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Effective Utilization of GIS in Urban Planning and Development for Daund City

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ABSTRACT: Rural and urban development, a determinant of a nation's progress, is one of the core functions of governance. The extraordinary growth of urbanization in India has given rise to problems of housing, sanitation, power, water supply, disposal of effluents and environmental pollution. Systematic mapping and periodic monitoring of urban land use is therefore necessary for proper planning management and policy making. For sustainable development of urban area, optimal urban land use plans and resources development models need to be generated by integrating the information on natural resources, demographic and socio – economic data in a GIS domain with the currently available satellite data. Planning becomes complex without use of modern technologies available. Now a days GIS proves to be most feasible and economical tool for urban planning and development. GIS enables to provide a single platform of required information by using various distinct databases. However, the urban planning and development scenario in developing nations is different, complex and more challenging than that in developed nations. This paper presents the case study of Malkapur, Daund & Talegaon town in Maharashtra. Adoption of technology in small and medium-sized towns is usually difficult due to budgetary constraints. The case studies selected are thus, an encouraging example since it exhibits worthiness of technology investment evident through the swiftness and accuracy attained in data collection and analysis at economy of cost and time. The collective application of management principles, planning principles and the geospatial technology for the purpose of preparing a development plan for an upcoming progressive town assuring sustainable development. The measures are also suggested with a view to have the implementation of the plan quantitatively as well qualitatively.

KEYWORDS: QGIS, Urban development, GIS, Construction Management

I. INTRODUCTION

1.1. Overview of GIS

A geographic information system, or GIS, is a computerized data management system used to capture, store, manage, retrieve, analyse and display spatial information. A geographic information system (GIS) is a computer-based tool for the input, storage, management, retrieval and output of information. In other words, a GIS answers questions about where things are or about what is located at a given location. The term "GIS" has different meanings in different contexts. It can relate to the overall system of hardware and software that is used to work with spatial information. Civil engineering is about developing and sustaining infrastructure. Geographic information system (GIS) technology provides the tools for creating, managing, analysing, and visualizing the data associated with developing and managing infrastructure. GIS allows to manage and share data and turn it into easily understood reports and visualizations that can be analysed and communicated to others. This data can be related to both a project and its broader geographic context. It also helps organizations and governments work together to develop strategies for sustainable development. Thus,

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GIS is playing an increasingly important role in civil engineering companies, supporting all phases of the infrastructure life cycle.

1.2. Problem statement

The main problem in current planning system is that the required information of planning & design is stored in different formats. The required information is available with different administrative authorities of Government and is not well recorded and managed as well. In addition there is another major difficulty of coordination as various information associated with public utilities is available with different Govt authorities. Thus it becomes necessary to look for a system which will help in generating new data set by integrating the existing diverse datasets with a spatial referencing system.

1.3. Objectives

1. Identification of various complications involved in urban planning.
2. Studying existing utilities and need of development.
3. Ascertaining different alternatives of development and selecting one out of it on the basis of impact analysis.
4. Cost comparison with conventional planning method.

II. LITERATURE SURVEY

2.1 Introduction

The literature review concentrates on the importance of utilizing GIS in managing projects predominantly in the area of construction throughout the world. The studies also highlighted in this paper have been thoroughly researched and assessed in order to support and address the arguments being presented in an organized and relevant manner for ease of reference.

With the advances in the field of information technologies, the construction industry has started taking advantage of some of these developments. "GIS is the tool used to manage construction projects and can improve the construction planning and design efficiency by integrating locational and thematic information in a single environment." (Coors & Abdul-Rahman, 2010)

This review also takes into consideration several parameters of how GIS can be employed by linking the system to other software (Microsoft Project and AutoCAD) to provide spatial representation of the varied aspects of a housing construction project, project status and also the possible challenges involved in implementing GIS within a project management organization.

2.2 Rationale for GIS in Construction Management

The history of Construction is considered to be fraught with problems particularly through poor and inefficient communication that usually exists between owners, engineers, contractors, and the public. Even in today's technologically advanced society, on some projects, field activities and information recording are performed manually and produced daily, weekly or monthly. This lack of communication and data sharing has a direct impact on claims, public relations, and project cost containment. (Carter & Seider, 2006).

The complexity coupled with the huge quantity of information in the building design and construction project requires an efficient system that may aid in the integration of various types of data and provide the required information and data in a timely manner that will finally support various decision and construction operations. The information required for planning and design are stored in different forms, such as drawings, specifications, and bar charts. In the planning process, the planner has to continually interpret and structure the information collected from various resources which can be tedious and prone to errors (Cheng and Yang, 2001).

Geographic Information Systems (GIS) is an appropriate technology for managing construction projects and can improve the construction planning and design efficiency by integrating spatial and thematic information in

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a single environment. It provides capabilities to solve problems, involving creation and management of data, integration of information, visualization and cost estimation to which most of the construction management software is lacking. In construction management, GIS leads to the improvement in collective decision-making among planners, designers and contractors (Bansal and Pal, 2005).

High levels of efficiency in construction management are crucial in the construction industry. A large number of data involved in the planning and design phases of construction projects are usually stored in various forms such as drawings, tables, and charts. These data need to be sorted properly to ensure it can be retrieved and manipulated by related parties when needed. (Coors, et-al, 2010)

Kartam (1997) further extrapolated that the construction industry is perceived to be one of the most hazardous occupations, and ranked low in safety, quality control, and proper information system. Both Vijay (2006) and Kartam (1997) discussed that these circumstances therefore indicates that there is need to have effective computerized methods which would efficiently integrate safety and quality control, during construction as well as the incorporation and evaluation of other important aspects of a project such as costs. One such identified system would be a Geographic Information System, because of its extensive areas of application across the construction industry (Kartam, 1997). In this case the Geographic Information Systems would be utilized as a computerized tool used for capturing, storing, querying, analyzing and displaying the geographic information. Like any other information system, GIS is a special class of information system, which has four components involving a computer system, GIS software, human expert and data. (Bansal, 2007)

"In recent years, evidence has shown that GIS applications have proliferated in the construction industry. This fact has been illustrated by the growing number of articles being published in civil engineering and construction journals and conference proceedings, in addition to the handful of special publications devoted to GIS" (Oloufa et al., 1994). GIS use has also spanned in different areas of applications in construction which includes but is not limited to progress monitoring system in construction, networking solution, 3-D data analysis, site location and client distance, comparison of data, construction scheduling and progress control with 3-D visualization, Government Regulations. (Oloufa et al., 1994)

The application of GIS in urban planning and its limitations are deliberated by Ag-O Yeh. The author has explained use of GIS in different stages of planning. The paper also explains the development and selection of planning options. The paper covers aspect of using GIS in implementation stage. The author also mentions the factors influencing the use of GIS in urban planning the paper explains how the data can be organized and used for planning purpose. Finally the paper concludes that the GIS is becoming the main domain in planning and GIS with planning models, visualization, and the Internet will make GIS more useful to urban planning. (Urban planning & GIS by Ag-O-Yeh)

The research explains the diffusion of GIS within North American planning. The author explains the transformations brought about by the interplay of GIS and planning. The author also states that GIS meets a fundamental need for efficient spatial data-handling capability in planning at all levels and its emphasis on regional economic planning as well as environmental planning finally it concludes that GIS confronts well established, politically favorable, non-automated procedures that are able to obfuscate the decision-making process through inefficiency and lack of documentation

(Trevor M. Harris and Gregory A. Elmes, 1993)

III. DATA COLLECTION

3.1. Introduction of Daund

Daund is a city, municipal council and headquarters of Daund taluka in Pune district. Daund is semi urban in nature. It is one of the main talukas towards the Eastern side of Pune. East to West Distance of Daund is 75 kms and breath wise Daund is 45 kms wide. Daund is a very important railway junction, consequently floating population of the town is quite high.

Coordinates of Daund are Latitude: 18°27'33.44"N Longitude:74°35'14.41"E. The Daund municipal council limit is spread over an area of 9.2 sq km and is bounded by the Bhimariver to its north-east. It comprises of 23 wards. The existing road length of the town is 91 km and it has 13578 buildings.

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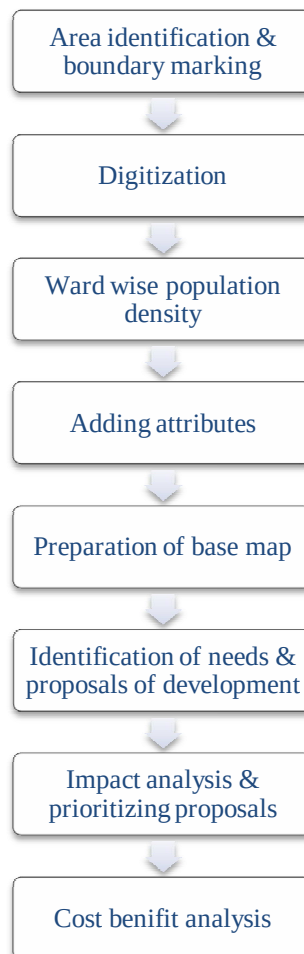
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Data of area boundary, ward boundaries, ward wise population was collected.

IV.METHODOLOGY



1. Area identification & boundary marking

First of all study was identified on google earth. The same area was identified on QGIS by using XYZ Tile function. By doing this a base map of google earth was added in the background of new GIS file previously created. It will help in digitizing the different layers like roads, buildings etc.

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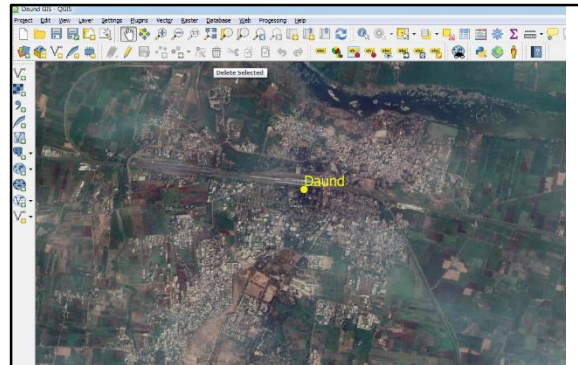


Fig: Adding google earth as background

2. Digitization of the Study Area

Digitization is the process of conversion of data into digital format. In GIS context it is the process in which coordinates from map, image or any other data are converted into digital form. Different vector data sets i.e. point, line, polygon can be created in the digitization process. Roads, ward boundaries, water bodies etc are digitized.

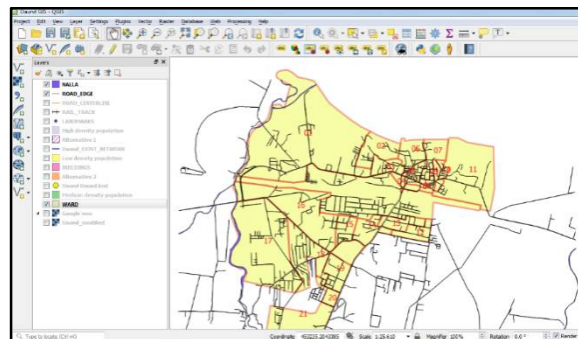


Fig: Digitization of study area

3. Population density

Data of ward wise population was collected and tabulated. The collected data was further analysed and bifurcated on the basis of the population density criterion. The data was mainly bifurcated in high, medium & low density categories. It will be the governing criterion for proposing the development alternatives.

4. Adding attribute data

The attribute table displays information on features of a selected layer. Each row in the table represents a feature (with or without geometry), and each column contains a particular piece of information about the feature. Attributes of ward wise population, density, ward no are attached to the attribute table of ward. Attributes related to pipe network such as diameter, material, year of installation etc are also added to attribute table of a pipe network.

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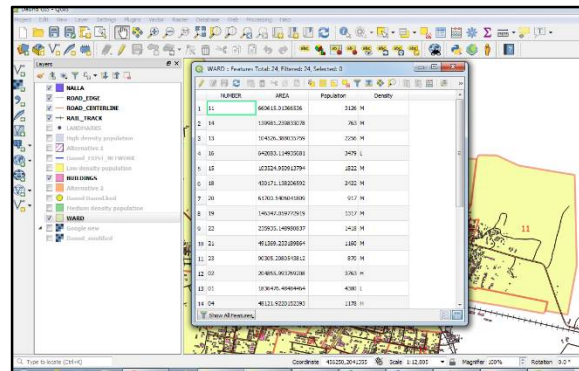


Fig: Adding attributes

5. Preparation of base map

A basemap provides a user with context for a map. All the required information can be added to a single platform. Basemaps contain reference information that may provide different geospatial information based on what the cartographer is trying to communicate. Typical GIS data and imagery that make up the layers for a basemap: streets, parcels, boundaries (country, county, city boundaries), shaded relief of a digital elevation model, waterways, and aerial or satellite imagery. A basemap of study areas is prepared with various layers of road, ward boundary, landmark etc. this base map will serve basis for future planning.

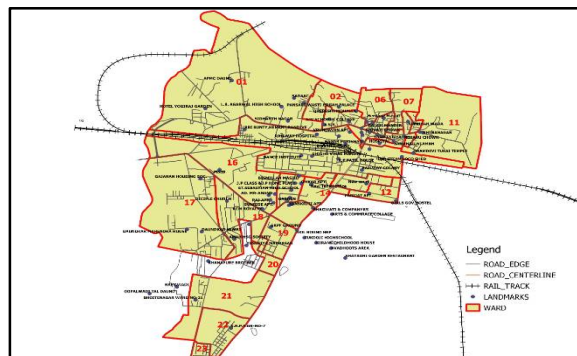


Fig: Basemap of study area

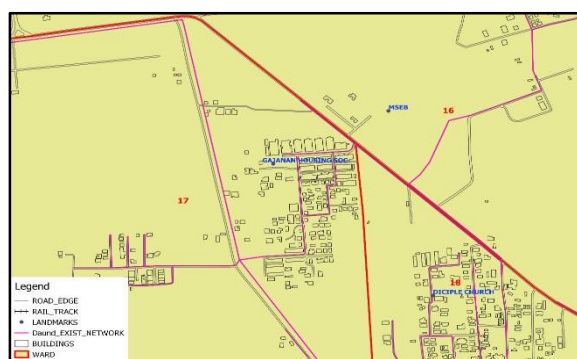


Fig: Detailed view of basemap

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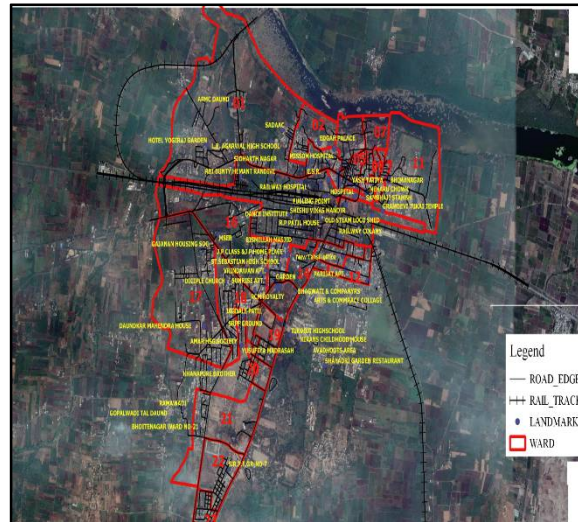


Fig: Basemap of study area with google earth background

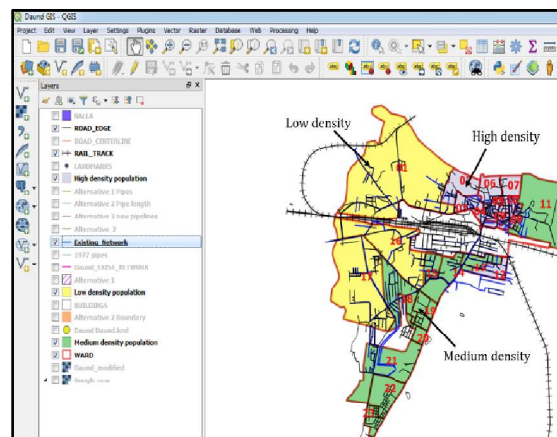


Fig: Basemap showing ward wise density

Proposals of development in Daund

Selected area:

In this proposal, area under ward number 2,3,5,6,7,4,8,9&10 is taken under consideration. These wards are high population density wards. Population density of these wards is 419, 329, 448, 369, 372, 390, 527, 692 & 6088 respectively.

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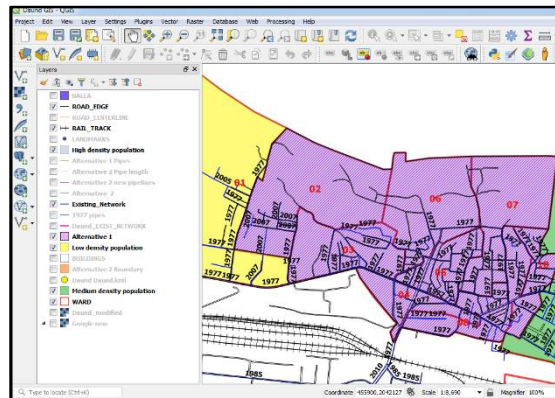


Fig: area of proposal 1

Reason of selection:

The main reason behind the selection of ward no 2,3,5,6 & 7 is less percentage of existing pipeline network in spite of being highly populated area. And the primary reason behind the selection of ward no 4,8,9& 10 installation year of some of pipelines in these wards is 1977.

Water supply network is designed for 30 years of life span as per CPHEEO norms. Considering the population growth in this area as well as installation year, the entire network laid in the year of 1977 needs to be replaced as the designed life span of 30 years is over quite long back. Keeping in view the population served in this area, the existing system is lacking in both ways of coverage and design life span. Hence the recommendation 1 could be of replacing the entire network laid in the year 1977 and laying the new pipe network in uncovered area.

Proposal:

As mentioned above total 9 number of wards are considered under this recommendation. Total existing pipe network laid in these wards is 12.5 Km out of which 11.5 Km is laid in the year of 1977. Therefore it is proposed to replace all these pipelines installed in the year of 1977 having total length of 11.5 Km.

It has also been perceived that, there is newly developed area which do not have any pipe lines. Length of these roads is around 3Km. therefore it is also proposed to lay new pipe lines in this area to serve the newly developed habitat. Thus total 14.5 Km network needs to be placed.

Impact analysis:

Population of the considered wards is 3763, 1649, 1813, 1949, 2121, 1178, 2505, 2282 & 1422 respectively. Hence the total population of the area considered under this alternative is 18682 which is equivalent to 37.69% of the total population of Daund. Consequently by replacing 11.5 Km old pipe lines and placing 3 Km pipe lines, total population of 18682 can be served with new pipe network.

Proposal 2:

Selected area:

In this Proposal, area under ward number 18,19,20,21,22&23 is taken under consideration. These wards are medium population density wards. Population density of these wards is 117, 148, 183, 127, 142 & 143 respectively.

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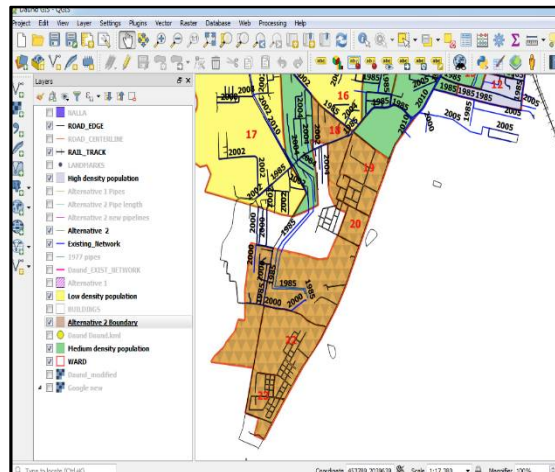


Fig: area of proposal 2

Reason of selection:

The main reason behind the selection these wards is less percentage of existing pipeline network in spite of being populated area. Some of the existing pipelines are installed in the year of 1985 as well.

Water supply network is designed for 30 years of life span as per CPHEEO norms. Considering the population growth in this area as well as installation year, the network laid in the year of 1985 needs to be replaced as the designed life span of 30 years is over. Keeping in view the population served in this area, the existing system is lacking in both ways of coverage and design life span. Hence the alternative 1 could be of replacing the network laid in the year 1985 and laying the new pipe network in uncovered area.

Proposal:

As mentioned above total 6 number of wards are considered under this Proposal. Total existing pipe network laid in these wards is 3.98 Km out of which 1.89 Km is laid in the year of 1985. Therefore it is proposed to replace all these pipelines installed in the year of 1985 having total length of 1.89 Km.

It has also been perceived that, there is newly developed area which do not have any pipe lines. Length of these roads is around 12.3Km. therefore it is also proposed to lay new pipe lines in this area to serve the newly developed habitat. Thus total 14.2 Km network needs to be placed.

Impact analysis:

Population of the considered wards is 2422, 1317, 917, 1160, 1418 & 870 respectively. Hence the total population of the area considered under this alternative is 8104 which is equivalent to 16.35% of the total population of Daund. Consequently by replacing 1.89 Km old pipe lines and placing 12.3 Km pipe lines, total population of 8104 can be served with new pipe network.

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Comparison of Proposals

Sr. No	Description	Proposal 1	Proposal 2
1	Replacement of old pipes	11.5 Km	0.7 Km
2	Installation of new pipes	3 Km	12.5 Km
3	Area	Developed	Developing
4	Population affected	18682	8104

Recommendation

After digitizing and analyzing all the data in GIS, comparison of proposed Proposals become easy. Consequently studying the impact analysis of both the Proposal on GIS base map it can be clearly seen that, proposal 1 serves more population if the pipe network of 12 km length is placed, whereas area population served under proposal 2 is 10912 if only 3Km of pipe line is placed. If both the proposals are compared it can be clearly seen that, though proposal 1 is serving more population proposal 2 can serve more population with less pipe network. Also proposal 2 will give early and additional recovery as it is developed area with high population density as compared to proposal 1. Therefore considering the current scenario proposal 2 should be considered as first priority while developing the city area as it will affect more population with less pipe network.

Cost benefit analysis

Cost benefit analysis of Daund has been carried out as follows

Description	Man-days consumed	
	With use of GIS	Without use of GIS
Digitization of roads	10	15
Digitization of pipelines	5	9
Digitization of buildings	6	15

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Digitization of water bodies	1	2
Digitization of ward boundaries	2	5
Software required with cost	QGIS- Freely available	AutoCAD- Rs 67,044 per Year
Total man-days	24	46

Let us consider that, salary of a person is Rs 50,000 per month.

Therefore per day amount will be $1666.66 \approx 1667$ Rs

Thus,

Cost of working with GIS = $1667 \times 31 = 40,008$ Rs

Cost of working without GIS = $1667 \times 57 = 76,682$ Rs + 67,044 (software) = 1,43,726

Hence % reduction in cost = $(1,43,726 - 40,008) / 1,43,726 \times 100 = 72.16\%$

V. DISCUSSION & RECOMMENDATION

- From the above results it is clear that to make maximum beneficial of available data of a certain area, a planner should take into consideration the use of GIS tool in the planning stage itself
- There are various parameters which are taken into consideration. Different options of development can be proposed using the base map prepared with aid if GIS
- Impact area of every option can be plotted and indicated on a base map and comparison study is carried out
- This type of work can be applied in future to plan & develop any town or city

VI. CONCLUSION

This study illustrates the importance of GIS tool at planning stage would assist planner to obtain the accurate and real time data in a single click.

Development in planned manner will can optimise execution time which in turn will optimise cost as well

By using QGIS software the records of existing utilities of Daund & Talegaon are prepared which will help to prioritize the development of the town easily in less time with maximum precision

GIS is a tool if used in planning stage can optimize time as well as cost. Cost benefit analysis of the study area shows 72.16% cost reduction.

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REFERENCES

- [1] Bansal, V. K., and Pal, M. (2005). "GIS in Construction Project Information System" Proceedings of Map India, 8th annual international conference and exhibition in the field of GIS, GPS, Aerial Photography, and Remote Sensing. New Delhi, India.
- [2] Bansal, V.K. and M. Phal. (2006). GIS based Projects Information System Construction Management. Asian Journal of Civil Engineering (Building and Housing). 7(2): 115-124.
- [3] Bennett, I. (2012, March 15), Interview on Current Capabilities and Utilization of GIS at the National Water Commission.
- [4] Burrough, P.A. and McDonnell.(1998). Principles of Geographic Information Systems: Spatial Information Systems and Geostatistics. India, USA: Oxford University Press.
- [5] Bestebreurtje, J.A. (1997). GIS Project Management. Netherlands, Amsterdam: Manchester Metropolitan University.
- [6] Boxe, N., Spence, D. and Lane, K. (2003). Basic Construction Manual - For A Single Storey Domestic Dwelling. Incorporated Masterbuilders Association of Jamaica.
- [7] Carter, N. and Seider, D. (2006) GIS Improves Construction Management, Newstead, India. Cheng, M.Y and Yang, C.Y. (2001). "GIS-Based Cost Estimate Integrated with Material Layout Planning." Journal Construction Engineering and Management, Vol. 127, no. 4, pp. 291-299.
- [8] Clarke, J., (2008.) Appetite for Construction. Presentation. Australia: Thiess. Easa, S., and Chan, Y. (2000). Urban Planning and Development Application of GIS. USA, AL: American Society of Civil Engineers (ASCE).
- [9] Coors, V, and Abdul-Rahman, A. (2010). Incorporating 3D Spatial Operator with Building Information Models in Construction Management using GEO-DBMS.
- [10] ESRI. (2004). Building Geodatabases. California, USA: ESRI
- [11] ESRI. (2004). Introduction to ArcGIS: for ArcInfo 9, Arc Editor 9 and Arcview 9. California, USA: ESRI
- [12] Environmental Systems Research Institute. (1999). Spatial Analyst Extension. California, USA: ESRI., 186 p. Kartam, N.A., Integrating safety and health performance into construction CPM.
- [13] Journal of Construction Engineering and Management, ASCE, 123(1997) 121-126. Li, H. Z., Chen L. Y. and Kong S.C.W., (2004). Application of Integrated GPS and GIS Technology for Reducing Construction Waste and Improving Construction efficiency. Presentation. 14 (3): 323-331.
- [14] Liske Chris (2007). Designing, editing, and maintaining a cadastral GIS. Presentation. Rapid City. Retrieved on February 2011. <http://www.sdgs.usd.edu/bhdma/2007-09/pdf/ChrisLiske.pdf>.
- [15] Musliman I., Abdul-Rahman A., and Coors V. (2010). Incorporating 3D Spatial Operator with Building Information Models in Construction Management using Geo-DBMS Pelepkov, S. (2008). Geographic Information System (GIS) Base Management of Construction Aggregate Resources in the Commonwealth of Pennsylvania.