IMPLEMENTATION OF THE ROAD ASSET MANAGEMENT SYSTEM IN SINDH PROVINCE

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ABSTRACT

In Asian Development Bank funded project ”Sindh Road Sector Development Programme” in 2005-2009 one component was development of Road Assets Management System (RAMS) including Bridge Management System (BMS), Geographic Information System (GIS), Road Maintenance Management System (RMMS) as well as bridge and road data collection. Incorporating the experiences learnt in other similar projects the systems were developed and tailored for the Government of Sindh during 2008-2009 incorporating the existing components thus as the previous road database with minor modifications.

The new data systems were used to generate a 5-year maintenance plan for 9,850 km of roads, 1,237 bridges and 10,467 culverts. Around 2 % of the surveyed roads are in very poor, 11 % in poor, 46 % in fair, 33 % in good and 8 % in very good condition, whilst the average IRI is 7.3 for the surveyed road network of 7,479 km. Bridges are generally in better condition as 1 % of the bridges were in very poor, 1 in poor, 6 % in fair, 19 % in good and 72 % in very good condition and 1 % was not evaluated. According to the strategic analysis based on IRI value around 22 Billion Pakistani Rupees (360 Million US Dollars) is required to get the average IRI to 4.5 by the year 2015. For the 5-year maintenance plan around 6.3 Billion Pakistani Rupees should be invested in road maintenance and 1.5 Billion Pakistani Rupees in bridge and culvert maintenance.

System development for road assets management is interdisciplinary work with some risk areas. As experiences have shown, implementation of information systems often fail and these experiences from the IT discipline should be taken into consideration when projects like this are planned. Enough time and resources should be assigned to the design and especially the testing phase of the systems as the comprehensive system and software testing can only take place having them in real use. People responsible for the system use should be recruited before or in the beginning of implementation. At the organisational level it is important that there is a mind set of adopting new technology as well as preserve infrastructure assets by maintenance thus showing the importance of road asset management systems.

Keywords: Road Asset Management System, Road Asset Management, Geographic Information System, Bridge Management System, System Implementation, Organisational Change

BACKGROUND

The province of Sindh is the second largest province of Pakistan in terms of its population and area. Sindh has a population of 30.4 million as per the 1998 census of which 49% is urban whereas 51 % is rural. The population growth is estimated at 2.8% per annum while the population density was 213 persons/km^2.

The road network of Sindh is about 40,000 km of paved roads which is quite meagre as compared to the yardstick of 1.0 km/sq km. The road network is administered by road agencies at the federal, provincial and district levels. The federal agency is the National Highway Authority (NHA) which has a 1365 km of inter-provincial road network in Sindh.

The provincial road network is administered by the Works & Services Department (WSD), Government of Sindh. It has a portfolio of about 11,743 mks of road network which it manages directly whereas it also oversees directly and indirectly the district road network of about 16,900 mks. Majority of these roads are in the rural setup and do not include the urban road network, which is about 10,000 kms in length. The Works & Services Department manages the road network from its own resources i.e. the annual grant received from the provincial government to carry out its annual development plan in terms of road construction and maintenance. But with the growing demands and limited fundingsand because of the huge backlog of maintenance works the WSD had to obtain funds in terms of loans from foreign donor agencies such as the Asian Development Bank (ADB), JICA (Japan International Cooperation Agency).

The objective of this paper is to present a case study with a theoretical framework for implementation of information systems. Additionally, the main lessons learnt are described in the end.

INTRODUCTION AND HISTORY OF THE PROJECT

During the period 1997-2000, the Asian Development Bank assisted WSD in the development of its road infrastructure (Umbrella project: 1401–PAK Rural Access Roads Project, $ 140.0 million) and also helped in the establishment of a Road Management Unit (RMU), The responsibilities of RMU included the creation of a road database and maintenance management planning which comprised of annual and multi year priorities list of roads for maintenance.

In 2005, the WSD again managed to procure a loan for the development of its road infrastructure in the shape of a Sindh Road Sector Development Program, Loan No. 1892-

PAK, 1893-PAK (SF) and OPEC 899-P ($236.0 million). The project was divided into two components i.e. the Investment and the Reform Components. The Investment component dealt with the rehabilitation and improvement of about 164 mks of provincial road network along with 1200 mks of rural access roads; whereas the Reform Component dealt with institutional improvements within the WSD to gear it towards the creation of a road agency which would manage the road network. In this context, the first step was the creation of a Road Sector Development Directorate (RSDD) within the department having different aspects of the reforms, namely:

1. Road Planning Design and Asset Management
2. Resource Mobilization and Financial Management
3. Road Safety
4. Community Development and Environmental Management

The overall objectives of the reform component were focused on initiating institutional reforms, establishing efficient resource management systems, preserving road assets, increasing road safety, improving governance, community development and environmental management. One component was establishment of Road Asset Management System (RAMS).

GENERAL FRAMEWORK OF INFORMATION SYSTEM IMPLEMENTATION

The life cycle of an information system including road assets management system can be divided into six steps starting from requirement analysis and ending at system disposal as Presented in Figure 1. System testing and implementation can be seen as one or two separate tasks.

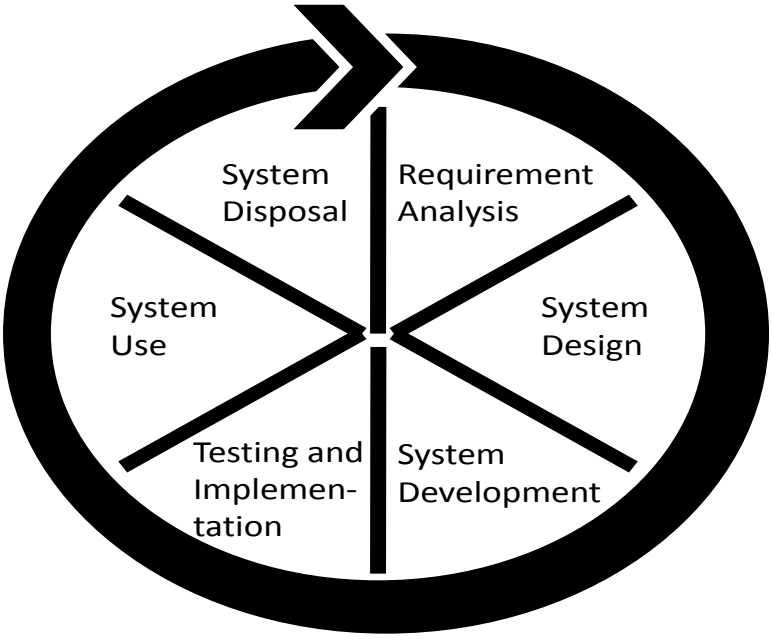

Figure 1 – Information System Life cycle

In traditional system development the above-mentioned phases are sequentially following each other, but during 1990s and the beginning of 2000 agile or lightweight methods were conceptualised and gained popularity. In these methods information systems are developed in team and often the 4 first phases are done in parallel according to the needs.[1]

An extensive study on Road Asset Management Systems states three critical factors for successful RAMS implementations. These are the following:

A) Technology
B) People
C) Processes

Road asset management cannot be done effectively if any of the critical components are missing. Technology is needed for right data collection, processing and distribution. Dedicated and sufficiently educated people have to be assigned to the tasks required by the idea of asset management. The mindset of asset management requires processes within one or several organisations being responsible for public infrastructure.[2]

The concept can be enlarged to include more organisational aspects from general studies of implementation of information systems. The MIT90s configurational framework contains 5 aspects as illustrated in Figure 2.[3]

1 Aydin, M.N., Harmsen, F., Slooten van K., Stegwee, R.A., 2005
2 S McPherson, K., Bennett, C., 2005
3 Scott Morton, M. S. (Ed.), 1991

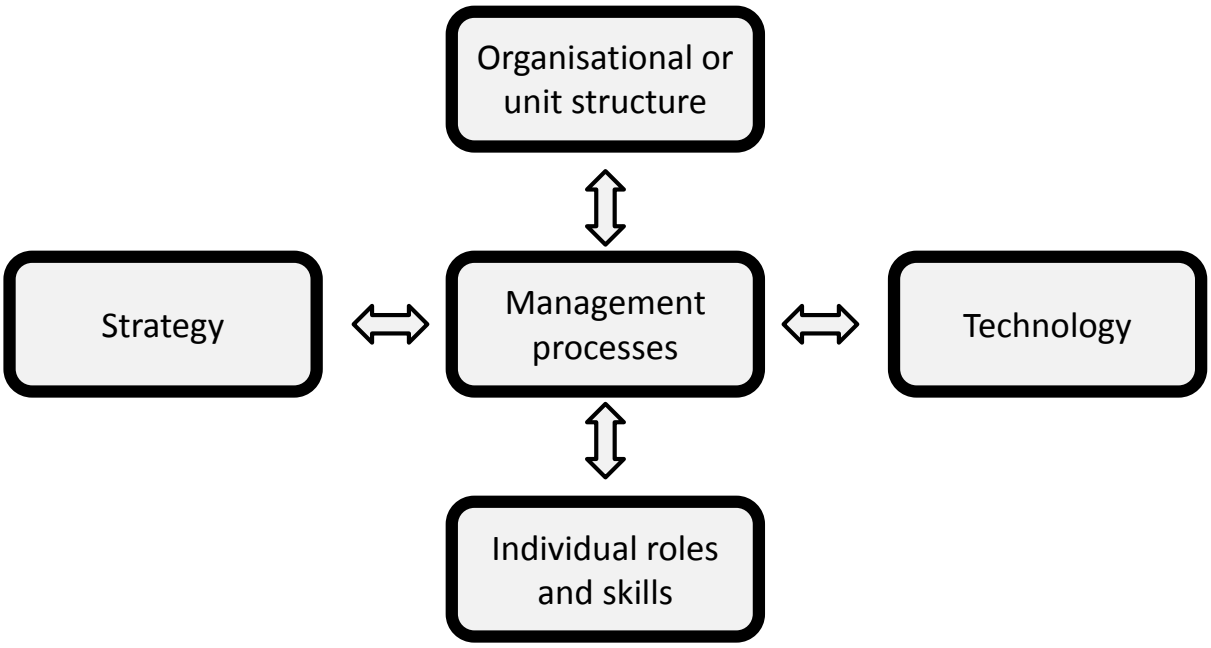

Figure 2 – MIT90s configurational framework

CASE STUDY OF SINDH ROAD ASSET MANAGEMENT SYSTEM

Implementation of the road asset management system in Sindh is examined both by the information system life cycle model as well as by the configurational model. By combining the both models we can represent the idea by Figure 3.

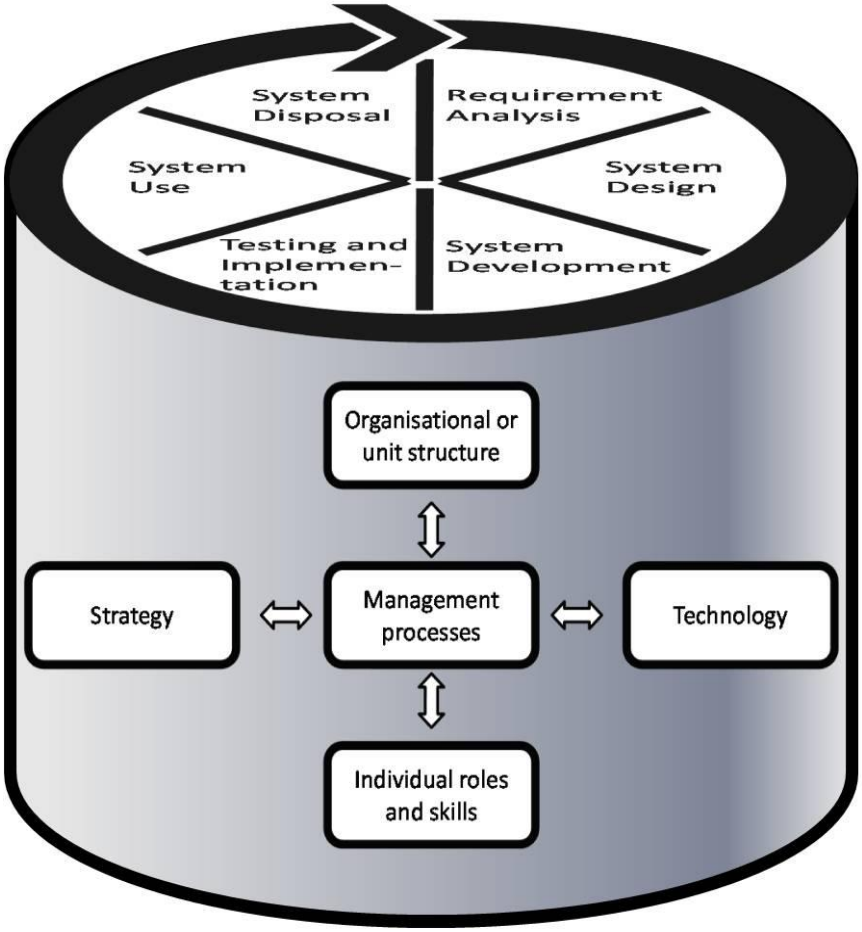

Figure 3 – Combined framework

The configurational model presents a static view of various aspects in implementation of information systems, but considering the configurational model at various stages of the life cycle of the systems gives a more profound idea of the implementation as various aspects tend to change during the life cycle These aspects are examined when applicable in the following chapters.

Requirement Analysis

When it comes to **technology** it was noticed in the beginning of the analysis that there was once a RMMS established that didn't work with the new operating system. A proper Geographic Information System (GIS) was not in place, but maps could still be produced with a Computer Aided Design (CAD) software. Basic bridge information was stored in RMMS. The requirements from the client's side were to establish a RMMS being as close to the previous system as possible, a separate Bridge Management System (BMS) due to increased data under collection and a proper GIS. The **strategy** was to keep everything as simple as possible due to restricted resources and future financing.

In the analysis **process** the client had the key role in the beginning phase, but the consultant participated in the process by introducing good and bad examples from elsewhere. As the client **organisation** already had several people having worked with infrastructure asset

management including some processes with assigned **roles** it was easy to define the future needs.

System Design

It was clear from the beginning that the **strategy** for the future overall system would be dividing it into subcomponents Road Maintenance Management System (RMMS), Bridge Management System (BMS) and Geographic Information System (GIS) as there were multiple users using different components and a Local Area Network (LAN) did not exist in the premises of the client. In **technology** selection, another problem with an integrated, commercial off-the-shelf asset management system would also have been a long evaluation and procurement process and possible annual licence fees that could not be financed from the project loan. An overall system architecture is presented in Figure 4.

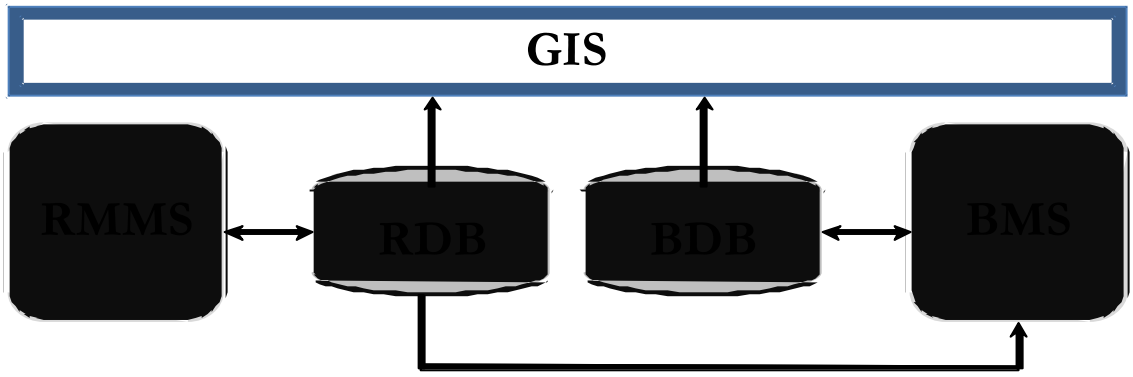

Figure 4 - Implemented sub-systems of Road Asset Management System

The design included database design, design of system components as well as their interaction. Road database design followed the already existing road database while the bridge database was designed according to the previous experiences of the consultants. RMMS and BMS was tailor-made and designed for the client, while the GIS was a commercial off-the-shelf software. The BMS requires also road-related data for index calculations and prioritisation and therefore it accesses the road database. GIS accesses only the databases and forms a live link with the data. There is no interaction at the software level between the systems, but only at the data level. During the design **process** the consultants took the leading role in answering the requirements as the client organisation did not have **personnel** skilled in IT development. The process was iterative due to time restrictions and arising needs.

System Development

During the development phase the consultants developed the systems in Sindh meeting the design and new arising requirements by the client. Therefore, the **process** was still iterative, but manageable with agile system development. The development was done in 3 stages

within 1 year so that each time the current version was installed on the clients' computer. The **team** included a Bridge Expert, GIS Expert, Road Maintenance Expert and Road Asset Management System Expert and they contributed with an input between 1 to 3 months. Crucial issue in this stage was a close cooperation with the client and taking flexibly into consideration the arising needs. There was not a rigid **structure** for the organisation of the work and development team, but the team work followed the agile development process.

Due to the **technological** restrictions a traditional client-server software was developed instead of web-based applications. The database platform remained Microsoft Access while C++ was used as the programming language for the user interfaces. ArcGIS was the selected off-the-shelf Geographic Information System.

System Testing and Implementation

The **strategy** for the system testing was to separate the final system testing from the development work although system testing occurred in several steps. The first testing was done by the developers during the development so that the systems ran and produced the desired outcome. However, the problem was that as there were thousands of programme code lines and many possible ways to use the systems the complete test could happen only during system use. This was the reason that the testing was divided into several parts as the incomplete versions of the system were installed on the clients computer for testing purposes. Thus, the systems were gradually being integrated in the clients' management **processes**.

The testing phase and corrective measures was the crucial aspect of the whole life cycle and the leading **role** was with the client, the users of the system. Although there exists some automatic software solutions for system testing there wasn't any special **technology** used for the system testing in this project.

The final systems were installed and training was given to the end users at the end of the whole institutional development project.

System Use

During the testing and implementation the systems were used for **strategic** analysis and maintenance programming of a 5-year maintenance plan for 9,850 km of roads, 1,237 bridges and 10,467 culverts. The data was collected from December 2007 to June 2008 and this activity was entirely outsourced to the private sector. The maintenance planning was based on IRI values for roads and bridge inspectors' estimations and unit prices in case of bridges and culverts.

It was noticed that around 2 % of the surveyed roads were in very poor, 11 % in poor, 46 % in fair, 33 % in good and 8 % in very good condition, whilst the average IRI was 7.3 for the surveyed road network of 7 479 km. Bridges were generally in better condition as 1 % of the

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According to the strategic analysis based on IRI value around 22 Billion Pakistani Rupees (360 Million US Dollars) is required to get the average IRI to 4.5 by the year 2015. For the 5-year maintenance plan around 6.3 Billion Pakistani Rupees should be invested in road maintenance and 1.5 Billion Pakistani Rupees in bridge and culvert maintenance. The surveyed network, maintenance plan and condition after maintenance were presented on maps produced by the GIS.

Organisationally the systems will be used in the future by the dedicated **employees** in the Road Maintenance Unit (RMU) in the Works and Services Department (WSD). As the systems are separate from each other it is possible to add new software **technology** before disposal of all the current systems. Some sub-components can also be modified without interfering with the source code. Asset management systems should be integrated in the overall management **processes** and give support in decision-making. The most important decisions would take place annually when new maintenance projects are decided and money assigned on the network.

System Disposal

During the project the system disposal was not covered as the future of the **technological** development is unclear. Another important issue in scheduling the system change will be financial issues related to the overall **strategy** of the organisation. The managerial decisions will be made in the future when the current systems are considered obsolete, restrictions are overcome and a new technological or **process** improvement investment is considered viable.

LESSONS LEARNT AND CRITICAL ISSUES

A) At the technological point of view the following was noticed:

- System testing requires a long time, but the RAMS implementation was postponed at the end of the whole project. In similar projects information systems should be implemented at the early stage or a mechanism created for corrective and maintenance actions after the project
- Road condition surveys produces huge amount of data, but the quality and data format is not always right. When surveys are outsourced the data format should be clearly defined and people made understand that at the current technological level there are no systems inferring all possible data format combinations and inputting them right in the databases
- Simple is often more practical and off-the-shelf packages are not always the right solution

B) As far as people and skills were concerned the following could be seen:

- Various expertise areas were covered by the team of client representatives and consultants. Implementation of such systems is faster and easier when people know the expertise of other team members to certain extent
- Due to skilled and experienced personnel the development and implementation process was substantially easier and faster than in the opposite cases
- Civil Engineers in WSD do not consider road maintenance jobs as a source of professional satisfaction

C) The most critical issues at the process level during the project were:

- Lack of commitment from Provincial Government to sponsor road related data collection and maintenance activities
- Inordinate delay in the creation of Sindh Road Agency and creation of Sindh Road Fund
- Week coordination links between the RSDD and the field formations or the executing agencies
- Frequent transfers and postings of staff

D) The organisational structure did not always support the objectives of the project since:

- RSDD's role has been designed as maintenance project's planners rather than project's managers
- Lack of commitment in WSD staff as maintenance works are not taken seriously

E) The problems found in the strategy of the organisation were the following among others:

- Sufficient funds were not available for the huge backlog of maintenance works
- Lack of any mechanism or policy to facilitate the influx of private sector in this field

As a summary the experiences of the project are fully in line with Kathy McGrath's idea that:

> "Information system implementation in organizations is a delicate balancing act that requires constant attention to subtly shifting cognitive-emotional ways of arguing and acting framed by institutions."[4]

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