ISBN: 978-81-968830-3-4

3. Planning, Implementation and Management of GIS

Deepali Vishwakarma

Research Scholar,
Department of Entomology,
RVSKVV,
Gwalior, M.P.

Dheerendra Mahor

Assistant Professor,
Department of Entomology,
B.M. College of Agriculture,
Khandawa, M.P.

Shraddha Tare

Research Scholar,
Department of Entomology,
JNKVV,
Jabalpur, M.P.

Abstract:

In recent years, geographic information systems (GISs) have received a lot of attention and use. The organizations, groups, and people who use the technology stand to gain a lot from it. The way the technology is used, though, will determine how effective it is.

The majority of effective GISs are put into place in accordance with a planned procedure that ensures the final output will satisfy the demands of the users. It consists of five fundamental phases: planning, requirements analysis, design, acquisition and development, and operation and maintenance. It is a typical IT implementation process that has been modified to the unique qualities and difficulties of GISs. The process defines, refines, and implements the GIS components incrementally, the procedure builds upon the outcome of each phase. The resultant GIS may take one of myriad shape, depending on the nature of the organization and the GIS project, and the organization's goals and needs.

The future prospects include the extensive usage of geospatial data and technology, as well as a combination of GIS and conventional technologies. GIS project managers are the people who manage a staff in geographic data analysis for a specific goal.

GIS project managers may become more integral and important to address the challenges of the projects. Project management like the knowledge application, skills, tools, and techniques to project activities in order to meet or exceed end user needs and expectations.

Keywords:

Geographic Information System (GIS), GIS Planning, GIS implementation, GIS management, geospatial information and technology.

3.1 Introduction:

A GIS is a potent tool for creating, managing, analyzing, and using geospatial data. As such, it may provide users with a number of benefits for improving operations, saving money and time, and facilitating decision making capabilities. GISs make it feasible to enable data analysis and manipulation that were previously impossible**.**

Geographical Information System (GIS) is a technique which allow the means to collect and use geographic data to help in the development and growth of Agriculture. A digital map is generally of much greater value than the same map printed on a paper as the digital version can be merged with other sources of data for information analysis with a graphical presentation.

GIS offers a powerful tool for agricultural scientists to better service to the farmers and farming community in answering their query, doubts and helping in improving decision making to implement planning activities for the growth of agriculture.

3.2 Components of GIS:

GIS enables the individual to input, manage, manipulate, examine, and display geographically referenced data using a computerized system. To perform various tasks with GIS, the components of GIS such as software, hardware, data, people and methods are essential to carry out variety of tasks by using them.

The functions and tools provided by GIS software needed to store, analyze, and display geographic information. Key software components are here below.

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

Currently available commercial GIS software comprises Arc/Info, Intergraph, MapInfo, Gram++ etc. Out of these Arc/Info is the most popular software package. And the open-source software are AMS/MARS etc.

3.3 Reasons Behind the Failure of GIS Project:

GIS projects take a big contribution in making better decision in the improvement of our nation. Mismanagement led to failure. The probable reasons for GIS project failed may be because of as follows:

A. Poor Planning:

The proclaimed father of GIS, Dr. Roger Tomlinson once remarked "One culprit is often to blame- poor planning".

B. Lack of Corporate Management Support:

It includes inadequate staffing, unfulfilled commitment and insufficient funding. It required the management collaboration and assistance, just like any other initiative of project, it does really need a co-operation and support from the management.

If not, then be ready for cancellation or cutbacks.

C. Poor Project Management:

Project management may be differentiated into two categories or area, which is the software development process and the responsibilities of the project manager.

D. Need of GIS Implementation Plan:

The most important benefits for using GIS to any project generally stem from the following two major groups of GIS functions:

a. To provide a user-friendly database that can allow simple access, visual manipulation, geographic analysis, and graphical presentation of array of data.
b. To serve as a logical, coherent, and consistent platform so that diverse databases can be integrated and shared among various divisions of an agency. Because of the nature of rapid changes in GIS and related information technology, a well- developed GIS implementation plan is essential for the following reasons:
c. To reduce the possibility of making mistakes.
d. To enable integrated management of the several aspects of data issues, computing environment, organizational structure, staff behavior, and information technology application.
e. To provide a reliable and authentic platform for dealing with unexpected problems.

E. Benefits of GIS Implementation Plan:

Some specific benefits of the GIS implementation plan are given as follows: -

a. It can provide early warnings of potential problems and serve as the basis for understanding the implications and identifying the solutions.
b. It is helpful in defining goals and future directions for the GIS program.
c. It facilitates the project manager and related staff to proceed with confidence, which improves productivity and efficiency.
d. It provides instructions for an effective, organized, systematic, and efficient deployment of this new technology so that every part of a complex system functions well.

e. It can serve as a background or foundation for creating budget requests and staff requirements to meet the present and future needs of all users will be met through the proposed GIS.
f. It can help justify the program and provide top-level managers with the degree of understanding and confidence required to the program approval.

F. Types of GIS Implementation:

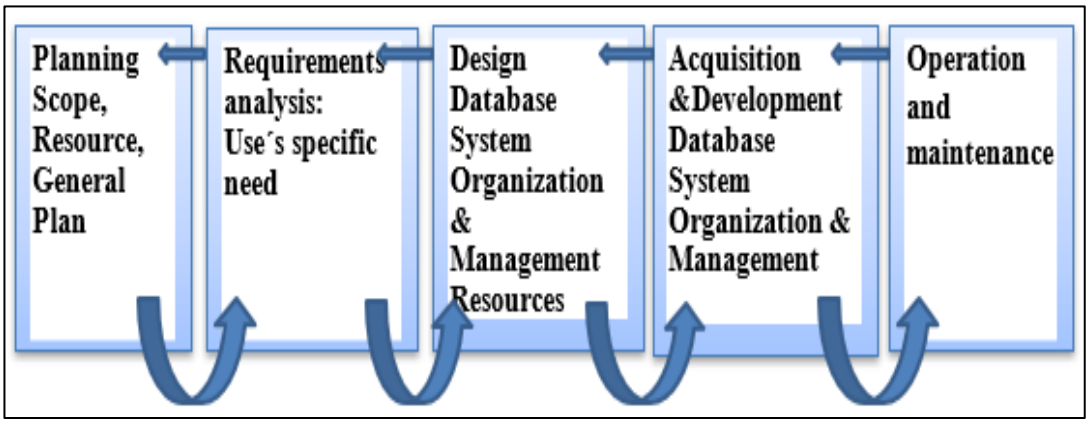
- Project
- Single department application (Departmental GIS)
- Multi departmental application
- Enterprise system (Enterprise GIS)
- Multi Institutional endeavor (Community GIS)

G. Phases of Planning & Implementation:

The GIS planning and implementation process comprises five basic structured phases that ensures that the GIS ultimately meets the users:

- **Planning:** defining the scope of the GIS and developing a general plan.
- **Requirements analysis:** determining users' specific requirements.
- **Design:** integrating all requirements and developing data and system specifications,
- **Acquisition and development:** acquiring system components and putting them together to create a unique system, and
- **Operations and maintenance:** putting the system into operation and maintaining the data and the system.

Steps Involved in GIS Planning & Implementation:



a. Planning: Planning is a crucial phase for any type of GIS. It offers a firm foundation for GIS implementation and operation and helps in preventing costly mistakes. Planning establishes the GIS direction. The following major aspects that are addressed during the planning phase:

b. Scope: The fundamental nature of the GIS and its role in the organization are defined. This includes identification of the GIS as a one-time project or ongoing program, the kind of applications and users who will be involved, how much integration with other systems and databases will be needed, and how the GIS will affect the way the organization does business. The scope, nature, and role of the GIS indicate directions for further planning and implementation activities.

c. Participants: Who should be engaged in the design and execution of the GIS depends on its scope. Participants might include users and stakeholders, management and policymakers, the task team that will plan and implementing the GIS, and a designated project manager. Additionally, appropriate GIS knowledge and education is provided, based on individual needs, to ensure that the identified participants can engage effectively in the next implementation processes.

d. Resources: Resources include money, time (in terms of a schedule), labor force, and skill sets. In addition, the scope of the GIS indicates the general types of benefits that can be expected, so it is possible to do a general comparison of benefits to costs. Estimates made at this early stage in GIS planning are necessarily very rough estimates but help establish basic planning resources and goals.

e. Approach: At this step, a broad strategy is created. Further, the primary concern is the GIS's scope. It outlines a suitable planning and implementation methodology. For a small or basic GIS project, the decision-making process might appear obvious and simple. More complicated planning techniques will be needed for GISs that are greater and/or more complex. For instance, a straightforward, single-purpose GIS project that maps resource sites may simply require a straightforward implementation procedure that is completed by the end-user. It's probable that the system's data requirements are simple.

On the other hand, a local government would need to go through a lengthy planning and implementation process in order to develop a multifunctional, enterprise-wide GIS programme that would assist with decision-making and alternatives choice. It would also require the involvement of many participants, and often outside assistance.

GISs that are large, complex, multipurpose, and/or multiparticipant require more extensive planning. In addition to each of the elements mentioned above being more complicated, more sophisticated planning techniques are required. Strategic planning approaches are often used for these types of GIS in order to examine effectively broad, diverse goals and viewpoints, establish understanding and agreement, and ensure that the GIS fits the organization’s overall goals.

f. Requirements Analysis: The requirements analysis provides information must for GIS implementation. In this task the future uses of the GIS and the current geospatial data handling situation are analyzed in analytical detail. Each work process is examined in terms of its purpose or goal, the process steps, the inputs and outputs, the data involved, and the functions performed. As part of this task, the current geospatial data handling environment and resources are addressed. This includes analysis of the current forms and sources of geospatial data: maps, files, systems, and other sources. The IT environment of the

organization, if applicable, is also addressed in terms of how the GIS would fit in. The requirements analysis results in a clear, documented specification of users' detailed GIS needs as well as the organizational support factors. The working products produced include:

- A description and/or diagram of each future GIS work process; including specific data needs and functionality requirements.
- The expected benefits to be derived from each GIS application.
- Any constraints, opportunities, or problems associated with individual work processes.

For a simple GIS project, this analysis may involve only one or two applications. For a large GIS, this process may involve examining dozens of work processes to be performed by hundreds of users.

g. Design: GIS design is the final outcome of the requirements analysis, and often included as the final phase of that step. It compiled all of the requirements together, and designing the GIS components that will support all the users' needs. This task is preparatory to obtaining GIS software and data.

Key Components Considered in Design Phase:

- **Database:** Data are the most important component of a GIS. Case studies and industry experience indicate that organizations spend the largest portion (as much as 80 percent) of their GIS budgets on data. Database design includes identifying all the data that must be in the GIS, the characteristics of those data, and how they are to be structured and organized in order to meet the users' and the organization's needs. Data modeling is an important component of database design.
- **System**: The system components include GIS-specific software and applications, as well as database support, hardware, supporting systems software, and systems integration. Small GIS projects may require only a self-contained system, using simple geospatial databases and software. Larger, multipurpose GISs usually involve complex database systems, a suite of GIS software products, specially developed applications, and systems integration. Furthermore, organizations developing multi- participant GISs usually attempt to minimize the number of different GIS software packages that they use in order to minimize redundancy and simplify support. Increasingly, web access to GIS data and applications is becoming an important component of GIS programs.
- **Organization and management:** In addition to the technical database and system components, the GIS design also specifies the management components that will support them. Management aspects include organizational components such as GIS support staff, the GIS labor force for tasks such as data creation, and training. Important management components include data management, system management, and project management for GIS implementation.
- **Resources:** The resources involved in the GIS, as designed, are also detailed at this point. This includes a detailed cost/benefit analysis based on the detailed GIS design, budget, and funding sources, and implementation plans for resource utilization and system implementation. Again, for a simple GIS, the design task may be straightforward. For a large, multipurpose GIS, on the other hand, the design task can be very complex and technically demanding.

3.4 GIS Project Management:

Wysocki et al. (2003), one of them, define a project as "a sequence of unique, complex and connected activities having one goal or purpose that must be completed by a specific time, within budget, and according to specification". The Project Management Institute (PMI) defines project management "the application of knowledge, skills, tools, and techniques to project activities to meet the project requirement". This definition is added to five Project Management Process Groups (PMPG) that describe the lifecycle of any GIS project, and ten knowledge areas for the project managers should be competent. The five PMPG are: Initiating processes, planning processes, executing processes, monitoring and controlling processes and Closing processes. The ten knowledge areas, focus on management expertise in: project integration management, project scope management, time management, cost management, quality management, human resources management, communications management, risk management, procurement management and stakeholder management. The field of geographic information systems is very broad and needs comprehensive management skill, which is often not acquired from university education centers, but is built through years of cumulative experience. There are few experiences available today in managing advanced and complex GIS projects.

Project Management:

It is the application of knowledge, skills, means and techniques to a broad-spectrum activity in order to fulfill the specific requirements of that project to which this concern department. The practical elements of project management are initiation, planning, executing, control and controlling, closing or locking.

3.5 Project Departments:

There are many project departments like project integration management, scope management, project time management, managing project budget and costs, project quality management, quality, resource human project, project communications department, risk management for the project, achievement management, Procurement.

3.6 The Implementation of the Work in Stages According to the Method of Work:

A. The analysis and design stage: At this stage, a geographic information system is analyzed, and an analysis report is produced for the system, which will contain the needs of users and assess the needs of the systems, applications and data required to be entered into them in preparation for their design.

B. The implementation phase and initial delivery: Establishing a geographic information system database according to the specifications specified in the analysis and design stage.

C. Final handover stage: Final delivery of the system, its supply and operation after implementing the required modifications. Preparing and submitting the systems' user / help manual.

3.7 The Training Phases:

Two Types of Management:

A. Strategic management It defines mission, vision, and value, and designs the broad lines through which a sector or facility will run. The rationale for the facility or sector is also created, and it defines the areas of marketing, the target customers or customers, as well as what the product is. Strategic management must continue.
B. Project Management: It focuses on short-term results The project must start and then finish.

Project Initiation Document:

It should also include, as a minimum, the following elements:

- Constrains determinants.
- Scope
- Objectives & Mission Project Plan's
- Project Planner - Organization of the project
- Outputs, timelines, output acceptance criteria and milestones, Deliverables acceptance criteria.
- Analysis Risk

3.8 Characteristics of Advanced GIS Projects:

a. Understanding user needs & requirement.
b. This means that you interact as if you are a member of the user sectors and are aware of all their needs.
c. Keep your balance.
d. I mean, be neutral without giving preference to desires or specializations over others except to the extent of interest.
e. Skill and craftsmanship in Geographic Information Systems “be a GIS professional.”
f. It means providing the best of geographic information systems and its technologies so that the beneficiary sector can improve its performance, support its decisions, and feel the difference that geographical information systems make to its sector.

3.9 The keys to Success of GIS project:

- Good communication and understanding between all parties.
- Good coordination of resources
- Adequate planning of resources
- Good estimate of costs and duration
- Good control and follow-up of project progress and progress
- Existence of quality control mechanisms
- Project deliverables should be scoped and defined-well.
- Resources allocated to the project must be available and assured.

- The structure and organization of the project must be sound, and responsibilities are defined.

3.10 The GIS Project Manager Must Know:

- Mission - Why are we doing this project?
- Objective - what will be done?
- Strategy - How can the project objectives be achieved?

Key Known Reasons for Failure of GIS Projects:

- Bad project planning
- Little or no support for the concerned administrative sector
- Bad project management
- Lack of focus on user requirements and lack of active participation

3.11 The biggest challenge for a project manager:

Scope – Quality – Cost - Time

Figure 3.2 Project Manager

- **Scope:**

Scope is what we are going to produce and deliver at the end of the project as deliverables. It comprises all the required features and functions that already explained and documented during the beginning of the project. Also, scope needs the supporting project efforts and functions needed to oversee, organize, coordinate and support the development of all deliverables.

- **Quality:**

Quality is the minimum acceptable quality for the deliverables.

- **Schedule:**

Estimate time for each task in the project. We must make sure that we have the resources and time to complete the project.

- **Cost:**

The project cost is a cost required to: Procure all the needed products for the project. Resources and Services needed to deliver the tasks of the project successfully.

3.12 Project Management Lifecycle PMLC (Five Phases):

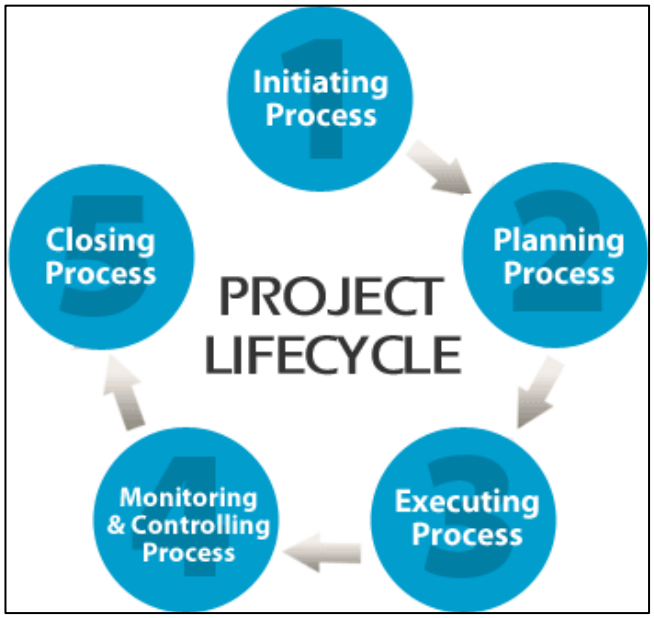


Figure 3.3 Project Lifecycle

A. Project Initiation:

The starting of the project is the first step of the project management lifecycle and at this point, business determine if the project is needed and how valuable it will be for them. The two factors used to evaluate a proposed project and determine its expectations are the feasibility study and the business case. Project Initiation contains identify problem/ opportunity, establish the goal of the project, define objectives of the project, perform analysis of the cost/benefit, determine the criteria of success and assumptions list, obstacles list and risks list.

- **Project Planning:** Project Planning contains identify activities of the project, estimate the requirements of the resource, construct the workflow and prepare the proposal of the project.

Steps:

- Understand the value and scope of the project plan.
- Conduct a thorough search
- Ask the hard questions.
- Create your outline of project plan.
- Talk to your team.
- Write down your entire project plan.
- Do your plan in Team Gantt
- Publish the plan.
- Make sure read plan with your team.
- Get ready to keep planning.

B. Project Execution:

After we develop a project management plan and set the right baselines for the project, it's time to start working and start implementing the project plan. This is often the stage at which management becomes more interactive and enthusiastic to see things being produced. Project Execution contains organize the project team, establish the rules for the team, assemble resources of the project and execute project work plan.

C. Monitoring and Control:

Monitoring and control keep projects on track. Correct controls can play a key role in completing projects on time. The data collected also allows project managers to make informed decisions. They can take advantage of opportunities, make changes and avoid crisis management problems. Monitoring and Control contain monitor the project progress with plan, establish protocol and procedures reports, install procedures of change management, establish mechanism of problem resolution and revise the project plan.

D. Close-out and Evaluation:

The project is closed at the end of the project life cycle (Project closeout). It's a coronation. Activities that start before the delivery of the facility, and end with the suspension of the capital in full financial activity to support the project.

The closure process involves closing the final contracts and closing the project management office. Archive records and produce a project completion report. The project manager is the project is expected to be closed within three months after completion of warranty period (usually one year after substantial performance). Close-out and Evaluation contain conduct the acceptance test, establish roll out plan and schedule, complete documentation of project, conduct audit of post-implementation and complete the final project report.

E. Stakeholder Management:

Early on in the GIS project, the project manager can identify stakeholders. Every stakeholder must be identified in order to find out what they require and the extent of their influence or power. This knowledge needs communication with them. The demand on the project and its complexity increase as the number of stakeholders rises.

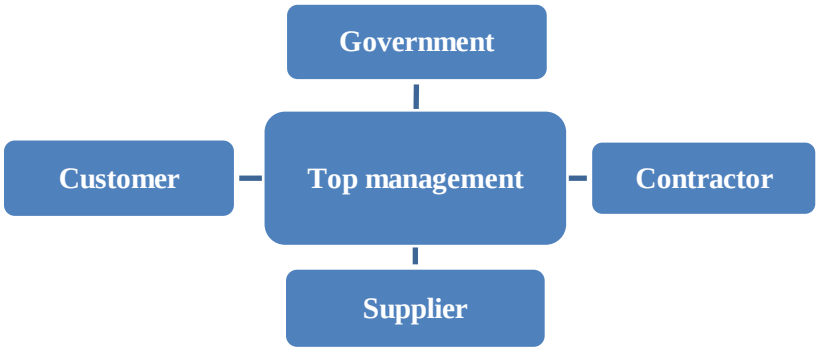


Figure 3.4 Project

3.13 Conclusion:

Now a days GIS is widely applicable in all most all the fields such as Mapping to identify the borders of cities, districts, countries etc. also in finding population estimation of an area. It is also essential to distinguish geological settings of a locality by digitizing maps. GIS technology can provide many benefits to the organizations, groups, and individuals who use it. However, the effectiveness of the technology depends on how it is implemented. Different kind of organizations have different approaches to GIS implementation, ranging from the large, complex, well-coordinated enterprise-wide massive efforts of many local governments to the small, independent GIS implementations found in some areas of companies. Individuals and groups also implement a wide range of GISs. In GIS project management we must need to look beyond the immediate use of GIS and consider GIS implementations in a larger enterprise perspective. A systematic investigation of what makes a GIS program successful requires thorough analyzing and abstracting each of all the aspects of GIS project management.

3.14 References:

1. Kingra PK, Majumder D, Singh SP. (2016) Application of remote sensing and GIS in agriculture and natural resource management under changing climatic conditions. Agricultural Research Journal.53(3):295-302
2. Kazemi H, Akinci H. (2018). A land use suitability model for rainfed farming by Multi-criteria Decision-making Analysis (MCDA) and Geographic Information System (GIS). Ecological Engineering.2018;116:1-6

3. Parmita Ghosh and Siva P. Kumpatla. (2022) GIS Applications in Agriculture. DOI: http://dx.doi.org/10.5772/intechopen.104786
4. Somers R. M. GIS Project Planning and Implementation. ADVANCED GEOGRAPHIC INFORMATION SYSTEMS – Vol. II - GIS Project Planning and Implementation – Somers R.M © Encyclopedia of Life Support Systems (EOLSS)
5. Bossler, J. (ed.). (2002). Manual of Geospatial Technology. 623 pp. London: Taylor and Francis.
6. Clarke, K. Getting Started With GIS, 2001.3rd edn., 352 pp. Upper Saddle River, NJ: Prentice Hall.
7. Eason, K. (1988). Information Technology and Organizational Change. 247 pp. London: Taylor and Francis.
8. Federal Geographic Data Committee (FGDC). Framework Introduction and Guide, 1997.106 pp. Washington, DC: FGDC.
9. Huxhold W.E. and Levinsohn A.G. (1995). Managing Geographic Information System Projects, 247 pp. New York: Oxford University Press.
10. Obermeyer N.J. and Pinto J.K.m. (1994). Managing Geographic Information Systems, 1994.226 pp. New York: Guilford Press.
11. Somers, R. (2001). Quick Guide to GIS Implementation and Management, 33 pp. Chicago: URISA.
12. Somers, R. Developing (1998). GIS management strategies for an organization. Journal of Housing Research, 9(1), 157–178.
13. Rebecca Somers, (2001). Quick Guide to GIS Implementation and Management Park Ridge, IL: Urban and Regional Information Systems Association, 2001, p.71
14. Barron, M and Barron, A. (2011) Project management for scientists and engineers. Galway, Ireland: Connexions
15. Burek, P. (2011). Influence of the scope statement on the WBS. Newtown Square, PA: Project Management Institute.
16. Chapman, A.D. (2005) Principles of data quality, Copenhagen, Denmark: Global biodiversity information facility.
17. Chrisman, N.R. (1983) "The role of quality information in the long-term functioning of GIS", Proceedings of AutoCarto 6, Vol. 2, pp. 305-321, Falls Church, VA: ASPRS.
18. Damodaran A (2007). Strategic Risk taking: a framework for risk management. Upper Saddle River, NJ: Prentice-Hall.
19. EPA (2003) Guidance for geospatial data quality assurance project plan, Washington, DC: Office of environmental information, US Environmental Protection Agency.
20. Harvey, F. (1997) "National cultural differences", in Theory and Practice. Information, Technology, and People. 10(2) 132-146.
21. Holton G. (2004) "Defining Risk", Financial Analysts Journal, 60(6): 19-25.
22. Huxhold, W. (1996) Managing geographic information systems projects. New York: Oxford University Press.
23. Jakobs, R. (2017). Good business: Why placing ethics over profits pays off. Philips Blog, online resource, available at http://www.philips.com/aw/innovationmatters/blog/good-business-why-placing-ethicsover-profits-paysoff.html, last accessed 11/25/2016.
24. Jochen Albrecht (2017) "GIS Project Management", City University of New York
25. Mulholland, N. (ed.) (2003) New York State project management guidebook, Albany, NY: New York State Office for Technology.

26. NETSSAF (2008). Proceedings, Network for the Development of Sustainable Approaches for Large Scale
27. Implementation of Sanitation in Africa Conference, 24 - 27 September 2008, Ouagadougou, Burkina.
28. Peters, P. (2008) Building a GIS. ESRI Press, Redlands, CA.
29. Zakaria Yehia, IJAEBS (2021), (2), (1), (11-24) 10.21608/IJAEBS.2021.44226.1004 24
30. Pressman, R. (2005) Software engineering: a practitioner's approach, 6th ed., New York, NY: McGraw Hall.
31. Project Management Institute (PMI) (2013a) Guide of the project management body of knowledge (commonly referred to as the PMBOK Guide), 5th ed., Newtown Square, PA: Project Management Institute.
32. Project Management Institute (PMI) (2013b). The standard for program management. Newtown Square, PA: Program Management Institute. 20. Project Management Institute (PMI) (2013c). The standard for portfolio management. Newtown Square, PA: Program Management Institute
33. Shi, Q., & Chen, J. (2006). The human side of project management: leadership skills. Newtown Square, PA: Project Management Institute, Inc.
34. Standish Group (2016). The CHAOS report 2015. Boston.
35. Summerville, I. (2005) Software engineering, 7th ed., Boston, MA: Addison Wesley. 24.Thomas J. Cova (2018) "Comprehensive Geographic Information Systems", The University of Utah, Salt Lake City, UT, United States
36. Tomlinson R (2005). Thinking about GIS: geographic information system planning for managers, Redlands, CA: ESRI Press.
37. URISA Journal (2015). Special issue on Return on investment in GIS, 27(1): 13-46. Des Plaines, IL: Urban and Regional Information Systems Association (URISA).
38. Wang, R (1908) "A product perspective on total data quality management", Communications of the ACM 41(2): 58-65. 28.
39. Wysocki, R.K., Beck, R. Jr. and Crane, D.B. (2003) Effective project management, 3rd ed., New York, NY: John Wiley & Sons
40. Ahmad Zakaria Yehia. (2021). International Journal of Information Engineering and Electronic Business. 2 (2): Page 1-15DOI:10.21608/IJAEBS.2021.44226.1004