GIS Based Expert System for Energy Resource Exploration

Sajida Aziz, Yaqoob Wani, Khalid Hussain

Abstract—GIS is the vast term that can be used lots of different technologies, processes and methods. Information system (IS) is the method of integrates ,store ,edit analyze ,shares, and display geographic information. It is the tool that give the permission to the user that he will create collaborative queries, analyze spatial information, edit data in maps and present the results of all these procedures. A geographic information system or geographical information system (GIS) is a method that is planned to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data. GIS is a special case of information system where the data base consist of observation on spatially distributed features, activities, which are definable in space as points, lines or areas. A geographic information system manipulates data about these points, lines, and areas to retrieve data for ad hoc quires and analysis. In this study we have evaluate the techniques used to get multiple information by using GIS system.

Index Terms—GIS, Data, Manipulation, Evaluation, Analyze

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1 INTRODUCTION

THE first GIS (K Eldrandaly) was developed the Canada Geographic Information System (CGIS), in the mid of 1960 that is the computerized map measuring system. GIS is the special class of information system that keep track not only events, activities, and things, but also of place where these events, activities and things happen. [1]

Longley et al.,2005 GIS basically consist of six components/parts that are people, data, software, hardware, procedures and network. Geographic information system grow with the passage of time and it is the great means of assembling and analyzing different spatial data. GIS collects the data in the different areas and store the information in the database. [2]

undefined problems for improved decision making. DSS are widely used in the modern world business for effective and efficient decision making. Yin Zihong et al., 2011 has been proposed an intelligent decision support system for bridge monitoring (IDSBM). They proposed an intelligent decision support system based on case-based reasoning developed for bridge monitoring which needs visual inspection of data and non-destructive testing. [3]

Kaklauskas et al., 2007 proposed a multiple on line criteria decision support system. The key idea of the research is to aid decision makers about decisions of various construction phas-

- *Sajida Aziz currently pursuing masters degree program in Computer Science in University of Lahore Islamabad Capmus Pakistan, E-mail: az- iz_sjaida@yahoo.com*
- *Yaqoob Wani is currently working as head of the department school of Information Technology University of Lahore, Islamabad Capmus Pakistan E-mail: yaqoobwani@yahoo.com*
- *Khalid Hussain is currently working as Professor and head graduate program department school of Information Technology University of Lahore, Islamabad Capmus Pakistan. E-mail: kusmani.utm@gmail.com*

es which include the complete life cycle of the projects. Now a

days decision making expert system are more complicated and multi-dimensional. With the improving of the decision making Multi criteria decision making (MCDM) tool are extensively useful in the solving of complex problems. The main advantage of the GIS base Decision expert system explore the energy resources through the AHP fuzzy system**.** [4]

2 RELATED WORK

Nese Yalcin et al.,2012 purposed an Fuzzy multi-criteria decision evaluation approach for Turkish Industry. Now a days where great competition be present in financial sector, an evaluation approach is great importance over there. For this purpose Author used AFP and VFP models. FAHP support to measure the criteria of two modals AFP and VFP. The classification of companies during the data collection process used TOPSIS and. Author used the combination of traditional and modern methods AFP and VFP for measures the financial performance. In this study also present the comparison of old and new methods of evaluation methods according to the financial performance. Return on assists , Return on equity (ROE) and Earning per share(EPS) used for the measuring the variable. The Aim of this study Multi-criteria decision making (MCDM) method select the best Company in the several alternatives business companies [5]

Mohammad Bagher Javanbarg et al (2011) purposed fuzzy AHP modal for multicriteria decision making. The basic advantage of AHP is it has the ability to handle the complex problems. Author says that it has many advantage like easy to understand, best in the pair wise comparisons , organize the critical aspects of a problems. Fuzzy AHP modified into Fuzzy preference programming that present Mikailov(2003). Fuzzy AHP modal changed into fuzzy prioritization nonlinear modal. It has the ability to solve the nonlinear problems. Author present upgraded module called particle swarm optimization (PSO). PSO solved nonlinear equation and optimization problems. This approached has the ability to generate priority

through fuzzy evaluation judgments (Cakir and canbolat -2008). PSO-fuzzy AHP used to resolve the fuzzy optimization problems [6]

E Bulut et al., 2012 describe Fuzzy AHP represent Laarhoven and Pedrycz (1983), author develop a simulation system for analyzing multi dimension system through which obtain high level of customer satisfaction in short time and improved the quality of product. Author using Fuzzy AHP tool for decision making answer obtain the best performance. Fuzzy AHP(analytic hierarchy Process) generate triangular Fuzzy numbers for the comparisons than this number used in the Pair wise comparison matrices. After using Fuzzy AHP for the decision making comparisons between three firms. Human being are uncertain to assigning the value of crisp AHP. Fuzzy AHP overcome this difficulty and obtain positive results in uncertain situation. [7]

Asakereh et al., 2014 purposed fuzzy AHP(*Analytic Hierarchy Process*)method and GIS geographical mapping module using GIS to find the solar energy in specific area(Iran). GIS expert architecture system collect the data to process, analysis , store, and make picture of the result and allow the user to access information of any object (number form/binary form) in the environment. Fuzzy domain based assessment techniques are used in application that get information to the area and take decision .Fuzzy logic is used when information is unclear. [8]

Pedro Pablo González-Pérez et al., 2015 explain the module that estimate the environmental impacts using the following three techniques , artificial intelligence ,expert system and neural networks. The system work on three steps identification ,characterization and evaluation. In the first part used heuristic rules for the identification impacts and in the second step neural networks used for the characterization and in the third step decision algorithm is used for the evaluation. Expert system identify environmental impact. Process of system is first takes data from the geographic information system then organize the knowledge according to the inference motor and the user interface. In this paper authors presents the expert system for the environmental compliance auditing. The expert system integrates Geographic Information System (GIS), Statistical and Database software packages for environmental acquiescence inspecting. Above work explain the forward chaining hybrid expert system Work for environmental and technological risk assessment and management tasks. Its task is make establish the association between set of predictor maps. When WofE modal invented its work is only in the field of non-spatial application but mathematical researcher also used it in research because it is instinctive and easy implementation. Mineral prospectively modal consist of three procedures .first is identify the input predictor map, secondly process on the data with GIS for built predictor map, thirdly use the mathematical modal and integrate the predictor map in the GIS or external GIS. Mineral deposit modal base on the mineral spatial. There are four main methods in mineral potential modelling: probabilistic, regression-based, artificial-intelligence-based (AI-based) and Dempster-Shafer-belief-theory-based methods. [9]

E Triantaphyllou et al., 2013 purposed MCDM with integration of GP and LLSM model. Traditional MCDM technique used to solved the complex Problems. Author explain that function of MCDM is to solved the divergence of problem. The objective of this study developed GP_AHP modal for solving complex problems that is the mixture of GP and LLSM technique. This model have ability to deal AHP problem with fuzzy techniques . [10]

Khalid Eldrandaly et al., 2011 presented the new module of GIS selection how to select best method for solving complex multiple problem and also present the GIS software with the integration of expert system and multicriteri decision making techniques for the problem solving. selecting the right GIS expert system for the problem solving is difficult task. All industries tries to find best Information system for the complex problem. For implementing the proposed technique a knowledge based system was invented which is based on analytic Hierarchy process (AHP). After building the information system was able to capture, modelling, storage, retrieval, sharing, manipulation, analysis and present thee geographically referenced data. Five evaluation criteria cost, functionally, usability, reliability, and vendor are used for the selecting of GIS.MCDIM(AHP) module is the selection of several alternatives. In the last few years many MCDIM have been developed but the most suitable and effective is the AHP tool is batter for the selection of alternatives. they make the prototype advisory system of using above presented technology and run on the window environment . [11]

Imtiaz Chandio et al., 2012 present the review of the GIS MCDIM expert system. This paper discussed the GIS based AHP as a MCDA techniques in land availability through the literature review and surveys. Combination of GIS based expert system with the MCDA, it gives the outstanding result in the decision of alternative problems. To solve the spatial problems it is used and gain precision result. In Decision making expert system involve the following step.

> 1-problem definition
> 2- To get the specific criteria in the different stages invent the chain (Hierarchy).
> 3-Weight against each criterion using numerical pairwise comparison scale.
> 4. Perform computations to find the maximum eigenvalue, consistency index, consistency ratio (CR), and normalized values for each criteria/alternative.
> 5. If there is any matrix with an unacceptable CR value the expert is required to make a judgment on that matrix repeatedly till these values lie in a desired level (Lee and Chan 2008) neutral network models.

Author give the review of the GIS MCDA with AHP till 2010 and present the work of different researchers work and prove that GIS MCDA is batter analysis tool in the selection of alter-

natives. It give batter result in the land suitability and spatial problems solution. [12]

M.H. Vahidnia at al., 2008 discussed in the paper to used Analytical Hierarchy process as a multiple criteria decision making problems. It also discussed the AHP procedures and GIS based problems. GIS multicritera decision used in many areas of research that is like health care, land suitability, industry progress, spatial problems, vagueness complex problems. GIS technology have been growing in last three decades. Every field of information technology involve and try to find the best method in alternative decision making. MCDM approach handle the selection of several sites in the alternative. It have limited sets of option. Its aim is to grading the finite alternative according to the finite attributes. MCDM have several methods and the most usable method is the AHP process. When apply the AHP method then find out its limitation about the limited area in which it can used then it will combine with Fuzzy analytical proces9(FAHP). FAHP tool solve the complex and vagarious problem. It will wildly use to solved the spatial problem and GIS based problems. Author implement it in different situation in which it handle the uncertainty. Traditional AHP has failed in those situation in which problem is more complicated . [13]

Mahesh Prasanna et al., 2015 describe the introduction of fuzzy logic and image processing. Digital image processing is used in field of medicine, industry, and other important area like defence. Artificial intelligence contains many important techniques like fuzzy logic is one of effective technique in the decision making . this study consist of three parts , in the first part discuss about the introduction digital image processing, importance, and how to implement it on the hardware for getting the batter result. It also discussed about the algorithms median filter, morphological process, convolution operation and edge deduction . image processing is the process in which processing on the digital image through the digital computer. Digital image built by finite number and every number has specific location. There are two ways of hardware implementation one is full custom hardware design that is known as the application specific Integrated Circuits(ASIC) and semi custom hardware device that are programmable devices and field programmable Gate arrays(FPGA). The second part contains the fuzzy logic techniques, signal processing sensors. It is linguistic techniques and rules like if then and if then els. Fuzzy logic is essay to understand and used in the complex and vague based problems. The last part is the how to apply fuzzy logic in image processing modelling. Fuzzy image processing study all methods that are used to collect, present, segmentation, of the fuzzy sets. [14]

Chong Xu et al., 2013 evaluate earthquake effected area by Bivariate statistical method . It's criteria of evaluation is check the prediction method ability in earthquake land sliding the region of china. Its research method is based on the optical remote and data that collected by the sensors through geographic information system(GIS). In this purpose author used related areas pictures satellite images, before and after earth-

quake images then test it in several locations. One element of this study measure the intensity of earthquake effected states other than main area. In this research Ten monitoring parameters used for production of basic caused of earthquake land sliding. Digital evaluation modal used for creating topographic map. ArcGIS software used for measure the counter lines and height of drainage pathway. [15]

Ved Kumar Mishra et al.,2015 presented the knowledge management system that have ability to modify interface regarding user need. In this study Author introduced geographic information system (GIS).GIS based system heaving capability to analyse and understand several geographically referenced data. GIS support the user to explaining events, predicting results and inform about future planning. GIS work as the best tool when combine it with remote sensors. Remote sensors provide information about earth condition, environmental changing, and weather condition, evaluate the earth events, and affect the human activities. An optical sensor used for earth data analysis and this technique opens new application. Integration of GIS with remote sensing assists the user, how to develop and design project in an excellent way. Author used DBMS tool for storing the data that collected through GIS and sensors. [16]

Balqies Sadoun et al.,2015 presented BAU GIS application that help the user to manipulate the data, take analysis, view the different geospatial data format. This is the analysis tool. The basic purpose to designed and develop the programming tool for research and project software. In spite of it researcher purchase a complete GIS expert tool use BAU GIS application. Author build GIS system after integration of GIS modeling and GIS application programming interface. It consists of mapping tool like mapping window and GIS application programming interface (API). Author used .NET for making the framework. Author used GIS tool for images collection, GPS for the connected into computer and for the converting images used image map tools. Path analyzer developed the path for the Digital Elevation Model. In this application researcher also used measuring tool, shape file editor and map window graph tool for area distance and editing different images. [17]

Abbas Mardani et al., 2015 assessed MCDM techniques that was commonly used among 2003 to 2015 in energy field. Author divide all Papers in two categories sustainable and renewable energy and research methods classified into six main group. He extracted all data form the web of science database. This study is the review of all decision making methods and after review Author concentrate on MCDM method is effective technique for solving the energy issues. The objective of study covers all energy associative approaches. Author described all finding in forms of graphs and tables. This is the comparative study about MCDM techniques for future research. Author explain those papers that have more cited and also give the data about all type of energy like solar energy, PV energy, wind energy renewable energies, sustainable energies. [18]

Justin Scott Giboney., 2012 examine the performance of knowledge based system(KBS). It increased the decision making ability of the human being. The objective of this study find that why Knowledge based system is so powerful decision making system in the information system research. Explanation play important role in knowledge based information system. Author compare that how KBS arguments and users arguments effects the information system recommendation. For this purpose used Toulmin argument classification and cognitive fit theory. He divides the research into two categories, in the first part how to build argument, evaluate according to the value and then authorize their fitness. Second part based on the experiment; examine the explanation according to the result of first part. Knowledge based system Explanation finds three type of results, desire for explanation, explanation processing and acceptance of the decision. [19]

Khalid Eldrandaly et al., 2007 presented integrating technique based on the Expert system (ES) and Geographic information system (GIS) for the analysis of the spatial decision making. Every organization required efficient decision making system for the financial improvement and growth. Spatial decision making is extremely critical procedures. This process is the multi-dimensional. Geographic information system in which involves assembling and analysing several spatial data. In the past it is used for map making and compilation of registers. The first GIS was developed in 1960 that have the capability to measure the map through computer system that is called computerize geographic information system. The objective of this study give the overview of GIS techniques and expert system. [20]

Gang Kou et al., 2012 purposed assessment disaster expert system that is the combination of fuzzy logic, survey and multi criteria decision making. Author study based on those experiment that conduct in the hurricane and earthquake. After experiment on integrated expert module author acquire

75% result that was proximately close to 78% ideal result. Expert system play an important role to control the disaster management systems. Deprived of this system lots of time and money would put away in it but cannot get efficient result. The evaluation process of disaster involve complex and uncertain data, so for this purpose used the fuzzy logic techniques for the decision making. In this study used five MCDM methods for the data computing and OWA is used for combine the other four methods. [21]

Salvati L et al., 2013 describe a tool, geographical information system(GIS) that works on the land and enquire the causes of ESD for land management. The basic purpose of study is to integrate the GIS system with the decision support system (DSS) and test the consequence on ecosystem sensitivity desertification (ESD. Authors presented integration tool DSS-ESI. The function of tool is to identify the causes of environmental sensitivity. After identification compare the sensitivity of the areas that have same level of sensitivity. DSS-ESI application give the outcome in percentage that based on the four classes and take analysis through the images of specific area that are called pilot area. [22]

Marc A. Nelitz et al., 2015 describes different methods and modals for measuring the uncertainty and complexity of the expert system. This study explain two approaches are important to solved complexity first is conceptual modelling and second is autonomic computing, heuristic technique's. Author study concentrate on the second approach give batter outcome to solve complex problem. In first part present the function and structure of modal and in second part absorbed on the breeding, traveling and hibernating of the birds in the specific research area. For comparing the results used analytical hierarchy process(AHP) that explain all pairwise comparison in the life stages of birds. [23]

Table-1: Broad research analysis of Expert System

Sr. No	Paper	Expert System	MCDM	Fuzzy Logic Based System	GIS Expert System	Energy Explore Recourse System	Decision Support System
1	[1]	✓	✗	✓	✓	✗	✗
2	[2,3,4,5,6,7,9]	✓	✓	✓	✓	✗	✓
3	[8]	✓	✓	✓	✓	✓	✓
4	[10]	✓	✓	✓	✗	✗	✗
5	[11, 12]	✗	✓	✓	✓	✗	✓
6	[13]	✗	✓	✓	✗	✗	✗
7	[14]	✗	✗	✗	✓	✓	✗
8	[15]	✓	✗	✗	✓	✗	✓
9	[16]	✓	✗	✗	✓	✗	✓
10	[17]	✗	✗	✗	✓	✗	✓
11	[18]	✓	✓	✗	✓	✓	✓
12	[19,20]	✓	✗	✗	✓	✗	✓
13	[21]	✓	✓	✓	✓	✗	✓
14	[22]	✓	✗	✗	✓	✓	✓

| 15 | [23] | ✓ | ✗ | ✗ | ✗ | ✗ | ✓ |

Table-2: Techniques Used in Expert System

Sr. No	Technique	Expert system	Selection	Data Collection	Spatial Analysis	Hardware Implementation	Image Processing
1	CGIS	✓	✓	✓	✓	✗	✗
2	Fuzzy Logic	✗	✓	✓	✗	✗	✗
3	DSS	✓	✓	✓	✗	✗	✗
4	MCDIM	✓	✓	✓	✓	✗	✗
5	FMCDM with AFP and VFP	✓	✓	✓	✓	✗	✓
6	PSO integration of GP AHP	✓	✓	✓	✗	✗	✗
7	simulation system (Fuzzy logic & MCDM)	✗	✓	✓	✗	✗	✓
8	MCDIM With GIS Integration tool	✓	✓	✓	✓	✗	✓
9	Artificial intelligence	✓	✓	✓	✓	✗	✓
10	Fuzzy AHP and MCDM	✓	✓	✓	✗	✗	✗
11	GIS Expert System	✓	✓	✓	✓	✗	✓
12	GIS MCDA	✓	✓	✓	✓	✗	✓
13	FAHP	✗	✓	✓	✗	✗	✓
14	Artificial Intelligence(application specific Integrated Circuits and FPGA)	✓	✓	✓	✓	✗	✓
15	ArcGIS	✓	✓	✓	✓	✗	✓
16	GIS and Senses	✓	✓	✓	✓	✓	✓
17	BAU GIS Application	✓	✓	✓	✓	✓	✓
18	MCDM	✓	✓	✓	✓	✗	✓
19	Knowledge based system	✓	✓	✓	✓	✗	✗
20	multi-dimensional. Geographic information system	✓	✓	✓	✓	✗	✓
21	MCDM and OWA	✓	✓	✓	✓	✗	✗
22	Integration tool DSS-ES	✓	✓	✓	✓	✗	✗

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23	autonomic computing	✓	✓	✓	✓	✗	✓

Figure-1 Literature Analysis

Above Graph present exclusive analysis of techniques that are used in GIS based expert system. This study discussed about data collection and selection of alternative, after selection finding the energy resources and problem solving. 91% papers consist of expert decision support system,56.52% research discussed the methods of image processing and 82.62% result come after spatial analysis.

Table-3: Broad research analysis of Expert System

Paper Ref.	Techniques/Methods/Protocols	Advantages	Disadvantages	Research Gap
1	Canada Geographic Information System	Measuring maps through computer	Lots of unorganized data	Decision making not possible
2	Fuzzy logic	Solved Complex problem	Give intricate result of spatial data.	There should be Implementation for proving the fuzzy logic
3	Intelligent decision support system.	Flexible information system for decision making, monitoring and testing	Limited implementation, used only in bridge monitoring	.required development in usability

4	Multi criteria decision making	Support decision making in construction field	Application Specifically for the construction management related field	It should be extensively useful
5	Fuzzy multi criteria decision support system	Show best result in industry related problems	Expensive and difficult to understand	Inclusive evaluation required
6	PSO (particle swarm optimization) for problem solving	Handle complex problem like pair wise comparisons and nonlinear problems	Restricted for problems related to the nonlinear equation	Perceptible Analysis required
7	Fuzzy analytic hierarchy process for improved quality of product	Firms improved product quality and performance	Spatial problems evaluation and testing	Comparison with other models
8	GIS expert system and fuzzy AHP for assessment and find solar energy in specific area	Observing and evaluation events	Implement in limited area	Need Comparative analysis
9	WofE modal for evaluation of environmental impact	Identify and calculate environmental effects	Comparison of four methods	Measurement of the Performance of methods required
10	Integration of GP-AHP and LLSM technique for solving problems	Deals with complex and divergence of problems	Integration of methods make modal more complex	Handle only fuzzy based problems and events
11	GIS expert system and multi criteria decision making for problem solving	Selection of alternatives.	Limited application	Comparative analysis
12	GIS MCDIM expert system for land availably	Present the review of different researchers on GIS MCDA	MCDA give better performance only for the land suitability	Case study required
13	FAHP	Used for complex decision, and easy to understand.	Traditional method	Limited implementation
14	FPGA and ASIC	Implementation on the hardware.	Comparison analysis	applicable in vague problems
15	ArcGIS	Measure the counter lines and evaluate earthquake land sliding	Incomplete exploration	Evaluation tool
16	Knowledge management system	Update interface according to the user need and explain events	Insufficient results	Incensement in the application required
17	BAU GIS application	Manipulate the data and it's a Programming tool for the analysis	Complexity	Need Improvement
18	MCDM techniques	Review of all papers among 2013 to 2015 in Solving energy issues	Comparison analysis	Complex and spatial problems unsolved, this study give the review

19	Knowledge based system	Improve decision making.	Comparison required of other techniques.	Experiment and case study required
20	Integration tool of ES and Geographic information system	Analysis of the spatial decision	Multiple system required	Limited execution
21	Disaster assessment expert system	Control the disaster management system and in less time.	Lots of time and money put in it for getting efficient results.	Expensive and limited applicable area
22	DSS-ESI	Works on the land management, identify causes of ESD.	Measurement of Land sensitivity through comparison.	Enhancement of the application required
23	Heuristic techniques	Used to solved complex and vague problems and analysis the uncertainty of different methods.	Pairwise comparison of the life stages of the birds.	Vast application requirement

3 DISCUSSION:

In the above table several authors presented different methods for problems solving and hide the important task of GIS based expert system. It is used to improve decision making through fuzzy logic. Researcher used Expert system for solving complex problems. Expert system analysis the results then make decision. AHP based on fuzzy logic support the decision about those problems that are vague based on uncertainty. Its implementation exist in every field of life for collection, editing, analysing, evaluation, assessment and decision making. Integration of AHP and expert system make batter results in evaluation process. Expert system take decision on the available data that provided to it in the way of database. It support the industry, agriculture, energy fields and almost every field required computing intelligence for the evaluation.

4 CONCLUSION:

Decision and evaluation play important role in every field. This study present a comprehensive analysis in table-1 about the function of Expert system and implementation of different fields of research. There are many loopholes concerning of Decision Expert system in the field of artificial intelligence. Different researchers use different methods to improve decision making and geographical information system. Researcher tried to get optimize results regarding decision after evaluation.

To analysis the work done under the domain of GIS, w .r .t expert system. We have concrete and extensive survey for this.

In this study we also have discussed the technique use to overcome the energy resources. This study has also focus the gaps which can minimize by using the available techniques.

This study can contribute the field of energy resources using the GIS expert system domain.

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