A MODEL FOR THE ECONOMIC EVALUATION AND MANAGEMENT OF REMOTE SENSING OPERATIONS.

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Abstract:

This paper presents a model for the economic evaluation of remote sensing operations. The principles of project management are used to provide a practical and efficient structure to this process.

The model is an outcome of an Australian study of the commercialisation of remote sensing technology. The study identified that an important facet of the operational success of new technologies is the use of cost-benefit analysis for project monitoring and control.

The paper concludes that the use of project management practice is a viable tool in establishing standards for the operational planning of remote sensing applications.

Key Words: Business Management, Economic, Remote Sensing, Remote Sensing Applications, Standards.

INTRODUCTION

This paper presents a model that has been developed to assist in the economic evaluation of remote sensing operations. The established principles of project management provide a practical and efficient framework for this modelling process.

The model has been developed as part of an Australian study of the commercialisation of remote sensing technology. The study identified that one of the important factors that lead to the operational success of new technologies is the use of cost-benefit analysis for project monitoring and control (Finegan and Ellis: 1991, 1992).

THE BACKGROUND TO THE PROBLEM

An increasing number of remote sensing applications, undertaken by Australian agencies, are now operational projects. This transition from the research and development phase must be accompanied by the development and use of appropriate technology management standards. The "real world fact of life" is that a new technology will only be adopted into an operational project if it can be shown to be cost effective. Not only must the technology be cost effective in fact, it must be shown to be cost effective. Failure on the part of remote sensing technologists to monitor and control both the costs and benefits associated with a "start-up" operational project can lead to management resistance to undertaking future projects using that technology.

A number of studies have been undertaken concerning the economic factors associated with remote sensing technology transfer. The opportunity costs of remote sensing is discussed by Paul and Wigton (1984), and the economic effectiveness and performance of 10 remote sensing projects is analysed by Epp and Whiting (1989). The benefits to society of industry use of remotely sensed data is presented by Aronoff (1985) and Morain (1985) discusses small business expectations regarding the performance, duration and returns of projects that use remotely sensed data. These studies all recognise the need for economic analysis, but they do not provide or suggest a framework model that would assist a project manager in developing a cost benefit analysis of an operational project that uses remotely sensed data.

There is now a real need to quantify the operational capability of remote sensing technology to provide more comprehensive, timely, and less costly information and analysis than through the use of traditional methods. The high direct capital cost of remote sensing equipment, data and training make it imperative that operational projects are shown to produce both direct and indirect benefits that are cost effective. Project success must be measurable.

METHODOLOGY USED

The success of a project may be measured by the application of proven project management practice. In this study, the project management activities for the development of management information systems (Murdick and Munson, 1986: 550-557) are used as guide-lines. A successful project is defined as one which produces specified results in a prescribed time. Effective project planning and control is achieved by:

- Making sure that objectives are established.
- Making sure that key tasks are identified.
- Providing a basis for control of time, cost, and performance.
- Establishing precedence relationships among tasks.
- Establishing costs and preparing budgets related to time and performance of tasks.
- Organising and assigning personnel to ensure that tasks will be performed.

The two detailed processes of **project planning** and **project control** are critical to the success of a project.

The key steps in these processes are:

Project Planning:
1) Establish the project objectives.
2) Define the project tasks.
3) Plan the logical development of sequential and concurrent tasks and task activities.
4) Schedule the work as required by management-established end dates and activity-network constraints (from 3).
5) Estimate labour, equipment, and other costs for

the project.
6) Establish a budget for the project.
7) Plan the staffing of the project over its life.

Project Control:

1) Ensure that project objectives are being met as the project progresses.
2) Maintain control over schedule by changing work loads and emphasis as required by delays in critical activities.
3) Evaluate expenditure of funds in terms of both work accomplished and time.
4) Evaluate manpower utilisation and individual work progress and make adjustments as required.
5) Evaluate time, cost, and work performance in terms of schedules, budgets, and technical plans to identify interaction problems.

APPLICATION OF METHODOLOGY

The first step in developing the model is to define project tasks.

Certain tasks are common to most remote sensing projects. The following are the general type of tasks that would make up a typical project programme where remote sensing is being considered:

Activity 1. **Define Project** - What is to be achieved?

Activity 2. **Evaluate Existing Databases** - What information is already available in existing systems?

Activity 3. **Initial discussion with Remote Sensing Consultant**

Activity 4. **Define need for Remote Sensing** - Make a comparative analysis of options available. An initial cost-benefit analysis may be required.

Activity 5. **Set Remote Sensing Objectives** - How will the use of remote sensing achieve the overall project objectives?

Activity 6. **Define Data Processing Techniques** - What data is available, how can it be transformed into useful information, how will it be used, and what will happen to it at the completion of the project?

Activity 7. **Establish Standard for Digital Interchange of Data** - The information that the project produces must be able to be exported to the appropriate existing system (Eg. A parcel based Land Information System).

Activity 8. **Define type of Data** - A choice must be made, what platform and what sensor?

Activity 9. **Define type of Image Analysis System** - Which computer-based Image Analysis System will be used? Is it available in your organisation? Is it available for hire, lease or purchase?

Activity 10. **Define Personnel Requirements** - Can you staff this project from your organisation? Are consultants available?

Activity 11. **Image Selection** - Consider the following:
. Availability
. Cloud Cover
. Dates
. Format - Hardcopy (ie photographic)
Floppy Disk
Tape
. Level of Processing

Activity 12. **Image Purchase** - The Australian Centre for Remote Sensing (ACRES) is the principal provider of remotely sensed data in Australia.

Table 1: Resourcing a Remote Sensing Project

	Project Manager	Project Assistant	Application Experts	Remote Sensing Consultant	Remote Sensing Analysts
Activity 1	*	*			
Activity 2	*	*	*		
Activity 3	*	*	*	*	
Activity 4				*	
Activity 5	*		*	*	
Activity 6	*		*	*	
Activity 7			*	*	
Activity 8			*	*	
Activity 9				*	
Activity 10	*			*	
Activity 11				*	*
Activity 12				*	*
Activity 13					*
Activity 14					*
Activity 15					*
Activity 16			*		*
Activity 17			*		*
Activity 18	*	*	*	*	*
Activity 19			*	*	*
Activity 20		*	*		*
Activity 21	*	*	*		

Activity 13. **Data Conversion** - Import the remotely sensed data into the chosen Image Analysis System.

Activity 14. **Data Enhancement** - of the visual display.

Activity 15. **Rectification** - of the remotely sensed data onto the map grid.

Activity 16. **Classification** - The analysis of the remotely sensed data.

Activity 17. **Field Reconnaissance and Training Site Selection** - Verification of image analysis by observation on the ground (ground truth).

Activity 18. **Project Review** - Has there been satisfactory achievement of the project objectives? Has the desired accuracy been achieved?

Activity 19. **Integration** - with existing Land Information Systems or other databases.

Activity 20. **Output Production** - Presentation of the information in forms that may include:

- Layers in a Land Information System, both in digital and hardcopy form
- Thematic and other maps
- Images
- Statistical analysis
- Tabular data

Activity 21. **Report** - The final report which may include considerable information from other sources.

These activities form the basis of both project scheduling and project cost control. Table 1 illustrates the involvement of the different classifications of project personnel in each activity, and provides a template from which to develop cost estimates of labour, equipment, data, and materials for each specific project.

This methodology has been applied to several remote sensing projects undertaken by the RMIT Centre for Remote Sensing. The projects were for shire management (regional local government) in both mixed urban-rural and rural environments. The major emphasis in the projects were environmental monitoring, regional management and bio-physical resource mapping.

The objective of the project for the rural shire was to produce a forest cover map over an area of 40x50 km to a resolution of one hectare. The total project costs from the model are:

Personnel (Including Local Govt.)	$A 10,600
Image Analysis System Hire	$A 1,500
Digital Data	$A 2,500
Project Materials	$A 1,000
	========
Total Project Cost	**$A 15,600**

The second project, based on a near-metropolitan urban-rural shire with an area of 40x30 km, was a three year land use and land cover monitoring programme. The total project costs from the model are:

Personnel (Including Local Govt.)	$A 28,300
Image Analysis System Hire	$A 5,200
Digital Data	$A 15,000
Project Materials	$A 2,500
	========
Total Project Cost	**$A 51,000**

(Note: $A 1.00 = $US 0.75 - approx. 1992)

These results illustrate the relevance of this approach as a planning and control tool. It currently provides a financial model for the cost analysis of operational remote sensing projects. The challenge that remains is to develop a rigorous measure of project benefit.

CONCLUSION

This paper argues that the use of project management practice is essential in the establishment of standards for the planning and control of operational remote sensing applications.

The adoption of the methodology described in this paper will both enhance and quantify the degree of success of operational remote sensing projects.

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