

Role of Information Systems Architecture in E-Governance: The Case of Watershed Management in India

Harekrishna Misra

Institute of Rural Management Anand

Anand, Gujarat, India

hkmishra@irma.ac.in

Abstract— India is basically an agrarian economy having more dependency on rain-fed agriculture practices. Infrastructures like watershed structures are therefore, important components in the overall planning process. Watershed management through an appropriate governance structure with active participation from all stakeholders for sustainable use of resources has been an issue before planners. Indian rural development scenario has always remained a challenge having various political, administrative and social dimensions in the overall spectrum of governance. However, NeGP and UIDAI have created an opportunity to have “convergence” of various services. Studying convergence is a complex phenomenon and needs a careful “architectural treatment”. This paper considers watershed management to be an ideal case for architectural treatment with respect to NeGP having focus on citizen interfaces through e-governance. The paper takes inputs from guidelines formulated for the “Watershed Management”, an open document for the study through a framework.

Keywords— Information Systems Architecture, E-Governance, Organization Architecture, Citizen Services Convergence

I. INTRODUCTION

Watershed Projects Initiatives (WPI), an Indian rural development initiative, aims to contribute to the livelihood security of the rural households. The initiative calls for an actively considered introduction of information Technologies (IT) in a large scale [1]. There are many Mission Mode Projects (MMPs) in India under National e-Governance Plan (NeGP) which are either in the process of implementation or have been commissioned through IT interventions. NeGP architecture recognizes the layered properties of national governance in the forms of “national agency”, “state agency” and “Panchayat Raj Institutions (PRIs)” to ensure transparency [2]. As such there are twenty seven MMPs having eight components under NeGP at present. All these

MMPs aim to provide desired services through a well designed delivery system and to cater to national agenda through an implementation plan with unification of IT mediated services [3].

In this paper it is argued that capturing attributes of architecture and reflecting them in the WPI would enhance its effectiveness. Organization of this paper is as follows. In section two, architectural dimensions are discussed to appreciate their applicability in e-governance supported projects. It discusses relationships among Organization Architecture (OA), Information Systems Architecture (ISA) and Information Technology Architecture (ITA). In section three, global e-governance initiatives are discussed to appreciate benefits and challenges. In section four, a framework is presented to capture all the dimensions of OA, ISA and ITA architectures and discuss possible relationships. In section five, WPI is discussed with specific references to the guidelines framed and is evaluated through the proposed architecture to capture the planning process. In section six, the findings are discussed to understand the scope for improvement and identifies opportunities for having an IS perspective for WPI. In section seven, paper concludes with future direction to the research work.

II. ARCHITECTURAL PERSPECTIVES FOR E-GOVERNANCE

Architectural treatment to IT Management has remained a challenge for researchers, academia and practitioners. Ideally, robust architecture at enterprise level, choosing a good architecture, identifying scalable components and managing a

sustainable relationship among various constituents are basic tenets of architecture in the area of IT management. Successful architecture needs to address “views”, “relationships” and “growth” among various components to meaningfully contribute to IT management [4]. It is argued that robust ISA needs to draw inspirations from organizational strategies (OA) and then command dynamic ITA to meet user needs. Thus ISA is the interface between OA and ITA [5], [6]. ISA advocates for a comprehensive information systems planning prior to settling for ITA [7]. In rural development the scenario is not much different since it also has moderators, it has a major stakeholder in the form of rural citizens and governance system plays an important role.

A. Related Work on Systems Architecture

In order to appreciate the relevance of architectural treatment to e-governance projects, it is essential discuss the dimensions related to OA, ISA and ITA.

1) OA Dimensions

Treatment through OA principles includes understanding organizational strategies and its roadmap for information symmetry. This approach relates organization to systems for establishing technology interfaces. OA also considers “people” and “processes” as constituents to contribute to overall value additions at the enterprise level [4], [5]. OA considers two important dimensions for a robust architecture which are “views” and “relationships” [6]. Structural Views include “structural”, “behavioral” and “execution” dimensions to reflect on organizational arrangement whereas behavioral view extends the structural views to other areas in the organization. Execution views of OA include the way strategies are translated into action.

As regards “relationships” between the OA and ISA, it is essential to stratify the organizational layers and these are “strategic”, “tactical” and “operational”.

2) ISA Dimensions

ISA reflects the strategic behavior in three distinct layers in consonance with the organizational framework [5],[6],[7],[10]. These are

“core”, “network and distribution”, and “access”. ISA, in access layer, deals with “user interfaces” and the medium is “points of services” (PoS). This is the vital layer since success of all backend services/infrastructure lies in this layer. In “network and distribution layer” of ISA, movement of data across various agencies is taken care of so as to provide seamless user services. In ISA the core layer belongs to the strategy group in the organization. This layer engages the strategic planners to formulate IS strategy, IT acquisitions strategy, and establishing the desired information infrastructure.

3) ITA Dimensions

ITA is expected to follow ISA and OA in sequence. ITA provides the appropriate medium and mode to deliver desired user services “on demand”. Thus ISA has role to play in establishing architectural views for the ITA. ITA includes standards, protocols, quality management related to IT components and service orientation. These are software engineering principles, IT component management (hardware, operating systems, and applications). ITA aims to describe principles for mapping OA and ISA imperative, support their views described in structural as well as behavioral levels. Under ITA, standards are emerging in many areas such as Quality standards like ANSI / IEEE Standard 1471-2000, ISQA 4100/8106 (CIST3100- Organizations, Applications & Technology, ISQA3310- Managing the Database Environment, or ISQA8050- Data Organization & Storage) [5],[7], [8]. Service Oriented Architecture (SoA) is also part of ITA to focus on execution views to brokerage and to orchestrate the services [9].

B. Relevance for Indian E-Governance

In India, foundation of e-governance was laid during 1954 when the Planning Commission introduced computers followed by setting up of the Department of Electronics (DoE) in 1970 and establishment of the National Informatics Centre in 1970 as a national agency to make available necessary infrastructure across all states to provide required connectivity with the central government. OA, ISA and ITA in Indian scenario did not follow the ideal sequences to formulate, develop and implement architectural views and contexts. Recent

efforts indicate focus on ISA. However, an insight to OA and ISA indicates that the core layer is actively considering policies targeted at network/distribution layers. Tactical layers include state data centers, state level agencies and they are working towards delivering services demanded by the access layer. Access layer has remained disjointed.

III. GLOBAL E-GOVERNANCE SCENARIO

Global efforts in e-governance have delivered mixed results. Some countries (depending on size, socio-political complexity, and government) have been able to derive appreciable results out of this exercise. United Nations (UN), European Union (EU), and other global entities have embraced e-governance practices and have given importance to citizen-centered services[15]. It has been recognized that e-governance efforts need to bridge the digital divide, create digital inclusion opportunities and should be devoid of technology focus [11],[12]. Studies indicate that many e-governance efforts have either partially failed or do not meet expected outcomes during scale up of successful projects due to poor articulation of architectures [11],[14]. Consolidations and convergences are two major emerging areas of concern for e-governance planners globally [15]. WPI needs to recognize these issues and challenges and provide necessary roadmap while graduating to MMP.

IV. PROPOSED E-GOVERNANCE FRAMEWORK

In Figure 1, a framework is proposed. The inverted triangle presents “ISA” which draws inputs and directions from “OA”. These two triangles provide layered relationships with views of OA and ISA. Each layer in ISA has a specific task to accomplish while maintaining the integrity among relationships, views and contexts planned. The framework suggests a “triangular” presentation of architecture in order to discuss the focus. ISA aims to focus on “access layer” whereas OA considers governance system as the focal point. As explained in section 2, ISA needs to align with OA. OA components are governance systems, operating systems and citizens. Governance systems include elected bodies in the entire spectrum, government

agencies, funding agencies and civil society. Citizens form the critical component in OA framework who “moderate” the existence of governance and operating systems.

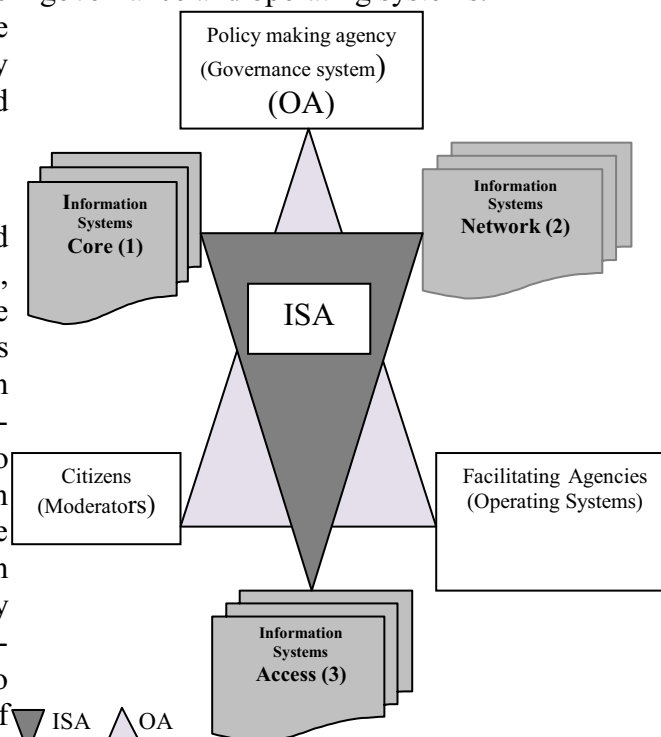


Figure 1. Proposed ISA Framework

As per ISA framework, Information Systems-1 (IS-1), IS-2 and IS-3 need to interface between OA components. This desired linkages among the organizational components together with that of ISA are termed as alignment. Such alignment needs to collectively adhere to the critical success factors of ISA framework. It may be seen here that ISA focuses on access layer whereas OA focuses on governance systems. ITA is considered complimentary to this framework. In Table 1, information systems views and the critical success factors of the contexts (indicative, not exhaustive) for interfaces are discussed. Critical success factors are contextual since they describe the ways views are captured through IS and IT planning.

TABLE 1. ISA FRAMEWORK FOR E-GOVERNANCE ASSESSMENT

ISA Framework for E-Governance (Indicative)		
Information System Layer	Views	Critical Success Factors
IS-3 (Operational Layer)	Citizen Interfaces -Citizens are Transaction Owners -Time, cost and convenience are important	IS Imperatives -Ease of use, Usability and Citizens' acceptance IT Imperatives -Convergence among Services

IS-2 (Network/ Distribution Layer)	Interfaces with Citizens -Standardized service Provisioning -Capturing latent demand -Preparation of Guidelines -Capacity Building	IS Imperatives -Building Information Infrastructure -Convergence among systems, processes IT Imperatives -Intranets, extranets -Unified Views of applications, databases and services
IS-1 (Core Layer)	Interfaces with Citizens -Mandates designed for citizen benefits -Collaboration with citizens to design systems	IS Imperatives -Information management policy -Convergence Policy IT Imperatives -Common Procedures for Infrastructure

V. WPI IN INDIA- ANALYSIS

Focus of the paper is on analysis of WPI initiatives through the architectural framework to identify scope for effective use of IT. In order to accomplish that a framework presented in Figure 1 is used.

A. WPI- An overview

WPI in India came into force in the year 1994. Though initially, the project aimed at addressing issues related to drought, the government treated the initiative with multidimensional approach in the year 2008 to meet the challenges of drop in water table, reduction in forest cover, non-availability of fuel, fodder and drinking water [1],[16],[17]. The concept of watershed project took this shape with a holistic view. Common guidelines consider the issues important in rain fed areas like poverty, productivity, fragile ecosystems, land degradation, low rain water use efficiency and high population pressure. WPI also aims to improve rural livelihood through participatory watershed development, to focus on integrated farming systems.

1) WPI and E-Governance

E-Governance systems are considered as a superset of e-government efforts. In other words, it is essential to appreciate that e-government solutions need to contribute to the large issues related to governance [11],[16]. WPI is a national level initiative having a huge financial outlay to create infrastructure at the village level. WPI provides the mandate to village level institutions to own, operate and manage the watershed structures through active citizen participation which is in line

with the agenda set by NeGP. Thus there is a scope to leverage the architectural benefits that NeGP provides and WPI looks for.

B. Approaches to Analysis

The framework considers the “WPI guidelines” to be the base document, an open document available. Framework was discussed and validated in a workshop arranged by Ministry of Agriculture and Cooperation which was attended by representatives from “National Rain Fed Authority of India”, State agencies including social planners, financing and accounting officials and engineers. WPI guidelines were analyzed based on OA, ISA and ITA. The focus of the paper is to prepare a document showcasing the rationale for having an architectural analysis and understand the deliverables, and scope to improve upon the IT management.

1) OA of WPI

Organizations under the WPI are designed to have specific delivery mechanisms for meeting the common objectives. In Table 2, these are analysed.

TABLE 2. OA FOR WPI

OA for WPI		
Layer	Organizations Planned	Objectives
Operational Layer	Joint Forest Management Committee, Watershed Committee/ Self Help Groups/ User Groups, Gram Sabha / PRI	Management of Watershed resources and the structures at the village level
Tactical Layer	District Watershed Development Units, Implementing Agencies, Planning Committee	Integration of schemes with Watershed Project; Project Management
Strategic Layer	Ministry of Rural Development, Department of Land Resources	Funding for Projects at National Level; IT infrastructure creation
	National Data Centre	
	National Rain-fed Area Authority	Project resource standardization, coordination, Monitoring, Evaluation
	National Level Nodal Agency	
	State Level Nodal Agency	

2) ISA in WPI

A careful analysis of the planning process of WPI indicates existence of standard operating procedures for executing the scheme at a national level. Operational guidelines are reflecting these procedures in detail. The scheme recognizes the importance of IS planning during its inception. Existence of a Ministry of Rural Development

portal is an indication of the organized planning process. The website contains information on gram panchayats, blocks, districts and states. An analysis based on the architectural framework discussed in section three provides following details (Table 3).

TABLE 3. ISA IN WPI

IS Planning Process Analysis as per ISA Framework		
Information System Layer	Views	Critical Success Factors Addressed (Contexts)
IS-3 (Operational Layer)	Citizen Interfaces Citizens' Entitlement, Local demand, work in progress or completed, Funds availability	Information on the Citizen rights, privileges and WPI deliveries
IS-2 (Network/ Distribution Layer)	Interfaces with Citizens 1.Roles and responsibilities of PRIs, Citizens are available in the guideline 2. Capturing Physical and Financial Progress Interfaces with Agencies 3. Modules to be available in the public domain 4.Convergence with other schemes	IS Imperatives 1.Availability of MIS in the public domain 2. Modules of applications related to have Standard Estimates, Quality of Work, Fund Management, etc. 3. Monthly Progress Reports at all levels in the operating system
IS-1 (Core Layer)	Interfaces with Citizens 1. Policy to converge 2. Policy to enhance to income of rural household 3. Plan for enhancing livelihood security 4. Analyze trends and planning for future at village level	IS Imperatives 1. Tracking funds utilization at national level with focus on individual household, Panchayat 2. Alerts for unfulfilled demand

3) ITA Planning in WPI

IT planning is an event that follows the IS planning [10]. It is essential for the national level agencies to provide a holistic view during execution of IT infrastructure projects that follow the IS planning process. In Table 4 below such a view is taken to understand the status of contexts met so far.

TABLE 4. ITA IN WPI

IT Planning Process Analysis as per ISA Framework		
Information System Layer	Views	Critical Success Factors Addressed
IS-3 (Operational Layer)	Citizen Interfaces Grant ownership to Citizen, Provide local language based interaction, Make available information at least cost, low latency and accurate	IT orientation is not available as per the guidelines
IS-2 (Network/ Distribution Layer)	Interfaces with State Wide Area Networks, Web interfaces for citizens and stakeholders listed, Exception Handling Alerts	Web based Portal for MoRD.
IS-1 (Core Layer)	Convergence among data sources, Unified views for all stakeholders, common operating procedures and guidelines for implementation	Procedures available for IT Infrastructure acquisition and deployment

WPI has recognized the relevance of technology interventions and IS-1 layer in the ISA has listed technology driven resources for the projects. The list includes rain gauges (automatic/manual), soil monitoring equipments (digital), GPS units, personal computers and other IT infrastructures [20].

VI.DISCUSSIONS

In Tables 2, 3 and 4, an insight to the planning process for IS and IT for WPI having considerable scale (physical and financial) and scope (social and digital inclusion) is presented.

A. Strength of IS in WPI

It amply indicates that IS-1 is quite strong in terms of guidelines, procedures to planning, execution and monitoring of the scheme. But there are few issues which need to be considered on priority to make the IS planning holistic and IT plan to follow them meticulously across all layers of IS. However, IS-2 and IS-3 need careful consideration for improvement.

B. Weaknesses of IS in WPI

Weaknesses are visible through analyses of ISA and OA frameworks discussed. ISA framework suggests that each layer in OA is expected to have at least one organization for such type of development projects. An analysis of WPI identifies weak areas for improvement as explained in Table 5. Some of the weaknesses are therefore, related to disjoint information systems in all the layers of WPI. Besides, weaknesses include absence of objective views on guiding principles and measurements for intermediaries.

TABLE 5. ISA-OA FRAMEWORK FOR UNDERSTANDING WEAKNESSES
Weaknesses of IS Planning Process for WPI

Information System Layer	Organizational Layer	IS Attributes Existing / Missing	Explanations
Access Layer	Operational	Existing	Village level Institutions exist with weak support structures for information planning, dissemination
	Tactical	Missing	
	Strategic	Missing	
Network/ Distribution Layer	Operational	Missing	Operational layers are missing across. Data Acquisition and Information planning are not available
	Tactical	Existing	
	Strategic	Missing	
Core Layer	Operational	Missing	Common Guidelines do exist; National Agencies are formed with National Data
	Tactical	Existing	
	Strategic	Existing	

Weaknesses of IS Planning Process for WPI			
Information System Layer	Organizational Layer	IS Attributes Existing / Missing	Explanations
			Centre Plan.

C. Opportunity of IS in WPI

As per WPI guidelines, the mission statement says the WPI should enhance livelihood security of local people through wage employment. Dimensions of livelihood security have a large canvas and they are complex. In such a scenario, the convergence plans may be in place in the core layer (IS-1) to ensure logical analysis livelihood security phenomenon. Besides, roadmap for WPI is to rise gradually to meet all the dimensions of livelihood security. These dimensions need to be reflected in IS-2 and IS-3 of ISA.

VII. CONCLUSION

WPI focuses on a national agenda having all the dimensions of MMP and has the scope to include all the categories. Architectural challenges seem to be enormous. OA analysis indicates that guidelines are well formulated with transparent roles and responsibilities. Each layer of OA has adequate mechanism to carry out the task. ISA framework indicates that there is much scope to provide a well designed framework. On priority, a “systemic convergence” approach is needed. WPI guidelines have the provisions for convergence.

WPI aims to empower rural households to create and own watershed structures. Thus rural households need to use services and they should be explained about the usefulness of the services. Withdrawal strategy becomes an important issue in this scenario with a policy to have a structure through which rural households manage the resources themselves and not through support agencies.

ISA needs to incorporate all the relevant metrics based measurements. For the purpose ITA needs to take care of challenging tasks to make “access layer” more citizen centric. This would be possible through good database architecture to support ISA and ITA. This paper identifies the scope for having all these dimensions mapped into WPI.

The future work aims to work towards benchmarking best practices, develop prototypes

covering possible the views and contexts of all the architectures and showcase the method to implement the metrics presented through architectural analyses.

ACKNOWLEDGEMENT

I thank Institute of Rural Management, Anand, my employing Institute, to provide necessary support to conduct this study and representatives of Ministry of Agriculture and Cooperation, Government of India, for validating the framework during workshop and providing valuable insights to the approach.

REFERENCES

- [1] Website of MoRD, Government of India, url: <http://www.rural.nic.in> accessed on 29.05.2010.
- [2] Ministry of Information Technology, url: <http://www.mit.gov.in/content/national-e-governance-plan> accessed on 03.05.2010.
- [3] Unique Identification Authority of India (UIDAI), url: <http://www.uidai.org> accessed on 04.05.2010.
- [4] Maier, Mark W., Rechtin, Eberhardt, *The Art of Systems Architecting*. Third Edition, Taylor & Francis, Inc, CRC Press, Washington DC, 2009.
- [5] Garlan, David and Shaw, Mary, *An Introduction to Software Architecture*. Carnegie Mellon University Technical Report CMU-CS-94-166, 1994.
- [6] Zachman, J. A. *A Framework for Information Systems Architecture*. IBM Systems, Journal, Vol. 26, No. 3, 1987.
- [7] Eóin Woods, *Experiences Using Viewpoints for Information Systems Architecture: An Industrial Experience Report*, Artech Limited, Hamilton House, 6th Floor, 111 Marlowes, Hemel Hempstead, HP1 3HY, UK, 2006.
- [8] Misra Harekrishna and Hiremath, B N., *Citizen-Led Participatory E-Governance Initiatives: An Architectural Perspective*, Metamorphosis-JMR. Indian Institute of Management, Lucknow, Vol. 5 No.2, 00-00, 2006.
- [9] Misra, H.K. (May 2010), *Understanding SOA Perspective of e-Governance in Indian Context: Case Based Study*, Book Chapter, Book Title “User Interfaces”, ISBN no. 978-953-307-084-1, published by IN-TECH, Vienna.
- [10] Luftman, Jerry, *Assessing IT/Business Alignment*, Information Systems Management, Vol. 20 (4), pp. 9- 21, 2003.
- [11] Misra, H K., *Managing Rural Citizen Interfaces in E-Governance Systems: A Study in Indian Context*, ICEGOV, Bogota, Colombia, Novemeb, 10-13, 2009.
- [12] Bhatia, Deepak, *Designing and Implementing e-government: Key Issues, Best Practices and Lessons Learned*, World Bank, April 25-28, 2005.
- [13] Heeks, Richard, “Most E-Government Projects-for-Development Fail: How Can Risk be Reduced?” Working Paper 14, IDPM, University of Manchester, 2003.
- [14] Heeks, Richard and Alemayehu Molla (2009) “Impact Assessment of ICT-for-Development Projects: A Compendium of Approaches”, Working Paper 36, Institute for Development, Policy and Management (IDPM), University of Manchester.
- [15] Mehdi Khosrow-Pour, *Practicing E-Government-A Global Perspective*, Idea Group Publishing, London, ISBN: 1-59140-637-4, 2005
- [16] The National Rural Employment Guaranty Act, 2005, 3rd Edition, Operational Guidelines, Ministry of Rural Development, Government of India, New Delhi, 2008.
- [17] http://www.dolr.nic.in/wiwmw_sciencitic_equipment.htm accessed on 25.05.2010