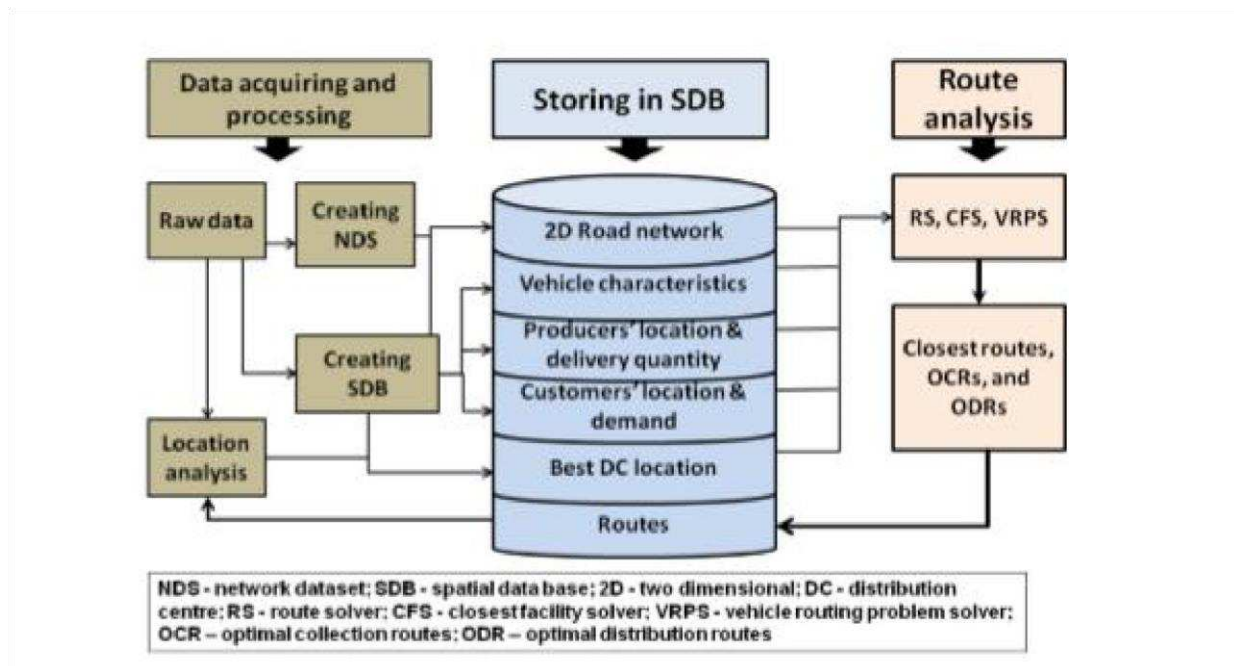
Figure 6: Source: ESRI (cited by Techane Bosona etal, 2013)

The main applications of GIS in a business include but not limited to: spatial data collection and automated mapping, facility management, market analysis, transportation, logistics, strategic planning, decision-making, design and engineering (Mennecke, cited by Lotfy, 2011) as illustrated below
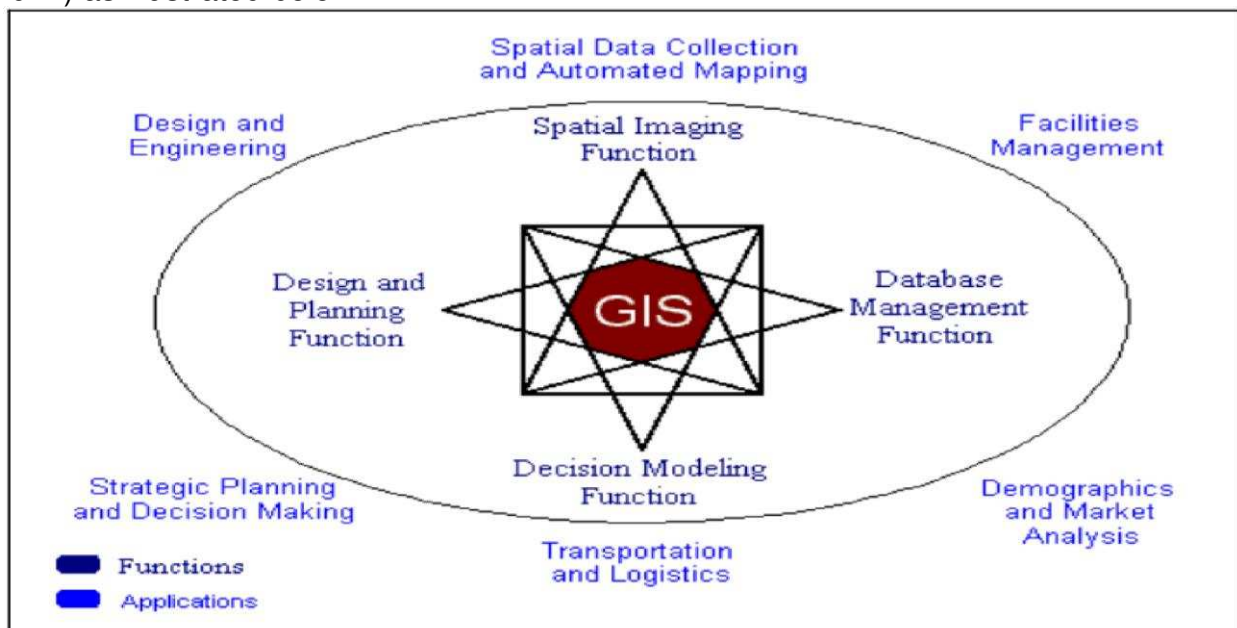

Figure 7: Functions and applications of GIS in a business. *Source (*Mennecke, cited by Lotfy, 2011)

GIS- based data processing for decision making

The first and most important step in data processing using GIS is data capturing which is sensitive and time consuming process that determines the quality of the final outputs from the data. The captured data undergoes a processing stage of analysis to achieve quality assurance in relation to the intended objectives. It is very important that the GIS analyst has a clear idea of what the project intends to analyze, because depending on the purpose of the study, one system or another could be the most appropriate at that moment (Manuel S. Pascual, 2012). GIS provides sophisticated analysis tools to provide timely information to managers and analysts, and really comes into its own when used to analyze geographic data to look for patterns and trends and to undertake "what if" scenarios (Ahmed Adel Ismael, 2014).

GIS eases the processes in which data undergoes right away from collection stage up to the final output in fast and more effective manner which as well eases decision making process.

Below is a proposed flow chart illustrating data collection, processing and management towards making relevant business decisions.
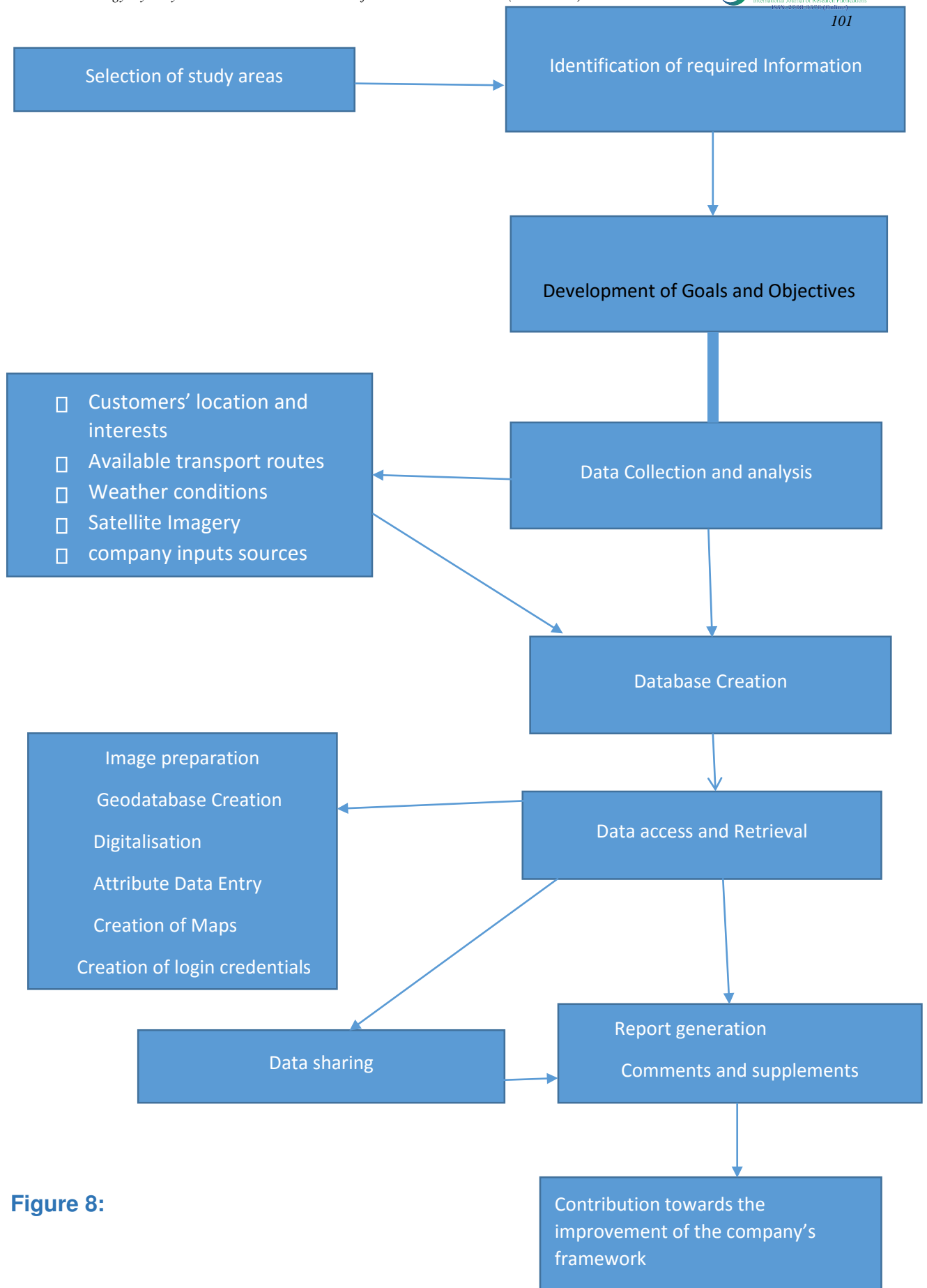
Selection of study areas	→	Identification of required Information

Development of Goals and Objectives

- Customers' location and interests
- Available transport routes
- Weather conditions
- Satellite Imagery
- company inputs sources

Data Collection and analysis

Database Creation

Image preparation

Geodatabase Creation

Digitalisation

Attribute Data Entry

Creation of Maps

Creation of login credentials

Data access and Retrieval

Data sharing

Report generation

Comments and supplements

Contribution towards the improvement of the company's framework

Figure 8:

Conclusion

With today's rapid growing technology, investing in GIS will make enterprises more powerful and beneficial to the world at large. GIS is a comprehensive technology with advanced capacity to handle decision making in multipurpose businesses in most effective manner. IT infrastructure being technology-based, businesses specializing in their supply, are capable of attaining their goals in fast and ease way by the help of GIS in all the involved operations i.e. allocation of raw materials suppliers, potential customers, expansion of markets, transportation, quality control, future prediction among others.

GIS technology is the most reliable tool that performs business operations effectively with improved communication and understanding among stakeholders and their clients. GIS helps users visualize, manage, and analyze any business asset from employees, customers, and facilities all the way to the supply chain network (Aurora, Colo. 2012). The effective performance of GIS to produce expected results is supported by availability of good quality data to the system users.

Therefore Business decision makers (managers and executives) should appreciate the benefits rendered by geographic information systems and fully utilize it, so as to advance the performance of their companies and ensure their sustainability

Effective utilization of Geographic Information Systems techniques in a supply companies, eases decision making and produces results that are more reliable and favorable to both stakeholders and clients in a cost effective manner.

Decision support systems to enable decision makers make effective decisions are essential for the smooth running of supply companies especially the ones supplying IT infrastructure since they have capacity to present complex and sensitive operations in a simplified form. The systems also enable decision makers to carry out quality monitoring and assurance towards achieving their clients' satisfaction.

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