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Developing a roadmap for planning and implementation of interoperability capability in e-government

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Developing a roadmap for planning and implementation of interoperability capability in e-government

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Abstract

Purpose – The purpose of this paper is to propose a tool in the form of a roadmap for planning and implementation of interoperability capabilities. The issue of interoperability is gaining importance for offering services as “one-stop shop” due to rapid developments in the field of e-government in recent times. Several complexities are associated with this important dimension, and there is an urgent need for developing a tool to facilitate rollout of e-government projects with interoperability capabilities. The proposed roadmap can enable knowledge sharing among key stakeholders for building a common vision and contribute to planning and implementation of interoperability features of e-government.

Design/methodology/approach – The paper is an exploratory study using the phenomenographic interpretive approach. The literature review identifies the facets and the issues that are crucial for facilitating interoperability. The status of interoperability in some of the developed countries is reviewed where e-government is in a relatively mature stage. Based on the review, this paper identifies an initial set of issues that can guide semi-structured interviews with policymakers, partners and the government agencies implementing e-government projects. The views of these key stakeholders are then analyzed and used for developing the roadmap for implementation of interoperability of e-government services. The findings are then mapped in India's context for triangulation purpose.

Findings – The paper provides insights into various planning and implementation issues that have to be addressed for building interoperability capability. A roadmap is proposed encompassing the essential legal, regulatory, organizational and technical aspects that are deemed essential for successful planning and implementation of interoperability capability.

Research limitations/implications – The study has the limitation that the exploratory part of the study is based on inputs from key actors in the Indian context only. It needs to be validated by empirical studies in various contexts.

Practical implications – The roadmap proposed will be useful for the policymakers, as it can guide them for planning and implementing e-government systems with interoperability capabilities. It can be used as a knowledge-sharing tool for spreading awareness of steps required for designing and implementing interoperability capabilities.

Originality/value – The paper contributes by providing a tool in the form of a roadmap that can be used by the policymakers and implementers to take a holistic view of requirements for development of interoperability capabilities. The paper can form the basis for future research in specific issues of interoperability.

Keywords Government policy, E-Government, Standards, Interoperability, Roadmap

Paper type Research paper



1. Introduction

Interoperability is the “property of diverse systems and organizations to work together” (Gottschalk, 2009). For the purpose of integrated services delivery, the data from various applications, which are distributed logically as well as physically, need to be exchanged seamlessly in a secure way (GOI, IFEG document, 2012). This requires interoperation of their independent e-government information systems (Scholl and Klischewski, 2007). Interoperability has been considered to be a key determinant for indicating maturity of the e-government (Estermann *et al.*, 2009). Interoperability capability can be defined as the ability of systems to interoperate with each other.

Interoperability is gaining importance from the perspective of citizens as well as the governments. It enables citizens to access government services as “one-stop shopping” (Layne and Lee, 2001), leading to significant saving of time and efforts. From the government perspective, it enables faster delivery of e-government services (due to improved back-end processes) with less errors (due to consolidated view of data) at less cost (due to elimination of duplication of data entry and processing) as compared to the present fragmented system of delivery.

However, despite the advantages of interoperability to citizens and government, there are several challenges and limitations to its proliferation, as it is a complex phenomenon with constraints in various dimensions such as technology, organizational capabilities, syntactic and semantics (Scholl *et al.*, 2012; Guijarro, 2007). The complexity is compounded by the fact that these constraints differ from country to country, as they are contingent upon prevailing political, economic, social and technological conditions in the country. United Nations e-government Survey (2014) reveals that there is a wide disparity among the countries with respect to maturity of e-government services being provided. Out of 193 member countries, The Republic of Korea, Australia and Singapore are reported to be the top three countries in terms of maturity of e-government services, while the three countries of Africa, Somalia, Eritrea and Niger are at the bottom of the ranking. The survey is based on E-Government Development Index which takes into account the extent of provision of online services, telecommunication connectivity and human capacity in the country. The survey clearly shows that socio-economic, technology and political factors play an important role in readiness for e-government.

Multidimensional facet of e-government maturity calls for taking a holistic view of the phenomena of interoperability. Although prior research has looked at individual dimensions of interoperability capability, but there is a scarcity of applied research which can be of use for the practitioners by providing a holistic view of essential activities for planning and implementation of interoperability capability. The objective of the paper is to fill this research gap by proposing a roadmap for developing interoperability capability based on the findings from prior research, experience of developed countries and insights from the stakeholders involved in the process. This proposed roadmap will be useful for the practitioners and researchers alike. The practitioners can utilize it for effective planning and implementation of interoperability capabilities, while researchers can use it as a framework for future empirical studies. It can be used as a knowledge-sharing tool for externalizing the tacit knowledge generally embedded with few stakeholders and can facilitate in evolving a common vision across all levels of stakeholders, thereby contributing to faster implementation of interoperability features of e-government services.

We believe that it is the appropriate time for developing such a roadmap because interoperability is at a nascent stage in most developing countries. The proposed roadmap can ensure that the policymakers do not lose sight of any of the important activities in the planning phase while embarking on the path of delivering e-government services with interoperability features.

Based on the objective of the study, we define our research questions (*RQ*) of the paper as follows:

RQ1. What are the major issues that need to be addressed for planning and implementation of interoperability capabilities?

Several facets of interoperability have been identified in prior research. [Kubicek \(2009\)](#) emphasized the importance of four layers of interoperability, namely, technical, syntactical, semantic and organizational interoperability. Similarly, studies by [Charalabidis et al. \(2009\)](#) and [Pardo and Tayi \(2007\)](#) have crystallized different dimensions and contexts for interoperability. These studies can form the basis for applied research in this paper to enable faster proliferation of interoperability capabilities:

RQ2. How can these issues be addressed while planning and implementing interoperability capabilities?

Identifying the key issues for developing interoperability capability is only one part of the solution for uniform development of these capabilities. The ultimate question is how these identified issues can be presented to the key stakeholders so that they have a common vision for addressing these issues at the planning and implementation stage itself. Moreover, while some of the issues may have a straightforward solution, other issues may require weighing pros and cons of multiple available solutions in view of the prevailing context. This research question addresses such issues and attempts to provide pros and cons of the multiple options available in the form of a roadmap.

These two research questions sufficiently capture the inputs required by the practitioners for effective planning and implementation of interoperability capabilities which is the objective of this study.

2. Literature review

Interoperability is an emerging area of research which has source of knowledge in research papers, government documents and country experiences. The literature review is accordingly carried out in two sections. The first section looks at the prior research consisting of research papers, white papers and government documents related to interoperability. In the second section, the status of interoperability in various countries is reviewed. Insights from both sections are combined to form a set of issues that form the basis for further exploratory research.

2.1 Review of prior research on interoperability

The revolution in information and communication technology (ICT) has significantly changed public governance ([Heeks, 1999](#)). This revolution has enabled transformation of government administration by adopting the principles of ICT in governance ([Abramson and Means, 2001](#)), leading to the concept of e-government which can be defined as “the use of information technology to enable and improve the efficiency with which government services are provided to citizens, employees, business and agencies”

(Carter and Belanger, 2005). It offers advantages of lower costs, promoting transparency, eliminating corruption besides providing new possibilities for resolving rural poverty and inequality which can lead to a better future for the citizens (Schware, 2000; Wadia, 2000).

The literature reveals that a number of stage models have been developed to capture the evolution of e-government and for predicting the future direction (Lee, 2010). Some of the classical and often cited models from the literature are summarized in Table I.

Layne and Lee's (2001) model of evolution of e-government is the most cited model which indicates that the catalogue stage is the first stage of e-government where government Web sites have the functionality of displaying government information. At the transaction stage, citizens can interact with the government departments online for fulfilling their service requests. At the vertical integration stage, local, state and central government departments catering to the same function are connected, while horizontal integration stage envisages integration across functions and services. These stages are depicted differently in various models shown in Table I, but the common theme is the evolution of e-government from just a stand-alone online presence of the government department to horizontal and vertical integration at maturity stage. Such evolution in maturity of e-government can take place only when the government organizations have the ability to share and integrate information across organizational boundaries (Dawes and Pardo, 2002; Gil-Garcia *et al.*, 2005).

Maturity of e-government with horizontal and vertical integration requires interoperability capability. The difficulties associated with achieving interoperability have been well recognized by the researchers. Scholl and Klischewski (2007, pp. 893-895) have listed nine types of constraints, namely, "constitutional/legal, jurisdictional, collaborative, organizational, informational, managerial, cost, technology and performance" which are to be addressed for interoperability.

Keeping in view the multiple dimensions involved, prior research has several frameworks to capture the complexities of interoperability. Cresswell *et al.* (2005) describe government interoperability as a set of multidimensional, complimentary and dynamic capabilities pertaining to policy, management and technology aspects. Pardo *et al.* (2012, p. 12) proposed a socio-technical perspective of interoperability with four strands, namely, enterprise architecture, capability maturity, information sharing and information systems. They have identified 16 dimensions of seven different capabilities ("business architecture, governance and leadership, strategic management, operational management, information policy, cross-organizational collaboration and technological readiness" under these four strands which are to be focused upon for success of interoperability).

At a more basic level, several layers and dimensions of interoperability have been identified by researchers which can help to reduce the complexity of the issue by breaking it down into manageable parts. Kubicek (2009) identified four layers of interoperability "technical, syntactical, semantic and organizational interoperability" and emphasized the need for standards for these layers which can lead to seamless working for interoperability. Charalabidis *et al.* (2009) suggested that the three dimensions of interoperability which are essential for seamless working pertain to the institutional, the functional and the technical domains. Pardo and Tayi (2007, p. 697) crystallized four contexts for information sharing, namely, "technology, organizational work flow, inter-organizational setting and policy and social environment". These

Table I.
Comparison of the
classic e-government
models

Source	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Layne and Lee (2001)		Catalogue	Transaction	Vertical integration	Horizontal integration	
Baum and Di Maio (2000)		Presence	Interaction	Transaction	Transformation	
Ronaghan (2001)	Emerging Presence	Enhanced Presence	Interactive	Transactional government	Seamless	
Hiller and Bélanger (2001)		Information dissemination	Two-way communication	Integration	Transaction	Participation
Wescott (2001)	E-mail & internal network	Enable inter organizational and public access to information	Two-way communication	Exchange of value	Digital democracy	Joined-up government

Source: Coursey and Norris (2008)

contexts can provide enabling and constraining forces for interoperability. [Hind et al. \(2014\)](#) have compared various frameworks of semantic technologies for facilitating interoperability and developed an enhanced framework for semantic description of public services.

Several studies have been carried out to understand the factors related to policy, technology and organizations which are hindering the progress of interoperability. [Chatfield and AlAnazi \(2015\)](#) carried out an analysis of a Saudi Arab Government portal and found that initially the Web site did not facilitate sharing of information. However, development of e-government interoperability policy framework and collaborative governance had an important role in delivering integrated interoperable e-government to the citizens. [Sheffer et al. \(2014\)](#) developed a fuzzy rule-based system to assess the maturity level of technical interoperability of the institution involved in delivery of e-government services. [Tripathi et al. \(2013\)](#) carried out an empirical study on the effect of organizational factors on adoption of interoperability in Indian portals and found that financial resources and promotional efforts are the two organizational factors that need to be focused upon for a higher level of interoperability. In a study on various countries of the European Union, [Otjacques et al. \(2007\)](#) found that there are significant differences in legal and administrative provisions and technical standards of these countries. They concluded that such differences are likely to result in problem of interoperability among these countries. They stated the need for Single Identification Number (SIN) and digital signature authentication for interoperability. [Scholl and Klischewski \(2007\)](#) concluded that the interoperability complexity increases as the number of organizations increase because the issues of interoperation multiply resulting in reduced degree of interoperability. They predict that high degree of interoperability can result only with limited participants. Further, it is well recognized that interoperability is an incremental process and can only evolve over a period of time. In this regard, [Gottschalk \(2009\)](#) has proposed that the interoperability is a temporal process and evolves over five stages, namely, computer, process, knowledge, value and goal interoperability.

Implementation of interoperability requires techniques can enable seamless transactions between government departments. A suggested solution for this purpose is that of adopting standards ([Kubicek, 2009](#); [Dawes, 2008](#)) for various dimensions of interoperability discussed above. Open standards are now playing an important role in government interoperability ([Guijarro, 2007](#); [Kubicek et al., 2011](#)).

Another technique for implementing interoperability is centralization of the tasks in which different applications involved are owned and run by a single agency. However, while this may be feasible in a small country, it may not be relevant for large countries due to issues of jurisdiction, authority and political intervention. Implementing a clearing house can serve as a temporary measure for implementation of interoperability which mainly includes data conversion from one format to another format. However, this is not useful in the long run. The important facets of interoperability capability are identified from the literature and presented in [Table II](#).

Review of prior literature indicates several facets to be considered for the study on developing interoperability capabilities such as layers of interoperability, need for standards, information sharing capability, need for single identity and digital signatures for authenticating transaction. The constraints and factors that can hinder developing interoperability capabilities are also indicated in prior research.

Table II.
Important facets of
interoperability from
prior research

Source	Facet	Core findings identified in research
Cresswell <i>et al.</i> (2005)	Information sharing capabilities	Identifies 16 major dimensions of information sharing capability in respect of organization, policy and technology aspects
Otjacques <i>et al.</i> (2007)	Factors hindering interoperability	Differences in legal and administrative provisions and technical standards hinder interoperability
Pardo and Tayi (2007)	Identification and authentication Information sharing	Need of SIN and digital signature authentication for interoperability Technology, organizational work flow, organizational setting and social environment determine information sharing for interoperability
Scholl and Klischewski (2007)	Constraints in interoperability	Identifies constraints in “constitutional/legal, jurisdictional, collaborative, organizational, informational, technology, managerial, cost and performance dimensions” (pp. 893-895)
Kubicek (2009)	Layers of interoperability	Interoperability has technical, syntactical, semantic and organizational layers. Standards are to be specified for each layer
Gottschalk (2009)	Evolution	Evolves over five stages, namely “Computer, Process, Knowledge, Value and Goal interoperability” (p. 78)
Kubicek (2009), Dawes (2008)	Techniques for seamless transactions	Adopting standards
Charalabidis <i>et al.</i> (2009)	Dimensions of interoperability	Institutional, functional and the technical domains
Pardo <i>et al.</i> (2012)	Capabilities required for interoperability	Requires capabilities in policy, management and technology aspects. Identifies seven capabilities required along dimensions of enterprise architecture, capability maturity, information sharing and information systems

2.2 Review of status of interoperability in countries

Review of best practices in developed countries can provide important inputs for preparation of guidelines for planning and implementation of e-government. The status papers prepared by international institutions like UNDP and the comparative studies in various research papers are important sources of information for such review.

Charalabidis *et al.* (2009) presented the National Interoperability Framework (NIF) of nine countries, namely, Australia, Belgium, Denmark, Estonia, Germany, Greece, New Zealand, UK and USA. Adoption of common open technical standards was found to be the technique for implementation of technical and syntactic interoperability in these countries. At the same time, they also found that NIF of these countries are not identical to each other. This fact points to the need for customizing NIF on the basis of cultural differences and specific needs of the national public administrations. However, the management of NIF in these countries is by a governmental agency.

A study carried out by [UNDP \(2007\)](#) compares and analyses eight NIF of Australia, Brazil, Denmark, Germany, Malaysia, New Zealand, UK and the European Union (EU). They have listed seven essential principles being followed, namely, interoperability, scalability, reusability, openness, market support, security and privacy. Three more principles listed were accessibility and multilingual in EU and transparency in Brazil.

Another study is a white paper by the consulting firm CS Transform ([CS Transform, 2011](#)) in which they have studied the E-Government Interoperability Frameworks (E-GIF) of 30 countries with a view to provide guidance to the countries which are in the process of setting up their E-GIF. The study found that the three major drawbacks toward interoperability in these countries were over-engineering, inadequate implementation and lack of focus of transformation of governance. The study looked into the necessity of specifying standards for implementing interoperability and suggested that instead of detailed specification, the standards should be broadly specified as open, mature, internationally accepted and easily deployable as this will quicken the pace of implementation.

A comparative analysis of 21 GIFs in developed and developing countries by [Ray et al. \(2011\)](#) indicates that most of the GIFs primarily concentrate on technical and syntactical aspects only and less attention is given to details of organizational and semantic issues. In India, the Department of Information Technology (DIT) under the Ministry of Communication & IT (MoCIT), Government of India (GoI), is designated as the nodal agency for developing the Interoperability Framework on e-Governance (IFEG) under the National e-Governance Plan 2006. The institutional mechanism for preparing the standards consists of working groups/expert groups and specialist committees consisting of experts from related government departments, industry and academia. The draft standards are displayed for review by public before notification (www.egovstandards.gov.in). The standards relating to semantic and organizational interoperability are under preparation while the GoI has notified the technical standards in June 2012.

The above studies indicate that the technique of standards has been followed by most of the countries in the form of layers of interconnection, data integration, metadata, information access and presentation, standards for business areas, standards for Web services and security. Due importance has been accorded to organizational and data/semantic dimension of interoperability too.

The standards are recognized to be evolving as per life cycle and are categorized as emerging (under development), current (ongoing) or fading (to be abandoned in future). As regards type of standards to be followed, all countries prefer open standards except UK which mentions international standards rather than open standards. Compliance for GIF in these countries is ensured by specifying GIF as policy, providing GIF compliance clause in bidding process, department-wise checking and even penalty (only in UK and Germany) for non-compliance. The findings of the survey of practices in advanced countries are summarized in [Table III](#).

The comparison above indicates that the issue of dimensions of standards (technical, semantic, syntactic etc), nature of standards (open, commercial, emerging, current or fading), compliance of standards (voluntary or with penalty) has received sufficient attention in planning and implementation of interoperability capabilities in developed countries.

Table III.
Summary of country
practices for
interoperability

Source	Country studied	Facet of study	Core finding
Charalabidis et al. (2009)	Australia, Belgium, Denmark, Estonia, Germany, Greece, New Zealand, UK, USA	Classification of standards	Technical and syntactic interoperability is implemented through adoption of common open technical standards
UNDP (2007)	Australia, Brazil, Denmark, Germany, Malaysia, New Zealand, UK, European Union (EU)	Interoperability principles being followed	Interoperability, scalability, reusability, openness, market support, security and privacy, accessibility, multilingual and transparency are important principles being followed
		Classification of standards	Standards are followed by most of the countries in layers of interconnection, data integration, metadata, information access, presentation, standards for business areas, standards for Web services and security concerns. Categorized as emerging, current or fading in all countries except Australia
Consulting firm CS Transform (2011)	30 countries	Compliance of standards	Compliance by suitable clause in bidding process and department checking. UK and Germany specify penalty for non-compliance
		Parallels between India and EU for EGIF guidelines	Draws parallel between India and EU in terms of size, highly federated structure and having mature e-government strategies developed over a period of time. Argued that interoperability in India and EU should be similar
		Extent of specifying standards	Suggest that instead of specifying the number and variety of standards in great detail, this should be left to market forces as will quicken the pace of implementation

3. Research methodology and approach

The paper falls in the category of applied research because its primary objective is to develop a tool that can be used by the practitioners for effective planning and implementation of interoperability capabilities in e-government projects. Because prior research in this domain is sparse and majority of the services initiated by the governments are yet to reach this stage of maturity ([Lam, 2005](#)), we follow the exploratory research technique for the study. An appropriate methodology for such study is the phenomenographic approach ([Marton, 1981](#)) that aims at description, analysis and understanding of experience and has been widely used by the researchers as a qualitative research methodology in several studies of this nature ([Osteraker, 2002](#)). Further, interpretive approach is apt for the study, as it aims to combine the perspectives of different stakeholders into a common set of beliefs ([Lin, 1998](#); [Boland, 1979](#); [Bevir and Kedar, 2008](#)).

Using these approaches, *RQ1* of identifying the issues in developing interoperability capability is addressed in three stages. In the first stage, the existing literature is reviewed to identify the facets which are crucial for facilitating interoperability. Further, the status of interoperability in some of the advanced countries is reviewed. Based on these findings from literature and country experiences, a set of issues is identified that are considered important for planning and implementation of interoperability. The set of issues forms the basis of semi-structured interviews with the key stakeholders (policymakers, partners and the implementing agencies) in the second stage for eliciting their views. In the third stage, the findings from the first two steps are analyzed for presenting the results. The research process is depicted in Figure 1.

According to Guest *et al.* (2006) and Mason (2010), the interview process is to be continued till no new information is forthcoming from the respondents. Accordingly, 15 such interviews were undertaken from the respondents having a good knowledge of issues of interoperability by their experience and interactions. The interviewees included three officers each from central and state government at policy-making level, two officials each from the implementing agencies at central and state government, two officials handling e-government centers at the district level, two IT professionals and a senior faculty at a leading business school. The transcripts of the interviews were analyzed, coded and categorized into two sets of issues. One set consisted of the issues on which there was general agreement among the respondents and the other set consisted of the issues where respondents had diversified views. These two sets of issues formed the basis for developing the roadmap for implementation of interoperability of e-government services.

RQ2 was addressed by analyzing the set of issues having diverse views among the key stakeholders. The diversity in views reflected the options available for the proposed roadmap. The pros and cons of each option are discussed and the final decision of tackling these issues is left to the planners keeping in view the specific context in which they are being considered.

The proposed research design triangulates the results among various research methods such as literature research, country experiences and discussions with key stakeholders and provides a richer insight into the phenomena of developing interoperability capabilities. This methodology is supported by Mingers (2001) who advocates the application of different research methods for a richer understanding of the

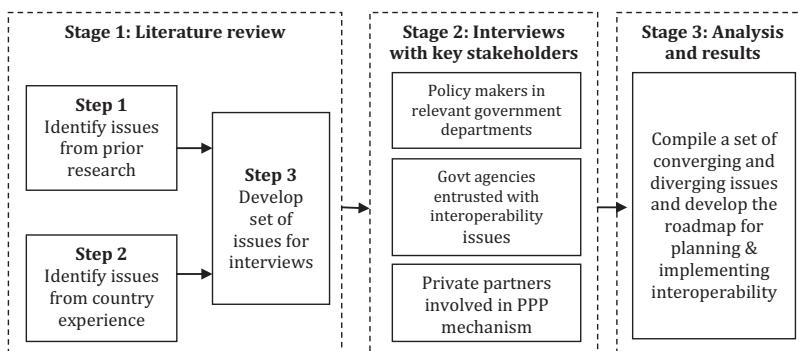


Figure 1.
The research process

research topic. To validate the findings from the study, we applied the proposed roadmap in India's context to identify the points of compliance and deviation.

4. Identifying facets and issues for interoperability capability

Findings summarized in [Tables II](#) and [III](#) were used for developing a comprehensive set of issues for the purpose of addressing *RQ1*. All facets of interoperability identified from literature were included for obtaining richer data from the interview process. Various facets and issues identified are presented in [Table IV](#).

These issues were used during the semi-structured interviews for guiding the discussions.

5. Views of key stakeholders on the identified issues

Based on issues compiled in [Table IV](#) (need for standards and user identification, information sharing, constraints in developing interoperability, complexity etc.), semi-structured interviews were held with key stakeholders, namely, the policymakers, private partners and the agencies involved in implementing interoperability. The participants in these categories were selected by snowball sampling method ([Goodman, 1961](#)) by viewing the organization charts of Ministry of Communication and IT and their related departments, namely, Department of IT (DIT), Department of Telecom (DoT)

Facets	Issues for discussion
Alternative techniques to enable seamless transactions	Whether standards for each dimension are required or other techniques can be adopted?
Ensuring compliance to standards	Should compliance be ensured through specification in bidding process or penal provision for non-compliance is a feasible option?
Need for multilingual applications	Is there a need for multilingual applications for interoperability or not?
Labeling of standards	Should standards be dynamically labeled as emerging, current or fading or not?
Extent of specification of standards	Should be standards be specified closely or loosely?
Identification of constraints in developing interoperability capabilities	What are the constraints envisaged in respect of constitutional/legal, jurisdictional, collaborative, organizational, informational, managerial, cost, technology and performance dimensions?
Identification of interoperability layers	Any layers other than technical, syntactical, semantic and organizational can be identified for planning and implementation of interoperability capabilities?
Information sharing	How can technology, organizational work flow, inter organizational setting, policy guidelines and social environment affect information sharing for interoperability?
Need for user identification and authentication	What is the need and alternatives for SIN and digital signature for interoperability?
Complexity associated with interoperability	Whether complexity increases with the number of organizations resulting in reduced degree of interoperability and suggest ways for controlling

Table IV.
Facets and issues of
interoperability
capability

and National Informatics Centre (NIC). Participants from government organization involved in implementing Internet connectivity, namely, Bharat Broadband Nigam Limited (BBNL) and Bharat Sanchar Nigam Limited (BSNL), were identified for the interviews apart from private organizations in public-private partnership (PPP) and knowledgeable faculty members from the academia. The main criteria for selecting the respondents were that they should have a holistic picture of interoperability planning and implementation issues. However, it was well understood that hierarchical position in the organization charts may not truly reflect the depth of involvement. Therefore, an appointment was sought for personal interviews from the shortlisted respondents by briefly describing the objective of the study. They were requested to refer the request to the officials having more in-depth knowledge of the issues. In this way, response was obtained from 15 respondents.

The interviews were held in the offices of respondents following the protocol of principal questions and follow-up questions on the basis of the facets listed in Table IV. As per the guidelines of Cope (2004), open-ended questions were asked at the generation stage to provide ample freedom to respondents to express their views. Leading questions were avoided and interest was evinced in the response without being judgmental. Follow-up questions were asked with a view to elicit more response and get a better understanding of the respondent's viewpoint on a theme.

The interviews were broadly divided in three phases where the initial phase was meant for ice-breaking with general discussions on e-governance and emerging issues in interoperability. In the second phase, the issues related to interoperability were explored by encouraging the respondents to talk freely. Finally, in the third phase, follow-up questions were posed and respondents were encouraged to discuss any other issues that they considered important. Each interview lasted between 45 minutes to 1 hour and was recorded and later transcribed in word document.

6. Results

Analysis of the transcripts of interviews was carried out by coding and categorizing the data collected from the respondents into sets of converging and diverging issues. Converging issues were those issues on which there was near consensus among the respondents with regard to their importance in developing interoperability capabilities, while, in diverging issues, there were differences in the opinion of respondents about how to handle the specific issues. The analysis is presented in Table V.

The issues compiled in Table V represent the collective view from literature and experience of key stakeholders and, therefore, can be included in the proposed roadmap. The issues on which there is divergence of views among the experts need be debated by the planners depending on specific conditions and requirements before implementation. These issues are discussed in brief in the following paragraphs.

6.1 Compliance for interoperability capabilities should be mandatory or voluntary

This issue can be decided on the basis of maturity level of the e-government. If the e-government is in preliminary level of maturity, then making interoperability capabilities voluntary for implementing a service may result in faster proliferation of the e-government services, albeit without interoperability capabilities. On the other hand, if sufficient proliferation has already taken place, mandatory requirement of

Facet	Converging issues	Diverging issues
Legal requirements	Presence of legally established government agency entrusted with responsibility for interoperability will aid in developing interoperability capability	Compliance of interoperability for all projects should be mandatory or optional? Will mandatory requirement slow down proliferation of e-government services or will it ensure that the services are launched at a certain maturity level
Need for user identification/ authentication	It is essential to have unique identification of users for linking various e-government services	There was no divergence on this issue
Means for unique identity of users	UID project in India is a good initiative for the purpose	Can we use existing identities for this purpose? Will multiple identities result in security issues?
Regulatory requirements	Presence of a regulator for overseeing, rewarding and penalizing the e-government functions (including interoperability) is desirable	There was no divergence on this issue
Technical standards	Standards for technical domains of presentation, archival, data integration, data interchange, network access and security are essential for seamless integration and will help in interoperability	Should open standards be made mandatory or not? Should the specifications be closely defined or broadly defined?
Organizational standards	Service-oriented architecture (SOA) among the organizations for seamless working will help in interoperability	Should the e-government projects be distributed in central and provincial domains or should all projects be centrally controlled for effective implementation?
	Identification and designation of ownership of data in the organization is essential for interoperability	There was no divergence on this issue
	Memorandum of understanding (MOU) and service level agreements (SLA) among the organizations should be encouraged among organizations to ensure service quality of interoperability functions	There was no divergence on this issue
	Cost sharing arrangement among organizations will stimulate initiatives for interoperability	There was no divergence on this issue
	A well-documented citizens charter for providing government services in a time bound manner with penalty for non-compliance will motivate interoperability	There was no divergence on this issue

(continued)

Facet	Converging issues	Diverging issues
Semantic interoperability	Business processes reengineering (BPR) must be mandatory while initiating any e-government service for seamless interoperability	There was no divergence on this issue
	A repository of key terms involved in semantic interoperability with their definitions is required as it will avoid incorrect interpretation by organizations	There was no divergence on this issue
	Any changes in data meaning should be marked and archived for back tracing when required	There was no divergence on this issue
	System of issue of alerts during possible mismatch of information should be put in place for error-free interoperability working	There was no divergence on this issue
Implementation of interoperability capabilities	Priority of services for implementing interoperability should be planned in advance for proliferation of interoperability capability in phased manner	What should be the criteria for deciding priority of services for interoperability? Should it be decided on the basis of requests received for sharing of information for an e-government service or on the basis of ease in extending interoperability capability?
	A system of penalty for ensuring compliance of standards by the departments	There was no divergence on this issue
	Set up a mechanism by which standards for new services can be enforced at procurement level itself by prescribing a standard procurement manual	There was no divergence on this issue
	Set up national level portal for making available all government services similar to the portal of US Government www.usa.gov	There was no divergence on this issue
Assessing e-government projects	Set up incentive schemes for timely implementation in targeted departments	There was no divergence on this issue
	Training of staff for interoperability and BPR must be planned in advance for smooth implementation	There was no divergence on this issue
	Weightage should be given to these capabilities for assessing e-government services for recognition and awards	There was no divergence on this issue

Table V.

interoperability capabilities for new services will progressively reduce the complexity of dealing with legacy systems.

6.2 Identification and linking of citizen identification to be done using existing documents or by a new identification document

Interoperability requires linking the database of various departments with a common key for identifying the citizen. The necessity of SIN and digital signature authentication for interoperability has been recognized (Otjacques *et al.*, 2007). However, this faces a lot of resistance due to several reasons. Citizens have several existing identification documents and a new identifier is generally perceived as a wasteful expenditure. Further, because covering the entire population is a mammoth and time-consuming task, even the policymakers try to look at ways of using existing identities without realizing that a foolproof unique identification is essential for delivery of e-government in an interoperability-enabled scenario. If the existing identifications are robust and unique across all regions, then policymakers can decide to identify the applicant using any of these identification numbers such as driving license, passport number, PAN card etc. For this, it must be ensured that the acceptable identification contains all verified details that may be necessary to uniquely identify the citizen such as name, date of birth, address, etc. If such documents are not already available, the policymakers have to design the new identification and embark on its implementation well in advance, as it will take a much longer time than building other interoperability capabilities.

6.3 Extent of specification of standards

Standards are believed to be essential for interoperability as seen in Table II (Otjacques *et al.*, 2007; Kubicek, 2009; Dawes, 2008). However, the extent of standards to be specified is a debatable issue because over-specification can restrict adoption of e-government services due to existence of legacy systems, less familiarity of the operating staff with the new standards, inability to exploit the capabilities of ubiquitous standards which are *de jure* but not specified in the policy due to copyright restrictions. On the other hand, under-specification can result in complexity for interoperability. Further, decision on use of open standards in preference to industry accepted proprietary standards too requires intense debate and evaluation of pros and cons which should be well thought of at the initial stage itself.

6.4 Deciding priority of services in interoperability implementation

Building of interoperability capabilities is a temporal process and evolves over several stages (Gottschalk, 2009). Policymakers need to decide whether they want to prioritize which e-government service should have interoperability capability. One of the criteria for priority can be to prefer the service that provides most requested data to other services. For example, PAN details are required to be verified online by banks for opening of account and by passport office for verification of identity of applicants. If such services are identified and targeted for interoperability compliance, it can have a positive cascading effect on other services, as it will favorably impact a sizeable population in a short time. This initial success can be showcased as a success story for promoting the adoption by other government departments. Another strategy for deciding priority of interoperability may be to cherry-pick the organizations with least resistance which will win trust of citizens and spur demand for similar interoperability

in other departments. This will ultimately provide the necessary fillip to the process. Policymakers can dwell on this aspect at planning stage itself.

6.5 Organizational barriers due to overlapping domains

E-government projects are distributed in central and provincial domains depending on the jurisdiction of the department in which the project is being implemented. For example, e-government projects in India are distributed among three domains – central, state and integrated. While this distribution of projects was beneficial for early implementation and acceptance of e-government, it presents a significant hurdle for ensuring compliance of interoperability norms by raising the organizational barriers.

From the above discussions, we present the roadmap for implementing interoperability capabilities in Table VI. Further, the proposed roadmap is validated by mapping it in the Indian context because India is just embarking upon its journey for developing interoperability capabilities. It has finalized the technical standards of interoperability in the year 2012, while the standards for other dimensions of semantic and organizational interoperability are in draft stage.

The roadmap described in Table VI is depicted in a simplified manner in Figure 2 with a view to provide a snapshot of the extent of work involved at various stages of developing interoperability capabilities, i.e. planning, implementation and operation stages. Visual depiction of activities in Figure 2 is intended to meet the objective of developing an easily understood knowledge-sharing tool which was mentioned in Section 1 of the paper. Figure 2 is presented in a manner that aims to externalize the tacit knowledge available in a limited set of stakeholders. It can facilitate in presenting a holistic picture of various complex activities required to be carried out at various stages and will be of immense use for evolving a common vision across various levels of stakeholders.

Analysis of the roadmap presented above immediately brings into focus the important points which are to be addressed by the government for faster implementation of interoperability. The policymakers and other officials at various levels can grasp the essence of required action related to planning and implementation at a glance and take corrective action accordingly. Therefore, it may be concluded that the roadmap prepared has been validated by mapping it in India's context and the objective of the paper is achieved.

7. Implications for research and practice

The study has contributed to research and practice by bringing into sharp focus the issues that are required to be considered for planning and implementation of interoperability capabilities. There is wide disparity between countries on the readiness for e-government as seen from the United Nations E-Government Development Indices discussed in Section 1. While the developed countries are rapidly moving towards maturity in e-government by enabling vertical and horizontal integration, many of the less developed countries are lagging even in establishing online presence which is the first stage of the maturity model described in Section 3.1. If these countries do not plan for interoperability at this stage itself, they will find it difficult to catch up later as they will be burdened with systems that do not support interoperability. The proposed roadmap can be a valuable tool for public policy in these countries by presenting the necessary actionable checkpoints in a concise form and enable them to easily move to

S. No.	Action points	Status in India
<i>Planning stage</i>		
1	Identification of a government agency with entrusted with responsibility for interoperability	Implemented
2	Appoint a regulator with executive powers for overseeing, rewarding and penalizing the e-government functions (including interoperability)	Not implemented
3	Decide the identity number which will be valid for citizens across all state and central government departments for user authentication	Implemented
4	Publish technical standards in the domains of presentation, archival, data integration, data interchange, network access and security for seamless integration	Implemented
5	Prepare a repository of key terms involved in semantic interoperability with their definitions to avoid incorrect interpretation by organizations	Not implemented
<i>Implementation stage</i>		
6	Mandate service-oriented architecture (SOA) among the organizations for seamless working	Not implemented
7	Identify and designate the owner of data to be used by various organization for interoperability	Not implemented
8	Encourage Memorandum of understanding (MOU) and service level agreements (SLA) among the organizations to ensure service quality of interoperability functions	Not implemented
9	Decide the cost-sharing arrangement among organizations to stimulate initiatives for interoperability	Not implemented
10	Mandate a well-documented citizens charter for providing government services with clear time lines and penalty for non-compliance	Partly implemented in some states
11	Mandate business processes reengineering (BPR) for initiating any e-government service for seamless interoperability	Not implemented
12	Set up national level portal for making available all government services at one Web site	Implemented
13	Ensure a archiving system of back tracing of changes in data meaning when required	Not implemented
<i>Operation stage</i>		
14	Implement a system of issue of alerts during possible mismatch of information for error-free interoperability working	Not implemented
15	Decide on priority of services for implementing interoperability	Not implemented
16	Implement a system of penalty for ensuring compliance of standards by the departments	Not implemented
17	Enforce standards at procurement level by prescribing a standard procurement manual	Implemented
18	Set up incentive schemes for timely implementation in targeted departments	Not implemented
19	Plan for training of staff for interoperability and BPR for smooth implementation	Implemented
20	Ensure significant weightage for interoperability capability while assessing e-government services for recognition and awards	Implemented

Table VI.
The proposed
roadmap

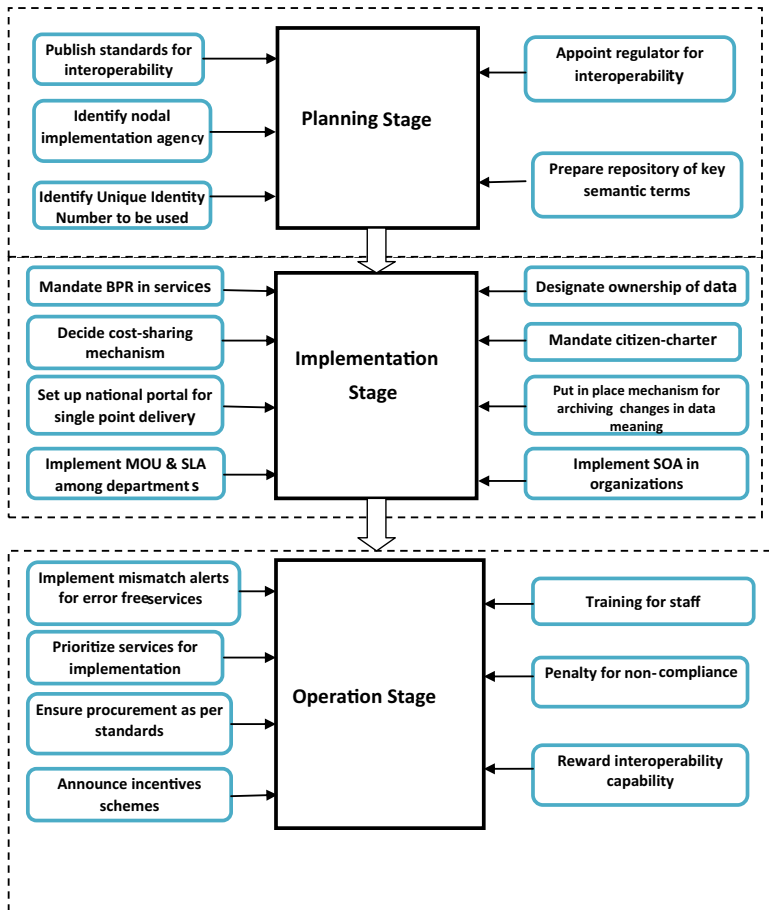


Figure 2. Simplified depiction of the proposed road map for planning and implementation of interoperability capability in e-government

higher level of maturity. It can facilitate knowledge sharing among different arms of the government by laying down in simple terms the issues that are deemed vital to effective implementation of interoperability capabilities. In this way, the proposed roadmap can contribute toward faster implementation of interoperability in less developed countries, thereby benefiting the society at large.

The study contributes to the body of knowledge by presenting a framework that blends prior research with best practices of advanced countries. The framework, presented in the form of roadmap, can form the basis of future studies that aim to benchmark the level of interoperability existing in a particular country or region. While the scope of the roadmap presented in this study is quite broad, researchers can look for developing similar roadmaps for each facet of interoperability such as developing standards, identification and authentication of users and information sharing processes, etc. Another exciting area of research can be in-depth analysis of the diverging issues presented in Table V such as type of compliance (mandatory or voluntary), control of e-government projects (centralized or decentralized), mechanism of citizen identity

(existing identities to be used or new identity required), priority in implementing interoperability (implementation in steps or not), etc.

8. Conclusions

The research was carried out with the objective of identifying a roadmap for uniform implementation of interoperability capability in e-government. For this study, the phenomenographic interpretive approach was adopted as the appropriate methodology. A thorough review of interoperability literature was undertaken to gain knowledge of the key issues of interoperability. Country experiences were presented to understand different ways in which the complex issues of implementation of interoperability have been addressed by countries at a relatively mature stage of e-government. Based on the facets and issues that evolved from literature review and country experiences, in-depth interviews were conducted with the experts in policy, implementation and partners involved in e-government projects. The data collected were categorized into converging and diverging domains on the basis of level of consensus among the experts. A roadmap for implementation of interoperability was prepared on the basis of data collected from the research. The roadmap was validated by mapping in Indian scenario. The points of non-compliance demonstrated the capability of the roadmap for converting the tacit knowledge with few stakeholders into explicit knowledge which can be easily shared at all levels.

The study has the limitation that the exploratory part of the study is based on inputs from key actors in Indian context only. Therefore, it needs to be validated by empirical studies in various contexts. This can be the subject of future studies related to planning and implementation of interoperability.

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