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# COST ESTIMATION FOR SPACE TECHNOLOGY APPLICATION IN PROJECT BUDGET DEVELOPMENT

**S.R. Rustamova [1] K.T. Mammadov [2] A. Kurnaz [3] S.N. Hasanova [4] R.B. Rustamov [5]**

*1. EBRD Business Advisory Services Program, Baku, Azerbaijan, sevinj@bas-az.org*
*2. Business Administration, Lindenwood University, St. Charles, MO, USA, ktmkamran@yahoo.com*
*3. Computer Engineering Department, Bahcesehir University, Istanbul, Turkey, ayca.kurnaz@hotmail.com*
*4. British Petroleum, Baku, Azerbaijan, s_hasanova@hotmail.com*
*5. Laboratory of Modern Method of Applied Electrodynamics, Institute of Physics, Azerbaijan National Academy of Science, Baku, Azerbaijan, r_rustamov@hotmail.com*

**Abstract-** A cost estimation is one of the important part of budget development. It is an excellent instrument for monitoring of the budget expenses. This approach of monitoring of the finance condition and circumstance makes possible to evaluate and implement corrective actions when required. The scientific grants related to the space technology research programs are accelerating the development of technologies enhancement to encourage the future space science and technology explorations and research activities for embracement of needs state authorities as well as commercial space entities. An investment in innovative space science and technology application increases knowledge and capabilities in response to a new problems and requirements, stimulates innovation and allows more creative solutions to problems constrained by schedule and budget. Moreover, it is obvious that an investment oriented to the fundamental research activities that has historically benefited for common interests of countries in space technology and its applications. One of the important aspects of a successful project execution depends of project budget development. Projects benefiting from the use of space technologies also need budget development, and their funding may vary. There are several approaches of the budget formation. It is needed to be undertaken appropriate budget form use might be effectively reflect financial status of the executed project. It is demonstrated suitability of use budget for successful project financial management processes during project execution.

**Keywords:** Budget, Scientific Grant, Space Technology, Space Image and Processing, Remote Sensing, GIS.

## I. INTRODUCTION

The project outcomes provided in this paper as an example is titled "Application of Remote Sensing and GIS technology to reduce flood risk" under Prevention Research & Action Grants project in association with the University of Wisconsin – Madison Disaster Management Centre, USA for 2007-2008. One of the main targets of this project is to develop of an advance tool for monitoring, data collection, data processing, review and report on progress and challenges in the implementation of disaster risk reduction and recovery actions undertaken at the national level. An advance tool has been undertaken of the use and application of modern achievements of space science and technology for the natural disaster events in particularly the river flood.

Furthermore the other target of project is to undertaken to assist the local authorities to build up useful database in disaster risk reduction in particularly for the selected area with a more sensitively part of country in point of view the river flood in Azerbaijan. In the meantime the next issue was to demonstrate a contribution of the possibility and advantage of use of remote sensing methods and GIS technology based on space image data collection and data processing for application of similarity problem solving.

## II. METHODOLOGY

The use and application of space technology in a wide case particularly for the case of river flood reduction is a more suitable means due to the large area embracement, high accuracy, availability of application in the unacceptability areas etc. Moreover, according to the created and developed database there is an advantage to be very sensitive to any available change occurred in the investigated sites.

For carrying out of the goals undertaken within the framework of the project execution the following methods have been used:

- The use of ALOS space imagery to be created the land use / land cover basic map for the investigated area using urban, agriculture, garden, scrub, open area, river, stream, canal, road, railroad basic classes;
- The use of Landsat ETM space imagery to be detected potential flood inundation areas within the Kura River watershed in the Salyan district of Azerbaijan using a tasseled cap transformation;
- The derive 1 m Digital Elevation Model (DEM) from contour lines and elevation points of the investigated area

to be generated a deterministic model of potential inundated areas for the region using the DEM and a convex - areas surface; and

- The evaluate the sensitivity of each approach to be characterized the flood inundations through statistical tests involving comparison of flooding areas extracted from an inventory of soils and a geomorphology maps.

## III. KEY FINDINGS

- Space technologies are to develop of an advance tool for monitoring, data collection, data processing, review and report on progress and challenges in the implementation of disaster risk reduction and recovery actions undertaken at the national level;
- As a further step a wide scale of river monitoring is required for successful and effectively forecasting, preparedness and reduces of the natural disaster impact;
- Awareness information program of this hazard has to be developed and implemented in order to save the human life, as well as properties;
- To reduce disaster damage impacts;
- Potential flood inundation areas can by identified by satellite imagery and ground - based measurements; and
- The mapping of potential flood areas can help for further settlement planning in this region.

## IV. SPACE IMAGE PROCESSING

ALOS imagery was acquired 10 June 2007 (Figure 1). The image was geo-referenced to UTM zone 39 North, WGS84 using a first degree polynomial rectification algorithm with 30 ground control points (GCPs) extracted from a digitized topographic map at the scale of 1:100 000. The root mean square (RMS) error was equal to 0.5 pixel (5 m).

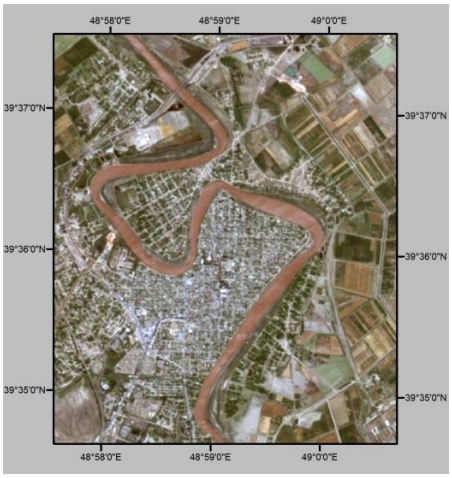


Figure 1. ALOS imagery of the selected area [2]

The image was classified between follow general classes (Figure 2):

1. Urban or Built - up Land;
2. Agricultural Land;
3. Garden;
4. Scrub;
5. Open area;
6. River;
7. Stream;
8. Canal;
9. Road;
10. Railroad.

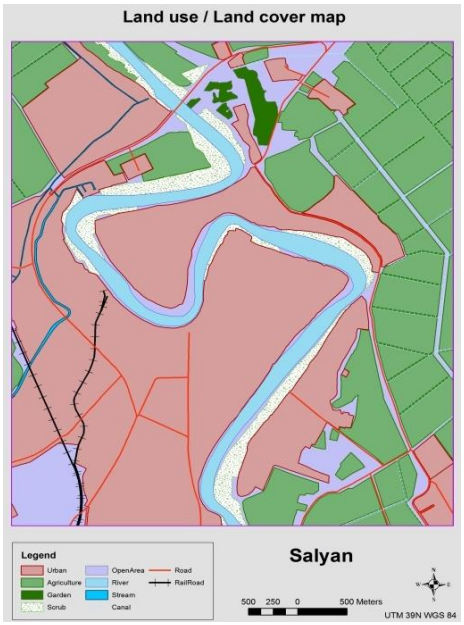


Figure 2. Land use / Land cover map [3]

One Landsat Enhanced Thematic Mapper (ETM) satellite image from June 2000 (path 167, row 32) was selected for analysis. This image was obtained from the Global Land Cover Facility of the University of Maryland (http://glcf.umiacs.umd.edu/data/). June corresponds to the dry season in Azerbaijan and the identification of flooded areas was unsatisfactorily. The image was geo-referenced to UTM zone 39 North, WGS84 using a first degree polynomial rectification algorithm with 25 ground control points (GCPs) extracted from a digitized topographic map at the scale of 1:100 000. The image pixels were resampled to 28.5 x 28.5 m using a nearest - neighbor interpolation method to preserve radiometric integrity. The root mean square (RMS) error obtained in the rectification process was less than 1 pixel (28.5 m).

## V. BUDGET DEVELOPMENT

The most important part of budgeting in space technology projects is acquiring space imagery. There are several steps necessary for a successful purchase of a space image. In this case is necessary to consider following aspects of space images requirements:

- The area that the image must cover;
- Image resolution;
- The season that the image was taken in;
- The year that the image was taken in;
- Other insignificant requirements.

When images are finally acquired experts with required experience in space imagery processing has to work with the existing data. The information gathered from the project has to be archived saved under necessary categories in order to be available for access at any moment when needed [2, 3, 4].

There are several budget formation used for project execution. There is no doubt that the budget in scientific grant performance required to be consider changing of the budget items depends of consequences during project execution. In this case it is desirable to make decision and selection of two main types of budget: fixed and adaptable (flexible for each item). Fixed budget means that no changes can be made for considered in budget time period. This budget formation has an advantages for instance lack of review of approved budget chapters which makes easily to monitor of financial capital motion. In this approach limits of financial risks in any project execution stages if the project executed within the frame of budget gaps.

The other way of budget development is to select flexible budget for scientific grant project. It is convenience of use of such a budget segment due to the easily and flexible change of expenses during project execution. It makes available to increase efficiency of project outcomes using existing budget gap flexibility and at the same time successfully to monitor of financial motions due to the simplicity of budget nature of scientific grants. In this paper has been demonstrated fixed budget developed in the tender stage and actual budget for project during its execution. Table 1 shows project budget initially fixed expenses.

Table 1. Initially fixed budget development in the tender stage

| Category | Amount in Approved Budget (USD) |
|---|---|
| Consumable supplies | 350 |
| Equipment purchase or rent | 500 |
| Subsistence | 800 |
| Translation | – |
| Printing | 300 |
| Postage and Shipping | – |
| Telecommunications | 900 |
| Publications and software | 200 |
| Transportation and Travel | 800 |
| Honorarium (for Mentor, if applicable) | 400 |
| Bank fees | 250 |
| Other, specify: Satellite image | 500 |
| TOTAL in Local Currency | 4 035 |
| TOTAL in US Dollars | 5 000 |

As derived from the Table 1 the budget for the project started with the approved amount of capital from the organization that awarded the grant. However actual expenses differed and adjustments had to be made. Therefore capitals from different parts of the approved budget were mutually replaced and the overall expenditure did not exceed the initial amount and the budget had to be modernized and became suitable and flexible, as seen in Table 2.

*U* and *F* describe unfavorable and favorable variances consequently. As it has been demonstrated in the Table 2 some items did not estimate correctly. The additional expenses required for each indicated items were transferred from other budget items thank to advantages of the Grant requirements. Indeed evaluation the Grant financial performance is required to outline an actual results can be differ from the master budget due to the following reasons:

(i) revenue or variable costs per unit of activity and fixed costs per period were not as expected; (ii) sales and other cost-driver activities were not the same as originally forecasted.

Table 2. Actual budget and variances developed during the project implementation stage as required

| Category | Amount in Approved Budget (USD) | Actual Expenses from Grant Budget (USD) | Budget Variance | Expenditures from other sources(USD) |
|---|---|---|---|---|
| Consumable supplies | 350 | 83 | 267 *F* | |
| Equipment purchase or rent | 500 | 581 | 81 *U* | 81 – telecom. |
| Subsistence | 800 | 900 | 100 *U* | 100 – bank fees |
| Translation | – | – | - | – |
| Printing | 300 | 698 | 398 *U* | 200 – publications and software; 198 – consumable supplies |
| Postage and Shipping | – | 79 | 79 *U* | 79 – telecom. |
| Telecommunications | 900 | 241 | 659 *F* | |
| Publications and software | 200 | - | 200 *F* | |
| Transportation and Travel | 800 | 1209 | 409 *U* | 409 – telecom. |
| Honorarium (for Mentor, if applicable) | 400 | 400 | 0 | – |
| Bank fees | 250 | 56 | 197 *U* | |
| Other, specify: Satellite image | 500 | 550 | 50 *U* | 50 – telecom. |
| TOTAL in Local Currency | 4 035 | 3 917 | 118 *F* | |
| TOTAL in US Dollars | 5 000 | 4 797 | 203 *F* | |

Taking into account indicated aspects the scientific Grants budget formation can include the following steps to construct the budget:

1. Determine the units' output
2. Identify the activities expected to deliver as an output
3. Estimate the demand for each items
4. Determine the cost of resources of the relevant activities required to produce

It is important to emphasize that the use of integrated way of budget formation in the area allowed successfully implement and complete of project in space science and technology applications.

## VI. CONCLUSIONS

Budgeting is important in space technology application grants because a little mistake can cause a huge unexpected expenditure that can lead to the termination of the project. Therefore the budget must be very accurately calculated up to the insignificant details. Developing a budget will also give a better picture of the overall project while reducing the risks of errors.

Fixed budget in space technology application grants is advantageous in small projects, or projects with a lower risk of changing its flow, but requires exact information on every minor detail in the project, including communication expenditures. If a project is larger, or it has a high risk to progress in a different way, then an adaptable budget is more useful and less risky, as it gives a lot of space to extend.

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## BIOGRAPHIES

**Sevinj R. Rustamov**a was born in St. Petersburg, Russia on October 12, 1984. She has completed her Master degree in Master of Business Administration at Azerbaijan State Oil Academy in cooperation with the Georgia State University (USA). She has experienced mainly in consulting for business advisory services in project developments and implementations. Recently, she has started to introduce the application of business administration processes in a wide area of management with application of space technology methods. She has published scientific a paper in the foregoing indicated area.

**Kamran T. Mammadov** was born in Baku, Azerbaijan, in February 1991. He has completed secondary school in at Baku-Turkish Lesseum, Baku, Azerbaijan in 2007. Currently, he is a last year student of Business Administration, Lindenwood University, St. Charles, MO, USA. He has an experience as a project coordinator involved for the preparing the project planning schedule and ensuring the project flows according to schedule, organizing and running the change register, reflecting clients' comments and desires, developing CTR (cost, time, resources).

**Ayca Kurnaz** was born in Izmir, Turkey on November 25, 1987. She is a Research Assistant in Software Engineering Department, Bahcesehir University, Istanbul, Turkey. She has graduated in Information Technologies Master Program at the Bahcesehir University. She is a Ph.D. candidate in Computer Engineering at the same university. She is interested in human computer interaction and ubiquitous learning environment. She participated to Resent Advances in Space Technologies International Conference Program Committee, Turkey. She is the author of an approved scientific paper and 2 proceedings.

**Sabina N. Hasanova** was born in Baku, Azerbaijan on November 11, 1988. She has graduated from Azerbaijan Architecture and Construction University, Baku, Azerbaijan specialized as designer. Currently, she is student of International Excellence University with the Head of Office in Madrid, Spain, for a Master in Architectural Management and Design. She has the experience in engineering mainly as the designer. She has involved actively the use of advances space technology in engineering generally in engineering management processes. She is an author of a number of scientific papers and published four books in the US and Europe famous publishers.

**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 11 books published by the European and United States famous publishers and more than 80 scientific papers.