An Open Ontology Framework for Functional Composability Analysis of One Stop Government Portals

A. Sreejith[1]*, Rakhi Tripathi[2] and M.P.Gupta[1]

ABSTRACT

On the move from e-government to connected government, one stop portal`s functional role in their decentralized governance process enhance considerably. In this process, to provide e-value services, portals require a smarter functioning backend. Analyzing portals functionality is of multifaceted and its modeling is crucial for managing customized portal solutions. In our work portals functionality is observing from its people, process and technology aspect. Paper discusses elements of one stop portal and then conceptual interoperability in their relations. We discuss a transformation matrix of public administration and give an Open Ontology Framework (OOF) for analyzing functional composability of one stop government portals.

Keywords. Functional Composability, Levels of interoperability, Ontology, One stop portals, OOF.

1. Introduction

In government there are multiple diverse data sources: Unstructured data that lies in the form of rules, procedures and concepts, guidelines etc; Data referring to facts and figures treated as operational idea; and Structured data which is derived from information that can be stored in computerized form database and further be used for decision making (Gupta et. al, 2005). Literally composability is the capability to select, create, configure and logically assemble a unique simulation execution from a pool of reusable components in various combinations into simulation systems to satisfy specific user requirements (Petty, 2004). Government's concern is to maintain their data, develop integral, scalable and robust e-government solutions for transforming the public administrative system. One stop government portals are a move towards this; it is the single window services offered by government to its consociates. These portals emphasis the individual interest from its beneficiary perspective and is a mirror of government. Portals provide customized sectoral solutions like e-Health, e-Administration, e-Justice, e-participation etc. Connected government is a view towards the re-engineering of technology, processes, skills and the mindsets of public officials within a holistic framework (UN report, 2008). Hence analyzing ICT enabled public sector governance like one stop portal`s functional composability is of multifaceted, with technology perspective to perspectives of trust.

Composability is one of the key issue and main challenge of application development (FOI 2005). For modeling and simulation some of the existing composability approaches are Common Library Approach (JMASS), Product Line Approach (OneSAF), Interoperability protocol approach (JSIMS), Object Model Approach (Base Object Model), Formal Approach (DEVS), etc (Wiesel, 2004). And some software

[1] Department of Management Studies, Indian Institute of Technology Delhi, New Delhi-110016, India
[2] School of Information Technology, Indian Institute of Technology Delhi, New Delhi-110016, India
* *Corresponding Author:* (E-mail : a.sreejith@dmsiitd.org, Telephone: +91 9717 967 403)

engineering approaches for this purpose are Predictable Assembly from Certifiable Components (PACC), Prediction-Enabled Component Technology (PECT), Web Ontology Language (OWL), Semantic web, Unified Modeling Language (UML), Model Driven architecture (MDA) etc. (Bartholet, 2004). Although most web portals offer complete web site information, they simply collect and classify web sites and do not provide a further analysis of the relationship of web content information (Chun et.al, 2005). Intelligent analysis of portals components and its functionality will be helpful for enabling more efficient portal services. Research towards the area of portal maturity is fast growing, recently Petter. G. (2008) roposed five levels of maturity model for e-government and Chen et. al, (2007) contributed with three models of maturity for e-government applications. Even though much discussions on e-government maturity models taken place, none seems to focus on its equally important functional composability. Functional composability analysis of one stop portal is an intelligent process of exploring the functionalities and functional components of a portal to find out the gap between portals expected/conceptual functions and the obtained functions. Functional composability analysis of one stop portals is also helpful to identifying the risk of failure, change management etc. This type of analysis is more important when e-Governance becomes a global project. Factors affecting such project are complexity of system, difficulty of objective and context (uncertainty, flexibility etc), strength of relevant science and technology, quality of human consideration etc (Paul, D., 2004). Specific objective of this paper is to address portal`s multifaceted functionalities, identify functional components and to develop a model for analyzing portals functional composability.

In this paper we give an Open Ontology Framework (OOF), for functional composability analysis of one stop portals. Ontology is explicit specification of conceptualization (Gruber). It is the study of recurrence/reiteration of particular impress meaning in terms of entities events and relations (Sing. N, `07). In terms of ontology functional composability of one stop portal can be seen as the impressed functional meaning by portal`s objectives. OOF gives an analyzing framework for portal`s functional unities in the form of entities, events and their relations. Paper organized as follows: Section 2, portals functionality is observing from its people, process and technology aspect. These units are treated as mobilizing part of one stop portal in knowledge management point of view. Section 3, discuss elements of one stop portals. This is to identify the entities took part in the process of e-government. Section 4, discuss role of conceptual interoperability to form relations in one stop portal. We depict a transformation matrix in this part. Section 5, we give an Open Ontology Framework (OOF) for analyzing functional composability of one stop government portals. This section also discusses limitations and future works. Section 6, we conclude this paper.

2. Functional Levels of One Stop Portal

One stop government portals are the 24 hour service offered by government through outsourcing, participating or partnering various agencies, using a single window in a customized manner. It strategically implement by managing the modern aspect of people, process and technology for transforming the public administration and to reduce the cost of governance. Four dimensions of web portals functionality are usability, customization, openness and transparency (Jon, Diana, 2002). A good understanding of the expected functions in these dimensions for a connected government project is crucial for achieving the objectives/meanings of a portal. For this purpose we derive functional levels for a one stop portal. From knowledge management (KM) point of view functional levels of a portal can be shown as in figure1.

Composable units of e-government can be divided in to revitalize functions and technology functions, former is conceptually rich and the later technically inclined. Revitalize unit includes people and process views. Functional specifications in this unit are identified in six levels. This unit is influenced by factors like environment, politics etc. Transition from one stage to other is of two way process. This flexibility gives the advantage of the change management to our framework. One stop portal`s technical functions

mainly orient towards their integration and interoperability aspects. Interoperability levels and maturity of portals are of great research interest and discussed widely in various context. Petter G considers five levels of interoperability and Chen et, al contributed three models, for the composability analysis Turnista, C.D proposed conceptual interoperability levels is more relevant. We adopt *LCIM* (Turnitsa,C.D) proposed conceptual interoperability levels to explain the technical functionality of a one stop government portal. Unlike revitalize unit, functionality at this unit is unidirectional and is upward pointing (level 0 to level 6). From this KM views (people, process and technical), following the foundational ontology principles we chosen conceptual interoperability as a matured event. In section 4, we explain its role in forming relations for our framework.

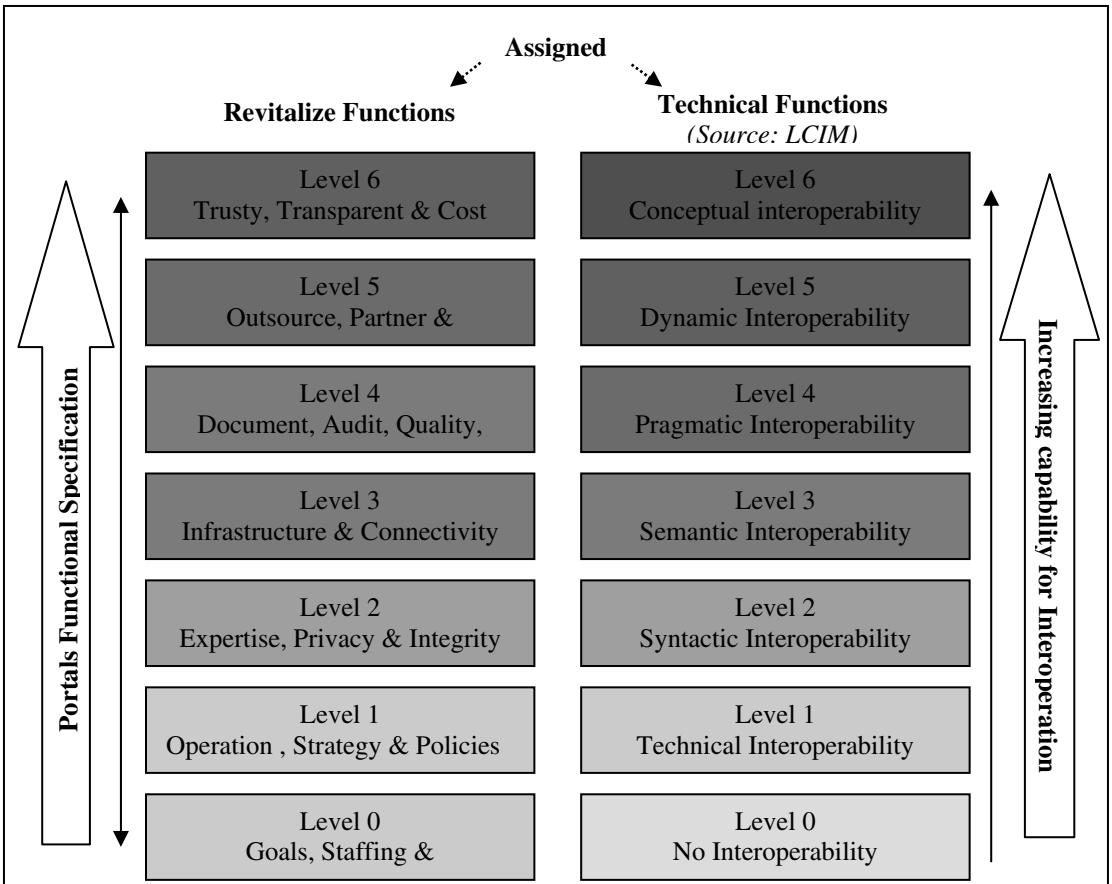

Figure 1: People, Process and Technical view of one stop

technical functions. These functionalities are interconnected and a layered approach helps to figure out all the hidden functionalities as well. Constraints that one stop portal might come across are constitutional constraints, jurisdictional constraints, collaborative constraints, organizational constraints, informational constraints, managerial constraints, cost constraints, technological constraints, performance constraints etc (Gottschalk, P., 2008). Based on the environment and service it offering, portals functional levels addresses various constraints during their functional specification. Functionalities (*revitalize functions (R.Function) & technical functions T.Function*) assigned to each units is explaining next.

- *R.Function Level 0*: At this initial level assigned functionalities are goal setting, constraints identifications, resource identification, requirement engineering, forecasting, staffing, training etc.
- *R.Function Level 1*: From the *organization perspective*, operational and strategic initiations, policy formation, coordination between the organizations, common understanding of various responsibilities and agreements on sharing knowledge, benefits and cost estimation etc are functions of this level.
- *R.Function Level 2*: From the *developer and user perspectives*, various functionalities are assigned at this level. Ensuring privacy of the user and information, integrity of issuing authority etc are some of them.
- *R.Function Level 3*: From the *information perspective*, enabling availability, usability, redundancy, easiness, connectivity, infrastructure development, etc are some of the functions at this level.
- *R.Function Level 4*: From the *services perspective*, Focusing on modernization, quality of data and services, feedback and assessing utilization rate of special services offering, redesigning, re-engineering, new technology adoptions, proper documentation, auditing etc are some functions assigned here.
- *R.Function Level 5*: From the *deployment perspective*, monitoring the process, leasing, strengthening the outsourcing, partnership and participation in the development process etc are some of the assigned task.
- *R.Function Level 6*: From *value perspective*, functions to bring trust, transparency, optimization of task, cost effective governance etc are some ultimate goal setting at this functional level.

Interoperability is the ability of government organizations to share information and integrate information and business processes by use of common standards and work practices. In a narrow sense, the term interoperability is often used to describe technical systems. In a broader sense, social, political, and organizational factors influencing systems and systems performance must also be taken into account (Gottschalk, P. 2008). Technical functions of one stop portal are often oriented towards interoperability issues itself. Assigned functions in the technical unit are discussing here.

- *T.Function Level 0*: At this level functions are traditional model of service delivery by the government.
- *T.Function Level 1*: From *network perspective*; protocol development, infrastructure development, recourse utilization etc are some assigned functions for this level.
- *T.Function Level 2*: From *structure perspective*; Open standards, common data format implementation, defining common format of information exchange etc are few functions at this level.
- *T.Function Level 3*: From *language technology perspective*; assigned functions are to make the portal operate on the basis of it`s contents/meaning. Bring language independent user friend end. Ensure meaningful interactions at the system and the user side.
- *T.Function Level 4:* From *application perspective*; make the portal interact on the contexts of its operations. More customized user applications. Offer and validate special web services and the solutions.
- *T.Function Level 5*: From *object oriented perspective*; Function is to ensure reuse, verification, validations etc.
- *T.Function Level 6*: From *ontology oriented perspective*; Make conceptually rich to identify the portals relational dependence.

3. Elements of One Stop Government Portal

In this section we discuss elements of one stop portal. Identifying and categorizing portal`s constituents is an important step in the functional composability analysis. Entities identification and positioning them in their respective hierarchy form a flexible and general institution for first order logic (Kent, R.E, 2001).

Forming a hierarchy is helpful to identify the impact factor of each e-government entity, over one stop portal. Effective management of cost, time, technology etc is also enabling by this process. Automatic composition and autonomous nature of system and web services are some other expectations from such categorization. A Bayesian network (BN) is a directed acyclic graph where nodes represent variables (factors) and arcs represent dependence relations between variables. Nodes can embody different types of variables (e.g. observable or latent, categorical, numerical etc) which do not need to be random. Arcs in a BN connect parent to child nodes, where a child node's probability distribution is conditional on its parent node's distribution. Arcs, nodes and probabilities can be elicited from experts and/or empirical data. BNs combine the advantages of an intuitive representation with a sound mathematical basis in Bayesian probability. We organize the portal elements using Bayesian network. A sample hierarchy is shown in Figure 2.

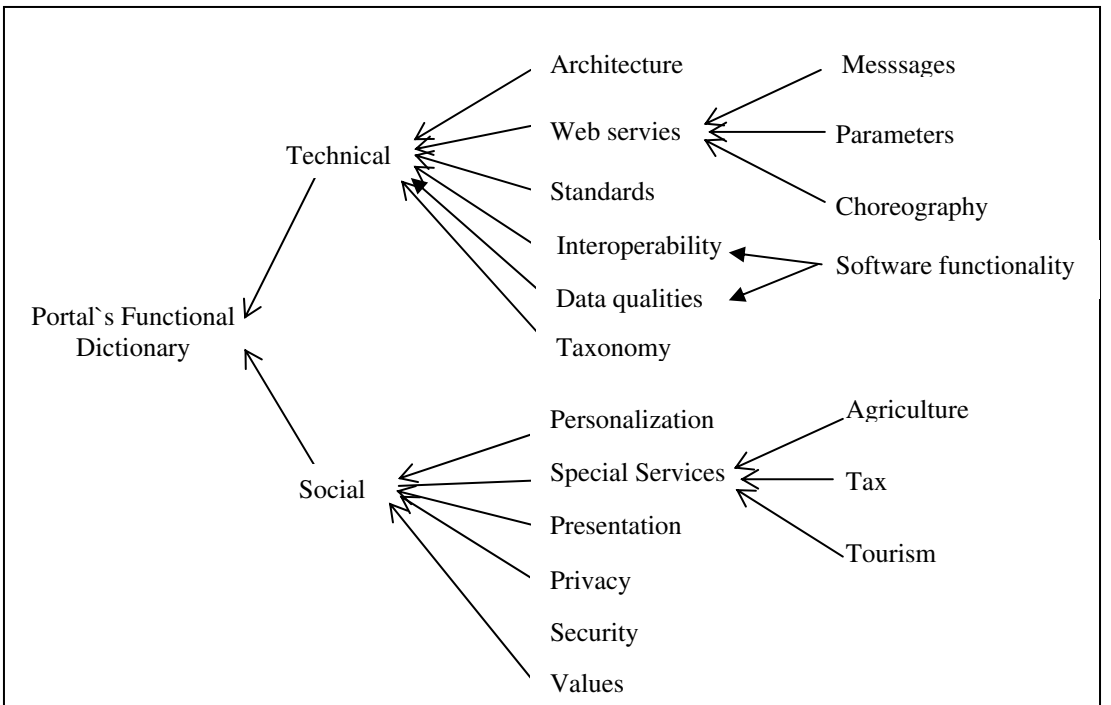

Figure 2: Bayesian network representing a portal functions

Web Portals provide the means to obtain a large amount of information therefore it is crucial that the information provided is of high quality (Angelica et, al, 2007). Researchers investigated web portal data quality in various aspects, but none in to the quality of portal`s functional composability. In our work with an eye towards the quality of portals functional composiblity, we breakdown BN in to two parts, one has got functions in consumer perspective and other with functions in provider/developer perspective. Portal utilization and functionalities might arise due to cultural and social peculiarities (Mario et al, 2002). To gain insight in to more functionality and for better analysis, we classify BN in to social and technical elements. The former got the functions in consumer perspective and later got functions in developer perspective. Web services can be described as local autonomous routines communicating with each other through message exchange. Hence a good understanding of the messages defined in each web service is crucial to enabling automatic composition (Baoping, et al. 2007). The functional components of web services are organized as shown in BN of portals functional dictionary.

4. Conceptual Interoperability in Forming Relations

Axiomatic theories of foundational ontology help to derive formal relations in domain-independent top level categories. One stop portal`s highest level interoperability (conceptual interoperability), uses principles of foundational ontology (Basic Formal Ontology (BFO), Descriptive ontology for Linguistic and Cognitive Engineering (DOLCE) etc) for its functional specifications. In Neo-Vaisesika Formal Ontology, relations is treated as entity itself (Sing, N. 2007). A matured entity or an event in top-level category can form formal relations/inherence in a domain. Ontological relations are relation which exists in reality. Conceptual interoperability is the highest level of interoperability where the assumptions and constraints of meaningful abstraction of reality are aligned. (Turnisa, C.D, 2005). Ontological relations in one stop portals can be derived from their functional specifications of conceptual interoperability. Functional specification of conceptual interoperability in one stop portal is a comprehensive list of ontological relations (both intra-ontological and inter ontological relations) that exists between the entities and events in a portal.

Four pillars of e-government are process, people, technology and resources. Composability is the ability of different simulations connected in a distributed system to collaboratively simulate a common scenario (Petty, 2004). One stop portal`s composability is the simulation of the relations between recourses and technology to support the transformation process. Technology is the strategic tool for the transformation of e-government initiatives (UN survey report, 2008). Interoperability and composability are enablers of transformation from e-services to e-vale services. Our discussions about functional specification of interoperability levels derived a transformation matrix. A matrix representation of relations between interoperability and composability is shown in figure 3.

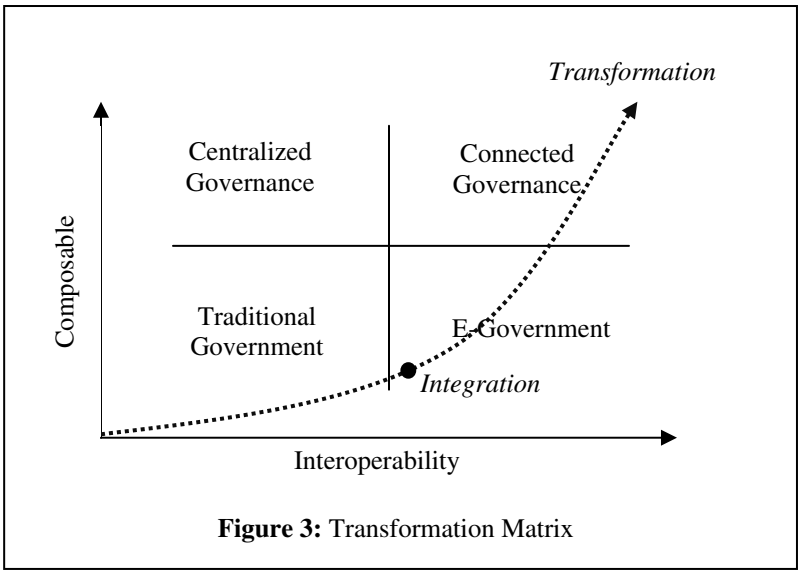

Figure 3: Transformation Matrix

Evolution of public service delivery takes place in three phases, traditional government to e-government (e-services) and then to connected government (e-value services) (UN survey report, 2008). During this evolution process gradual change from traditional static catalogs to various levels of integration, interoperability and then the transformation to connected government took place. High composablity with less interoperability is expected for effective functionalities at centralized governance process (eg. Defense department). Providing e-services at its best require high level of interoperability. In Connected governance both the composability and interoperability levels are high.

5. Open Ontology Framework (OOF)

Numerous ontology frameworks (e.g. KAON, Simple Ontology Framework API (SOFA), Semantic Specification Framework (for web services), Distributed Ontology Framework, Web Ontologies Framework (for digital right management), Object Oriented Ontology Framework (O_3F), Ontology framework for Semantic Business Process Management (SBPM), etc) are easily available. Most of them are for web based semantic applications and/or for various ontology management tasks. None of their discussion is in the context of portals functionality. Even though, the term ontology becomes popular by semantic web movements its principles and scope is not limited to web/semantic applications. For example it can be used for requirement engineering, mind mapping tools, decision making process etc. In this section we propose an Open Ontology Framework (OOF) that is for functional composability analysis of one stop portals. A simple Open Ontology Framework (OOF) for one stop portals is depicted in figure 4.

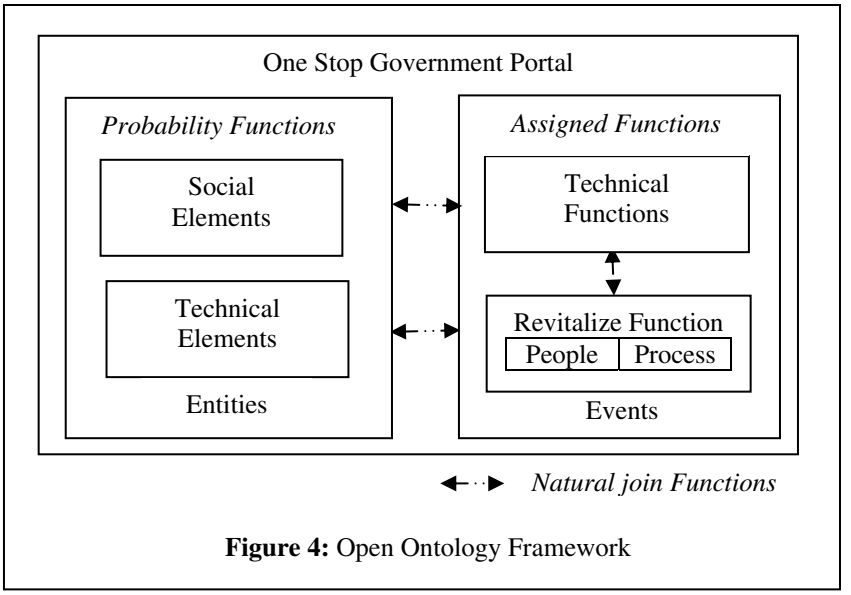

Figure 4: Open Ontology Framework

Framework consists of three functional modules of a portal 1) Assigned functions, 2) Probability functions and 3) Natural join functions. A synergy of these modules leads to the efficient function of a portal. In the context of ontology assigned functions also termed as events of a portal due to the primary functions specified in these modules has the temporal extension of time. It has got the revitalization unit and technical unit. Entities of portal dictionary have got social and technical units. Bayesian network of their structure has got the parent child distribution, and this conditional probability in our context depends on the functions of the nodes. This module is also known as probability function in OOF framework. Conceptual interoperability has been treated as formal relations builder in one stop portal. It is used for the mapping of the two functional units –Assigned functions and Probability functions. Here mapping relations have the nature of ontological relations (relations which exist naturally in real world, both intra and inter ontology relations.) and is considered as Natural join functions.

With in the modules of assigned functions intra-ontological relation is permissible. In this unit for every constituent at least one intra-ontological relation usually exists. This relation is not mandatory in our analysis. A good functional unit is found to have at least one intra-ontology relation and those which with more than one intra-ontological relation is not appreciable as well. In our analysis, between the assigned and probability modules at least one inter-ontology relation is must for each of their constituents, to pass

the functional composability test. A mapping process between each entity and the assigned module is the way to find out the existence of at least one natural joins in the portal modules. Any event or entity which forms a natural tie up in this frame work is analyzed as functionally composable. Those which fail to form a natural relation are eliminated, healed or fixed on the basis of context which fails. Over all functional composability and efficiency of a portal is analyzed from the gap between sum of successful relations and the failure rate of finding conceptual interoperability relation in each operation.

Reviewing our framework, focus of OOF is more on the details, functional and operational aspects. It might be limited to the features of solution architecture (Federal Enterprise architecture (FEA), 2006). Using feed back from the demographic profile and the portal utilization inputs framework can be enhanced. An empirical research is required to establish this theoretical framework.

6. Concluding Remarks

Paper discusses an Open Ontology Framework (OOF), for analyzing functional composability of one stop government portal. Entity, event and relations schema in ontology is underlying principle of this framework. Portal`s functional dictionary is represented using a Bayesian network. By the principles of impressed meaning and knowledge management views, we specify assigned functionality at each maturity levels of the portal. Paper discusses how conceptual interoperability forming natural relations in the portals. A transformation matrix of traditional governance to connected governance is also discussed.

Reference

1. Andreas T, James, A and Muguira. 2003. The Levels of Conceptual Interoperability Model. 2003 *Fall Simulation Interoperability Workshop* Orlando, Florida.
2. Andreja P, Kristina B, Maria W. 2007. Gap analysis methodology for identifying future ICT related eGovernment research topics – case of *"ontology and semantic web*" in the context of eGovernment.
3. 20th Bled eConference eMergence: Merging and Emerging Technologies, Processes, and Institutions, Bled, Slovenia.
4. Angélica. C., Coral. C., Emilia. M. and Mario. P. 2007. A Probabilistic Approach to Web Portal's Data Quality Evaluation. IEEE, *Sixth International Conference on the Quality of Information and Communications Technology.*
5. Baoping L, Qing Li, and Naijie G. 2007. A Semantic Specification Framework for Analyzing Functional Composability of Autonomous Web Services. IEEE *International Conference on Web Services ICWS.*
6. Chun, W.T, Jiun, H.H, Ting,W. L and Chau,S.Y. 2005. An intelligent Web portal system for Web information region integration. *IEEE International Conference on Systems. Man and Cybernetics,* 4: 3878 - 3883.
7. Davis, Fishwick, Overstreet and Pegden. 2000. Model Composability as a Research Investment: Response to the featured paper , *Proceedings of the 2000 Winter Simulation Conference*.
8. Darrell M. West. 2008. Governance at Brookings Studies at Improving Technology Utilization in Electronic Government around the World.
9. Furdik, T.Sabol, P. Bednar. 2007. Framework for Integration of e-Government Services on a Semantic Basis *Sixth International EGOV Conference 2007*. Regensburg, Germany.
10. Farshad. M, and Rassul, A. 2005 Composability issues in Network- Based Modeling and Simulation.
11. Swedish Defence Research Agency (FOI), Dept of Systems Modelling, Royal Institute of Technology (KTH), Stockholm.
12. Goudos, S., Loutas, N., Peristeras, V. and Tarabanis, K. 2007. Public Administration Domain Ontology for a Semantic Web Services EGovernment Framework. *In Proceedings of 2007 IEEE SCC*, 270-27.
13. Gottschalk, P. 2008. Maturity levels for interoperability in digital government, *Government Information Quarterly.*
14. Gupta, M. P., Kumar, P. and Bhattacharya, J. 2005. *Government Online: Opportunities and Challenges,* Tata Mc Graw-Hill Publishing Company Limited.
15. Hepp and Martin. 2008. E-Business Vocabularies as a Moving Target: Quantifying the Conceptual Dynamics in Domains, *Proceedings of the 16th International Conference on Knowledge Engineering and Knowledge*

Management. Springer LNCS, Vol 5268. 388-403.
16. Jon. P.G. and Diana. B.G. 2002. Web portal functionality and State government E-service. IEEE, *Proceedings of the 35th Hawaii International Conference on System Sciences*.
17. Jose, A,M.U., Maria P.B.O. 2005 Ontologies in the Context of Knowledge Organization and Interoperability in e-Government Services. IRFD World Forum 2005 – *Conference on Digital Divide, Global Development and the Information Society*.
18. Mariano, R and Diego, C. 2008. Towards an Open Framework for Ontology Based Data Access with Protégé and DIG 1.1, *Proceedings of the 5th Int. Workshop on OWL*: Experiences and Directions.
19. Mario, C, Ramayya, K, Daniel, N and Oliver, G. 2002. Measuring Web Portal Utilization. IEEE, *Proceedings of the 35th Annual Hawaii International Conference on System Sciences*. 2647 – 2653.
20. Mikel D. P and Eric W. W . *A Composability Lexicon. Virginia Modeling,* Analysis and Simulation Center, Old Dominion University, Norfolk VA 23529.
21. Pearl, J. 1988. Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference: Morgan Kaufmann.
22. Rakhi T, Gupta, M.P and Jaijit B. 2007. Selected Aspects of Interoperability in One-stop Government Portal of India, ICEG Proceedings.
23. Robert, E. K. 2006. The Information Flow Framework: New Architecture. Charles Sanders Peirce, Collected Papers 8:169.
24. Robert, E.K. 2001. IFF Category Theory Ontology. IJCAI, Work shop on IEEE Standard Upper Ontology.
25. Sing, N. 2008. Foundations of Ontological Engineering. HS4055 Lecture notes 1-24. IIIT, Center for Exact Humanities, Hyderabad.
26. Turnitsa, C.D. 2005. Extending the Levels of Conceptual Interoperability Model. Proceedings IEEE Summer Computer Simulation Conference, IEEE CS Press.
27. United Nations e-Government Survey 2008, From e-Government to Connected Governance, ST/ESA/PAD/ SER.E /112, Department of Economic and Social Affairs, United Nations, New York.
28. Vassilios, P, Nikolaos L and Konstantinos, T. 2008. Organizational Engineering in Public Administration: The State of the Art on eGovernment Domain Modeling. Proceedings of the 2008 ACM symposium on applied computing, Brazil. 580-587.
29. Wimmer, M. 2002. A European perspective towards online one-stop government, the eGOV project, Electronic Commerce Research and Applications 1, 92–103.

About the Authors

A. Sreejith is currently a Doctoral student at Department of Management Studies, Indian Institute of Technology Delhi. His areas of research interests are trust, ontology, semantics, e-government and standards He has twenty months of research experience. He obtained M.Tech in Software Engineering and B. Tech in Computer Science and Engineering from Cochin University of Science and Technology, Cochin.

Rakhi Tripathi is currently a Doctoral student at School of Information Technology, Indian Institute of Technology Delhi. Her specific area of research is 'Semantic Interoperability for achieving a One-stop Government Portal'. She has previously worked as a Project Scientist for two years under the project 'Establishment of Nation-wide QoS Test-bed' at Department of Computer Science, Indian Institute of Technology Delhi. Prior to that, she obtained MS (Computer Science) in 2003 from Bowie State University, (University of Maryland, USA).

M. P. Gupta is Chair-Information Systems Group & Coordinator-Center for Excellence in E-gov at the Department of Management Studies, Indian Institute of Technology (IIT Delhi). His research interests lies in the areas of IS/ IT planning and E-government. Prof.. Gupta has authored acclaimed book "Government Online" and edited two others entitled "Towards E-Government" and "Promise of E-Government", published by McGraw Hill, 2005. His research papers have appeared in National and International Journals/Conference Proceedings. He was the recipient of the prestigious Humanities & Social Sciences (HSS) fellowship of Shastri Indo Canadian Institute, Calgary (Canada) and a Visiting Fellow at the University of Manitoba. He supervised e-government portal "Gram Prabhat" which won the IBM Great Mind Challenge Award for the year 2003. He has steered several seminars and also founded the International Conference on E-governance (ICEG) in 2003 which running into seventh year. He is on the jury of Computer Society of India (CSI) E-gov Awards and also a member of Program Committee of several International Conferences. He is life member of Global Institute of Flexible Systems Management (GIFT), Systems Society of India (SSI) and Computer Society of India (CSI).