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A HIGH SPATIAL RESOLUTION SATELLITE DATA APPLICATION IN ENGINEERING MANAGEMENT

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Abstract- There is no doubt that management in any area demands good and high accuracy information as the first stage of the cycle. The next stage is to be able to select, systemize and analyze of collected information. The final point is to process of data. It defines the success of the management, which creates environment for decision making based on all the stages of data line. It is important to point out how to select the way and what kind of method needed to be used for achievement of expectations. This approach is one more aspect of success of high outcomes of management including in engineering. Advances of space technology application play a vital role in a variety of areas. It has been successfully used in engineering, especially with the means of remote sensing and Geographical Information System (GIS). This paper is dedicated to the use of remote sensing and GIS technology in the process of management of the Upgrade of Oil Petroleum Terminal and modernization of the filling complex of the oil refinery plant. Its conceptual approach to successful demonstration of required information is an essential tool for engineering activities management.

Keywords: Remote Sensing, Geographical Information System, Engineering Solutions, Project Management, Data Measurements, Space Technology, High Resolution Satellite Image.

I. INTRODUCTION

It is vital to consider all aspects of engineering activities starting almost from the tender stage of execution. Obviously it is highly demandable to try to gather high quality information embracing all aspects of engineering stages.

It is necessary to state that there is a close link between design and construction stages during planning of the engineering facility development. These processes should be considered as an integrated system. Generally speaking, designing is the process of creating a description of a new production facility, usually represented by detailed plans and technical requirements, such as construction planning. This process contains the process of identifying the actions and resources required to make the design physically functional. Consequently, construction is the implementation of design offered by architects and engineers from different engineering disciplines. In both design and construction, numerous operational tasks must be taken into account and implemented with multiple factors and engineering segments containing complex tasks.

It is worth noting that some aspects of planning during the production facility development process, which should be considered even at a very early stage of the project cycle. They include the following:

- each engineering activity – design and construction is considered as an individual project with a set project execution time;
- design and construction stages of the project have to meet conditions, specifics of the selected area;
- the project has to reflect natural, social and other geographical features of the selected area, such as climate, human resources, local construction standards, norms and regulations, etc.;
- the structures created provide for their long-term operation, which demand high requirements;
- technological complications and market requirements lead to a change in design plans during construction, which is common.

In an integrated system, design and construction planning can begin almost simultaneously, and various alternatives should be considered to eliminate the need to revise the project budget. In addition, it is necessary to evaluate the projects regarding their reliability in the implementation from planning to construction.

II. FEATURES OF APPLICATION OF SPACE TECHNOLOGY IN ENGINEERING

Remote sensing method allows registration of a scene on the surface of the surveyed area by means of electronic scanning, using the visible range of radiation,

as well as electromagnetic waves outside the visual range of the visible range of sensors and microwave cameras, radar, thermal, infrared, ultraviolet, and multispectral, special technical means for further processing and interpretation of remote sensing images. The results of processed data are presented in the form of conventional and thematic maps, which find their application in fields such as agriculture, archeology, forestry, geography, geology, etc. [1].

The purpose of the use of re mote sensing in construction is to obtain land use maps that help create an initial hierarchy of the surveyed territory and also provide geographic information that will allow to determine the boundary of the site, optimize the construction process and achieve an improved assessment of the entire process. Satellite imagery can also be very useful for preparing the necessary fieldwork materials.

III. GEOGRAPHICAL INFORMATION SYSTEMS

The Geographic Information System (GIS) is a unique way of collecting, storing, transforming and displaying spatial data for solving various tasks, depending on the goals set [2].

It should be noted that actions related to construction can be successfully linked to a geographic information system. Thus, it is a very good tool making possible control/monitoring and management of collected/processed database most effectively and efficiently on the basis of satellite images. It can be used as a tool to determine the boundary of the selected construction area, features of terrain, etc. The initial data within the GIS is very important information in the building for subsequent process management, including the preparation of materials and the collection of field data necessary for the collection and processing of information for subsequent analysis and decision-making. Using technological advances in electronic notebooks, a tablet and GPS devices in data collection, it is possible to achieve high accuracy results both in the collection of primary data and field data, which significantly reduces time and costs than traditional methods.

IV. STAGES OF APPLICATION OF GIS IN ENGINEERING

Figure 1 illustrates stages of engineering activities using remote sensing techniques with the subsequent creation of GIS technology. There is no doubt that any engineering activity originates from the tender stage. After the announcement of the tender, the participants submit their proposals on all aspects within the framework of the tender requirement covering the main parties of the tender package.

It is obvious that the tender participant that has the most advantage is the one that possesses more information compared to other tender participants. This circumstance directly affects the quality of the tender with more specific technical proposals in terms of engineering solutions, which in turn affects the cost of the project. There is no doubt that both factors play a decisive role in the evaluation and decision-making in the final stage of the tender.

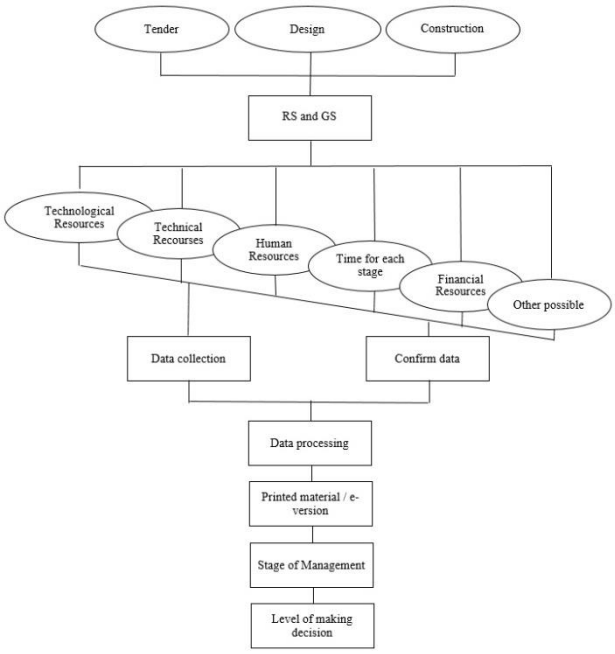

Figure 1. Description of stages of engineering activities and application of space technologies during implementation of the engineering project

Data collected during the tender can play a significant role in the design phase. This will allow a clearer approach and more precise definition of directions and ways of solving engineering problems. Certainly, this circumstance will lead to a reduction in financial expenses, which is a very significant factor in the commercial part of the project.

A. Achieve Success in Main Areas of Engineering

The application of space technology, in particular methods of remote sensing and GIS technologies, can significantly affect all aspects of engineering activities in terms of providing it with high-quality and accurate information covering fairly wide area.

To achieve the planned successes and efficiency of engineering activities in process management, it is necessary to create an appropriate environment for managing the resource segments that are part of engineering activities. As shown in Figure 1, such major resource segments are the technological, technical, human, time spent for each phase, financial and other possible costs that may appear in the design and construction process.

B. Description of Resources Segments

Technological resources - a set of resources that allow conduction of production activities in the area. This group of resources can include: objects of economic and non-economic purpose, the number and quality of the human workforce, the level of transport development and location of the main transport routes, the development of communication media (types of communication, accessibility and quality of communication), the availability of industrial infrastructure facilities, territory (including the development of business services).

Technical resources - a collection of material values, parts of the means of production that participate and serve the production process for a long time, in many production cycles, retain their original form in the production process, transfer their parts in parts to their value for products made with their participation or with the participation of their services. From the economic point of view, these resources can be divided into active and passive groups [3].

The active part of technical resources consists of tools (tools) of labor: machines and equipment directly engaged in the technological process. Passive technical resources consist of buildings and structures that provide conditions for the normal flow of the production process, but do not directly participate in it. Human resources define the quantity of personnel of the project involved in the project realization process.

Time for each stage is the spent time for each stage of engineering activity. The set of all financial expenses during implementation of the project contains financial resources as a whole.

C. Remote Sensing and GIS

The remote sensing data with the subsequent creation of the GIS allows to integrate all the data into the appropriate format, which is a good tool for managing the engineering process. This includes the collection of primary data with valid field data. The next step is the processing and presentation of data in the form of maps or digital data in the format of printed materials or in electronic form.

The obtained data allow the personnel in the decision making involved in the management process of engineering.

D. GIS Development

This work presents the results of using remote sensing methods with the subsequent creation of GIS for the "Upgrade of Oil Petroleum Terminal" project. The scope of work on the project includes:

1. Conceptual design;
2. Detailed design;
3. Procurement and supply of materials and equipment according to the project specifications;
4. Construction in one stage.

To create a GIS, maximum efforts are made to ensure that as many layers as possible are included in the GIS. From this point of view, the following conditions are included in the information base, such as:

- construction with seismicity of 8 points;
- average annual temperature varies from + 13.50 ℃ to + 14,4 ℃;
- July temperature varies from +24.7 ℃ to +25.6 ℃;
- January temperature varies from +2.9 ℃ to +3.8 ℃;
- frost penetration in the soil 0.3 m in depth;
- northern wind stream (North);
- average annual wind speeds of 6-7 m/s;
- average annual rainfall of 247 mm;
- average relative humidity: 70-73%.

The work at the Upgrade of Oil Petroleum Terminal was performed in the following directions:

- equipment foundations;
- buildings and warehouses foundations;
- pump station foundations;
- foundation supports;
- reservoirs foundations;
- foundation bases;
- funds of pipes for poles.

Figure 2 shows the schedule for construction works that was part of the information layer of the GIS.

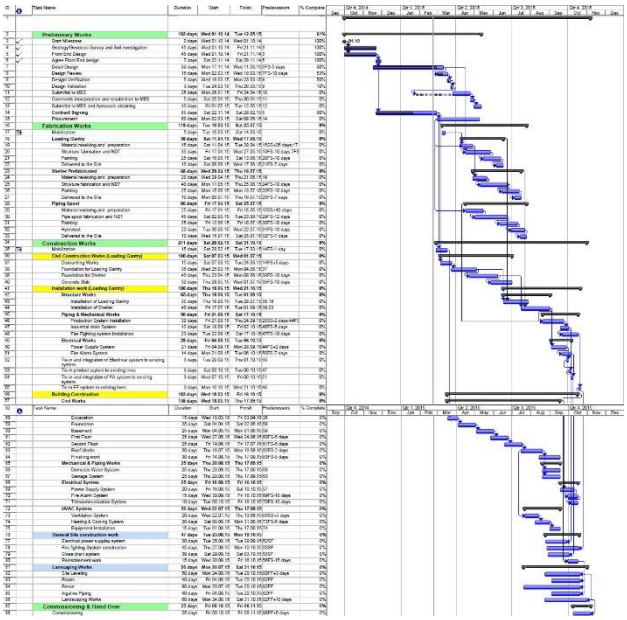

Figure 2. The developed temporal diagram of the executed construction works using "Microsoft Project" software

V. METHODS

A. Information Selection

The satellite image of the area where work was expected to be done was used during the project works. Detailed analysis and study of the terrain from the image and the linking of data with it through fieldwork were part of the work on the creation of the GIS of this work [4]. Work was not confined to the study site. All features of the area around this plant have also been studied in detail. The purpose of this work was to possess information so that it is possible to successfully integrate all engineering structures and systems within the plant with the appropriate communication facilities and engineering systems outside the terminal territory.

Figure 3. The space image of the territory where expected construction was to be carried out

B. Geodetic Measurements

Geodetic works were carried out in the terminal for establishment of coordinate network system and elevation data. This work has been executed using of the following equipment:

1. GPS - Leica SR20
2. TS - Leica of TC 09+

The created coordinate network allowed to accurately tie the space image with the topographic map, as shown in Figure 4.

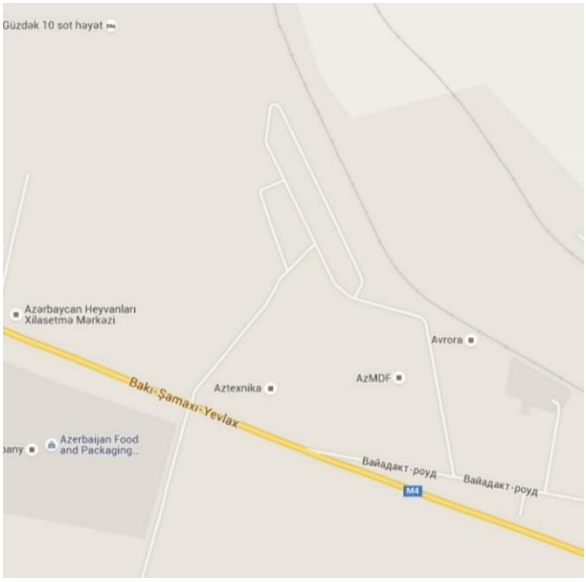

Figure 4. Graphical representation of the terrain created on the basis of a topographic map

VI. RESULTS

Figure 5 presents the results of the work done on the overhaul and modernization of the oil refinery plant at the terminal. A legend was created for the site of the plant, where work is planned on overhauling and modernizing the filling complex of the oil refinery using space information with all stages of its processing [5].

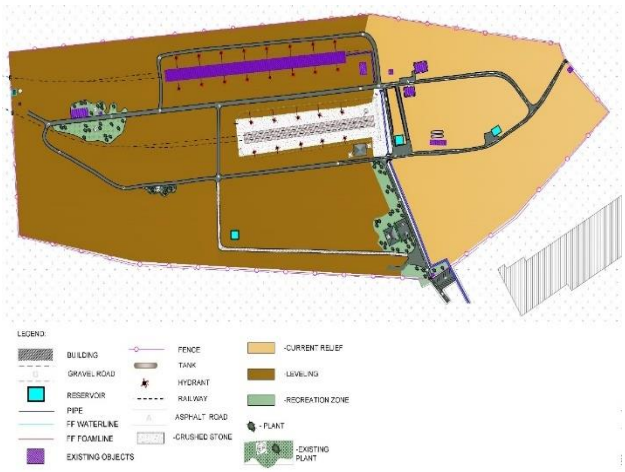

Figure 5. The results of remote sensing data and GIS for the upgrade and modernization of the filling complex of the oil refinery plant at the terminal

The presented data were refined and confirmed by field measurements and analyzed and compared, which created the necessary conditions for the implementation of the project for overhaul and modernization of the bulk refinery complex.

VII. CONCLUSIONS

The presented work demonstrates the conceptual approach to the use of remote sensing methods with the creation of a Geographic Information System in engineering activities, in particular on upgrade of oil petroleum Terminal and modernization of the filling complex of the oil refinery plant.

The advantage of this approach to the application of space technology in engineering is a positive incentive and impetus to manage the construction processes in such complex areas as engineering modification and the creation of new engineering infrastructures.

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BIOGRAPHIES

Sevil R. Ashumova was born in Baku, Azerbaijan, June 1990. She received the B.Sc. and M.Sc. degrees in Mechanical Engineering from Azerbaijan State Oil Academy, Baku, Azerbaijan in 2011 and 2013, respectively. She has completed an internship as an engineer of Manufacturing Processes Automation in 2012. Currently, she works as an engineer in Encotec Company, Baku, Azerbaijan. Her engagement within the company embraces for the calculation of reinforced concrete and steel structures, based on the use of the appropriate engineering software package Bentley Staad.Pro, and also manual calculation. She is involved for project execution "Fibro-Cement Plant" designer and project manager. At the same time, she successfully integrates her software abilities for integration of space and filed data for engineering solutions.

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Kamran T. Mammadov was born in February, 1991, Baku, Azerbaijan. He has completed secondary school in Baku at Baku -Turkish Lyceum in 2007. He graduated with a BA in Business Administration from Lindenwood University, St. Charles, MO, USA, in 2013. He has more than three years experiences as a project coordinator involved in project initiating, managing, controlling, and close out; ensuring the project flows according to schedule and budget, organizing and running the change register, reflecting clients' comments and desires, developing CTR (cost, time, resources).

Rustam B. Rustamov was born in Ali Bayramli, Azerbaijan, on May 25, 1955. He is an independent expert on Space Science and Technology. In the past, he was in charging of the Azerbaijan National Aerospace Agency activities as an Acting Director General. He has mainly specialized in space instrumentation and remote sensing and GIS technology. He has graduated Ph.D. at the Russian Physical-Technical Institute, S. Petersburg, Russia. He was invited for the work at the European Space Agency within the Framework of the United Nations Program on Space Applications at the European Space Research and Technology Center, The Netherlands. He has appointed for the United Nations Office for Outer Space Affairs Action Teams (member, Vienna, Austria), United Nations Economical and Social Commission for Asia and the Pacific (national focal point, Thailand), International Astronautically Federation (Federation's contact, France), Resent Advances in Space Technologies International Conference Program Committee (member, Turkey). He is an author of 15 books published by the European and United States famous publishers and more than 120 scientific papers.