USE OF BIG DATA IN E-GOVERNANCE:
A STUDY OF SELECT PROJECTS IN INDIA

THESIS

SUBMITTED TO THE
DELHI TECHNOLOGICAL UNIVERSITY
FOR AWARD OF THE DEGREE OF

DOCTOR OF PHILOSOPHY

BY
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2K15/Ph.D/DSM/01

UNDER THE GUIDANCE OF
PROF. P. K. SURI

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DELHI-110042 (INDIA)

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DECLARATION

I, hereby certify that the thesis titled **"Use of Big Data in E-Governance: A Study of Select Projects in India"** and submitted in fulfillment of the requirements for the award of the degree of Doctor of Philosophy is an authentic record of my research work carried out under the guidance of Professor Pradeep Kumar Suri. Any material borrowed or referred to, is duly acknowledged.

The matter presented in this thesis has not been submitted elsewhere in part or fully to any other University or Institute for the award of any degree.

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CERTIFICATE

This is to certify that the thesis entitled **“Use of Big Data in E-Governance: A Study of Select Projects in India”**, being submitted by Ms Charu Verma (2K15/Ph.D/DSM/01) to the Delhi Technological University for the award of the degree of Doctor of Philosophy (Ph.D.) is a record of bona fide research work carried out by her. She has worked under my guidance and supervision and fulfilled the requirements for the submission of the thesis, which has attained the standard required for a Ph.D. degree of the University. The results presented in this thesis have not been submitted elsewhere for the award of any degree or diploma.

Professor Pradeep Kumar Suri

Professor

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Abstract

The government is a constantly evolving mix of objectives, frameworks, and operations. Electronic governance, commonly known as e-governance, pertains to the utilization of Information and Communications Technology (ICT) in the operational aspects of governmental bodies. E-governance aims to foster SMART governance, which stands for "Simple, Moral, Accountable, Responsive, and Transparent" governance. E-governance brings about a revolutionary transformation in the manner in which governments engage with citizens, businesses, and other government entities, enhancing their interactions and connectivity. The advantages of e-governance are acknowledged globally. In India, substantial investments have been made by the government in recent years to implement numerous new e-governance initiatives and enhance existing ones, all aimed at enhancing the performance of these government services. However, studies suggest that the full benefits of e-governance projects in terms of beneficiary outcomes are yet to be fully realized. While considerable research has been conducted in the Indian context on various aspects of e-governance these studies primarily focus on adoption, service delivery, and performance assessment, etc. Given India's diversity, implementing e-governance has become crucial for realizing the vision of Digital India. The need to utilize data to track individual citizen transactions at a granular level is evident in order to analyze and constantly improve based on feedback. Given the vast amount of data being generated, the incorporation of big data becomes imperative for ensuring the efficacy of e-governance.

Big data is commonly characterized using the 3Vs framework: 'Volume' pertains to the extensive quantity of data that necessitates significant storage capacity or consists of a large number of records; 'Velocity' denotes the speed at which data is generated or transmitted; and 'Variety' encompasses data originating from diverse sources and formats, encompassing both structured and unstructured data with multidimensional fields. Over time, two additional dimensions have emerged in the understanding of big data: 'Value' underscores the importance of extracting economic benefits from the abundant data resources, while 'Veracity' emphasizes the criticality of data quality and the level of trust placed in diverse data sources. Leveraging big data provides numerous advantages, including fostering transparency, facilitating performance improvement, enabling data-driven decision-making, and enhancing customizations for target-centric applications. These advantages have stimulated the adoption of big data in e-governance to bolster

performance. However, research analyzing the utilization of big data for enhancing e-governance performance remains scarce thus far.

The comprehensive review of existing literature has revealed significant gaps, thereby facilitating the formulation of the research objectives. The specific objectives of this study are outlined below.

- To identify the variables that can be used to assess the ‘Performance of e-governance projects using big data'.
- To identify the variables necessary for the successful implementation of 'e-governance projects using big data'.
- To explore the relationship between the variables that contribute to the successful implementation and ‘Performance of e-governance projects using big data'.
- To propose an empirically validated framework aimed at enhancing the ‘Performance of e-governance projects using big data'.

To achieve these objectives, a multi-stage approach has been employed. Initially, a pilot study has been conducted to gather preliminary insights. Subsequently, a qualitative study has been undertaken to delve deeper into the subject matter. Finally, a comprehensive survey has been conducted to collect responses from beneficiaries and implementers of selected e-governance projects in India. The gathered data have been analyzed in detail to support the research objectives.

This research is grounded in a comprehensive approach that incorporates a literature review, expert interviews, and a survey conducted on specific e-governance projects implemented by both the Central and State governments of India. By drawing insights from existing literature, engaging with experts in the field, and collecting data through surveys, this research aims to provide a well-rounded understanding of the subject matter and contribute valuable insights to the field of e-governance. The implementation of these e-governance projects falls under the purview of the National eGovernance Plan (NeGP) 2.0. The study is specifically conducted with a primary focus on the utilization of big data in the five identified e-governance projects. Both State Government as well as Central Government projects have been considered to have a holistic coverage. The projects are: (i) Aadhaar card services from Unique Identification Authority of India (UIDAI), Ministry of Electronics & Information Technology (MeitY); (ii) Central Government Health Services (CGHS) from Ministry of Health & Family Welfare (MoHFW); (iii) Passport Seva Kendra

(PSK) services from Ministry of External Affairs (MEA); (iv) Income Tax Return (ITR) filing from Ministry of Finance; (v) Indian Railway Catering and Tourism Corporation (IRCTC) from Ministry of Railways. Prior to the main study, a pilot study was conducted specifically on the Aadhaar card services from UIDAI. These PAN India projects are selected due to their wider acceptability, being in operation for more than five years and using big data for more than two years and that too in huge manner.

The research is structured into three distinct parts. The first part involves conducting an extensive literature review on e-governance and the use of big data in e-governance projects. To gain deep insights for the research, the review of literature has been in broad areas of (i) E-governance/E-government: definitions and meaning, scope, maturity models, importance, assessment frameworks, performance indicators, critical success factors (CSFs) for successful implementations and challenges; (ii) Big data; definition and meaning of 5Vs, importance, values, CSFs, frameworks and challenges for implementations; (iii) Utilization of big data in e-governance: criteria, importance, CSFs, frameworks and challenges; (iv) Influence of big data use on e-governance performance: frameworks, models, performance indicators, etc. This extensive review of literature facilitated in identification of macro as well as micro variables for conceptual framework of this research.

The second section focuses on the research methodology employed and the survey conducted for this study. The research design incorporates a combination of qualitative and quantitative methods to gather and analyze data. The qualitative approach encompasses an opinion survey conducted with four domain experts. Their valuable insights played a pivotal role in shaping the factors used to evaluate the ‘Performance of e-governance projects using big data’. To evaluate the conceptual framework, the study employed the Total Interpretive Structural Modeling with Polarity (TISM-P) technique. For the quantitative aspect, a survey was conducted with a targeted sample size of 150 implementers and 500 beneficiaries. The survey received a total of 120 responses from implementers and 439 responses from beneficiaries. Out of these, 118 responses were considered valid for the implementers' analysis and 426 for the beneficiaries' analysis. The collected survey data were analyzed using the Partial Least Squares-Structural Equation Modeling (PLS-SEM) methodology. The analysis of the survey data was performed using Smart PLS version 4.0.

The third part consists of detailed outcomes of the study from qualitative as well as quantitative perspectives. The study revealed that the performance of e-governance projects can be significantly improved by leveraging big data. The comprehensive insights gained from quantitative as well as qualitative analyses have contributed to the development of a comprehensive framework for assessment of the ‘Performance of e-governance projects using big data’. This framework provides a generalized and structured approach to enhance the overall performance of e-governance initiatives through the effective utilization of big data. The study concludes by summarizing the research contributions, recommendations, implications, limitations and future scope.

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List of Abbreviations

ABDM	:	Ayushman Bharat Digital Mission
ACC	:	Accountability
AEPS	:	Aadhaar Enabled Payment System
AI	:	Artificial Intelligence
AMOS	:	Analysis of Moment Structures
AOA	:	Autonomy of agencies
AOG	:	Alignment & Awareness of organizational goals
API	:	Application Programming Interface
ARC	:	Administrative Reforms Commission
AYUSH	:	Ayurveda, Yoga, Unani, Siddha and Homeopathic
AVE	:	Average Variance Extracted
BDA	:	Big Data Analytics
BI&A	:	Business Intelligence and Analytics
BIP	:	Business Intelligence Portal
BMC	:	Better Monitoring & control
BPR	:	Business Process Re-engineering
CBDT	:	Central Board of Direct Taxes
CCTNS	:	Crime and Criminal Tracking Network & Systems
CFA	:	Confirmatory Factor Analysis
CGHS	:	Central Government Health Scheme
CIDR	:	Central ID Repository
CLR	:	Conducive laws and regulations
CMB	:	Common Method Bias
CMCPC	:	Compliance Management Centralized Processing Center
COI	:	Comprehensive information
COO	:	Consensus-oriented
CPC	:	Centralized Processing Center
CR	:	Critical Ratio/Composite Reliability
CSB	:	Cost structures, Budgeting, Budget allocation & disbursement
CSC	:	Common Services Centre
CSF	:	Critical Success Factor
CVR	:	Content Validity Ratio

CVPAT	:	Cross-Validated Predictive Ability Test
DARPG	:	Department of Administrative Reforms and Public Grievances
DeitY	:	Department of Electronics and Information Technology
DIP	:	Digital India Programme
DIPP	:	Department of Industrial Policy and Promotion
DS	:	Decision support
DSC	:	Digital Signature Certificate
DV	:	Discriminant Validity
DYI	:	Dynamic information
EAF	:	E-Governance Assessment Framework
EAI	:	Easy access to information
EF	:	Efficiency
EFA	:	Exploratory Factor Analysis
EGP	:	E-Governance Performance
EGMM	:	E-Government Maturity Model
EGPI	:	E-Governance Performance Index
eKYC	:	Electronic Know Your Customer
EMR	:	Electronic Medical Record
ENV	:	Environmental
EVC	:	Electronic Verification Code
FAR	:	Fairness/Reduced corruption
FAQs	:	Frequently Asked Questions
FEP	:	Fast execution of core process
GOI	:	Government Of India
G2B	:	Government-to-Business
G2C	:	Government-to-Citizen
G2CS	:	Government-to-Civil Society
G2G	:	Government-to-Government
GFI	:	Goodness of Fit Index
GIS	:	Geospatial Information Systems
GLS	:	Generalized Least Square
GOF	:	Goodness-of-Fit
GP	:	Gram Panchayat

HFR	:	Health Facility Registry
HIE	:	Health Information Exchange
HIE-CM	:	Health Information Exchange & Consent Manager
HIMS	:	Health Information Management System
HOC	:	Higher Order Component
HPR	:	Healthcare Professionals Registry
HR	:	Human Resource
HTMT	:	Heterotrait-Monotrait
ICAO	:	International Civil Aviation Organization
ICT	:	Information and Communications Technologies
ID	:	Information and data
IDM	:	Improved decision-making
IDQ	:	Information and data quality
IE	:	Institution and environment
IGR	:	Intergovernmental relationships
IMI	:	Improved interaction
IMP	:	Improved planning
IN	:	Interactivity
INR	:	Indian Rupee
INTRAC	:	Income Tax Transaction Analysis Centre
IRCTC	:	Indian Railway Catering and Tourism Corporation
ISM	:	Interpretive Structural Modeling
IT	:	Information Technology
ITDMS	:	Integrated Taxpayer Data Management System
ITR	:	Income Tax Return
JAM	:	Jan Dhan Yojana (financial inclusion scheme), Aadhaar and Mobile
KPA	:	Key Performance Area
KPI	:	Key Performance Indicator
LED	:	Light Emitting Diode
LOC	:	Lower Order Component
LR	:	Law and regulation
MAB	:	Manager’s attitudes & behaviour
MCD	:	Municipal Corporation of Delhi

MEA	:	Ministry of External Affairs
MeitY	:	Ministry of Electronics and Information Technology
ML	:	Machine Learning
MMPs	:	Mission Mode Projects
MoHFW	:	Ministry of Health & Family Welfare
MoRTH	:	Ministry of Road Transport and Highways
MP	:	Member of Parliament
NDHB	:	National Digital Health Blueprint
NeGP	:	National e-Governance Plan
NFI	:	Normed Fit Index
NGET	:	Next Generation e-Ticketing System
NHA	:	National Health Authority
NHP	:	National Health Policy
NIC	:	National Informatics Centre
NITI	:	National Institution for Transforming India
NLP	:	Natural Language Processing
NOFN	:	National Optical Fibre Network
NRI	:	Non-Resident Indian
NTF	:	National Task Force
OECD	:	Organization for Economic Co-operation and Development
OM	:	Organization and management
PAR	:	Participative
PAS	:	Privacy and security
PCC	:	Police Clearance Certificate
PLS	:	Partial Least Squares
PLS-SEM	:	Partial Least Squares-Structural Equation Modeling
PM-JAY	:	Pradhan Mantri Jan Arogya Yojana
PNR	:	Passenger Name Record
POPSK	:	Post Office Passport Seva Kendra
PPP	:	Public Private Partnership/Policy and political pressures
PPR	:	Public Sector Process Rebuilding
PRS	:	Project size
PSC	:	Privacy and related security concerns

PSK	:	Passport Seva Kendra
PSP	:	Passport Seva Project/Program
PSU	:	Public Sector Undertaking
PVC cards	:	Plastic Cards used to print ID cards
QUP	:	Qualified Personnel/ Talent
R&D	:	Research and Development
REC	:	Reduced cost
REI	:	Reliable information
REP	:	Reduced paperwork
RTC	:	Resistance to change/internal conflicts
RTI	:	Right to Information
RTO	:	Regional Transport Office
SE	:	Standard Error
SEI	:	Security issues
SEM	:	Structural Equation Modelling
SMART	:	Simple Moral Accountable Responsive and Transparent
SOP	:	Simplification of processes
SPSS	:	Statistical Package for Social Sciences
SRMR	:	Standardized Root Mean Square Residual
SWAN	:	State Wide Area Network
TAS	:	Techniques, Algorithms & scalability
TCS	:	Tata Consultancy Services
TEC	:	Technological compatibility
TEN	:	Technology complexity/Newness
TIN	:	Tax Information Network
TISM	:	Total Interpretive Structural Modeling
TISM-P	:	Total Interpretive Structural Modeling with Polarity
TR	:	Transparency
TSE	:	Technical skills and experience
UIDAI	:	Unique Identification Authority of India
ULS	:	Un-Weighted Least Square
UMANG	:	Unified Mobile Application for New-age Governance
UML	:	Unified Modeling Language

UN	:	United Nations
UNESCO	:	United Nations Educational, Scientific and Cultural Organization
UOD	:	Users or organizational diversity
UPI	:	Unified Payments Interface
US	:	United States of America
USE	:	Usability
UT	:	Union Territory
VBP	:	Variety and best practice
VID	:	Virtual ID
VIF	:	Variance Inflated Factor
WLS	:	Weighted Least Square
WWW	:	World Wide Web

Chapter 1

Introduction to the Study

1.1 Research Background

Government represents a dynamic blend of goals, structure, and functions as per Pardo (2000). The swift pace of advancement in information technology has brought most of the government services on the finger tips of citizens (Sahani and Thakur, 2021). E-governance, also known as electronic governance, aims to establish a seamless connection between citizens and government agencies by leveraging Information and Communications Technology (ICT). Through automated processes, e-governance reduces costs, enhances performance, accelerates service delivery, and improves the overall effectiveness of implementation (Almaraben and AbuAli, 2010; Bhatnagar, 2004). E-governance brings about a transformation in governance, creating a regime that is transparent, responsive, citizen-friendly, and highly efficient (Verma and Suri, 2019). E-governance strives to establish "Simple, Moral, Accountable, Responsive, and Transparent (SMART)" governance (ARC, 2008). Effective implementation of e-governance goes beyond the mere utilization of advanced ICT tools. It necessitates extensive restructuring of administrative processes, redefinition of administrative procedures, and revisiting formats. However, this transformation often encounters resistance from various departments at all levels (Dash and Pani, 2016). The objectives of e-governance encompass various goals: (i) Enhancing service delivery to citizens by providing improved and efficient services; (ii) Promoting transparency and accountability to citizens, ensuring openness in government processes; (iii) Empowering citizens through access to information, enabling them to make informed decisions; (iv) Improving the overall efficiency within governments by streamlining processes and reducing bureaucratic hurdles; (v) Enhancing the interface with business and industry, fostering a conducive environment for economic growth and development.

The adoption of the term "e-governance" or "e-government" is not consistent worldwide. Different countries embrace these terms based on their unique contextual considerations and requirements (Verdegem and Verleye, 2009). The term "e-government" refers to the integration of ICT with government departments to facilitate the smooth and seamless information exchange (Signore et al., 2005). Here, the government departments are required to upgrade their processes and information. For this, they undergo holistic changes in their approach starting from data collection, storage and management to data processing. The term "e-governance" or "electronic governance" refers to the utilization of ICT and the Internet to establish a continuous and uninterrupted flow of information between the government and its citizens (Paul, 2010). Here, the letter ‘e’ refers to ‘electronic’ where all communication takes place electronically and the word ‘governance’ means to coordinate, manage and organize people by utilizing ICT and the Internet. While e-governance encompasses the decision-making process, e-government focuses on the execution of decisions (Marche and Mcniven, 2003), typically involving one-way communication from the government to citizens. Although the terms e-governance and e-government are used interchangeably in this study, the term e-governance is more commonly used, considering the specific context of India (Planning Commission, 2007).

E-governance initiatives aim to improve the overall performance of governments by enhancing the quality of services provided to citizens and increasing the efficiency of internal government operations. Additionally, e-governance promotes citizen participation in the decision-making process (Almaraben and AbuAli, 2010). Various researchers utilize different indicators to measure the performance of e-governance projects. These indicators include information dissemination, two-way communication, service delivery, integration, political participation, security, usability, among others. E-governance can also be conceptualized as a value chain, illustrating how inputs are transformed into outputs (Heeks, 2006).

India, as the largest democracy and most populous country in the world, stands to benefit greatly from the implementation of e-governance. This is particularly crucial given that citizen participation in governance is a key characteristic of the advanced stage of e-governance (Suri and Sushil, 2017). However, accomplishing this task is not without challenges. India's vast population is accompanied by significant diversity in terms of religion, region, language, age, and various other parameters (linguistic, genetic, cultural diversity, etc.). Managing and accommodating this extensive diversity adds complexity to the implementation of e-governance initiatives in India. India has more than two thousand ethnic groups. Further, complexity is lent by the great variation that occurs across this population on social parameters such as income and education. In India, the development of e-governance can be broadly categorized into two phases: the "Pre-Internet era" spanning from the 1960s to the 1990s, and the "Internet era" that commenced in the late 1990s (Gupta, 2010). In 2006, the Indian government introduced the National eGovernance Plan (NeGP) to accelerate e-governance initiatives. Many of the mission mode projects (MMPs) initiated under the NeGP in 2006 are now being implemented as part of the Digital India Programme (DIP), which was launched in 2014 by the previous government. The primary objective of the Digital India Programme (DIP) is to transform India by enabling digital empowerment and fostering a knowledge economy (www.meity.gov.in). To effectively track and improve services based on detailed citizen transactions, the utilization of big data analytics becomes essential (ARC, 2008). It is easy to process, analyze and extract the information when the size and nature of the data is limited. However, the management of big data becomes challenging when dealing with enormous volumes of varied data generated from multiple sources (Mahmoud et al., 2019). Big data technology employs parallel processing algorithms to handle large datasets and extract valuable insights in an analytical manner (Navdeep et al., 2016). Numerous authors have highlighted the multitude of benefits associated with big data. It is recognized for its high operational and strategic potential in generating substantial business value (Wamba et al., 2015). Big data has been described as the "next big thing in innovation" (Gobble, 2013), the "fourth paradigm of science" (Strawn, 2012), the catalyst for the next management revolution (McAffee and Brynjolfsson, 2012), and a facilitator of revolution in science and technology (Ann Keller et al., 2012). This is attributed to its capability to transform competition through process optimization, reshape corporate ecosystems, and foster innovation (Brown et al., 2011), while creating business value by uncovering new organizational capabilities (Davenport et al., 2012).

Given the diverse nature of India, the implementation of e-governance has become a necessity to achieve the vision of Digital India. With the vast amount of data generated by various government initiatives, the use of big data is crucial for effective e-governance. Big data has the potential to significantly enhance the performance of e-governance systems. However, utilizing big data in e-governance comes with its own set of challenges and requirements. According to Zoughbi (2017), the infrastructure requirements for e-governance using big data include managing high volumes of data over extended periods, handling the rapid generation of large datasets, distributing and replicating multidimensional data, supporting virtual e-governance communities, and ensuring robust security measures for data storage and retrieval, as well as data integrity, confidentiality, and accountability. Successful implementation of e-governance applications necessitates efficient processes, technology, and data (Dhoot, 2014). When incorporating big data in e-governance, data sharing, learning, grouping, and mining become essential. The framework for utilizing big data in e-governance involves resource management, data management, data analysis, data discovery, and dynamic reporting. However, there are several challenges to overcome, such as scaling data, ensuring auditing and replication, disaster recovery, and maintaining optimal performance.

To effectively utilize big data in e-governance, certain requirements must be met: reliability, speed, and efficiency in processing big data; faster and efficient policy implementation; data efficiency; and the transition from handling structured data to facilitating data sharing between applications. The performance of e-governance projects is measured based on transparency, accountability, and citizen participation, which encompass interactivity, decision-making support, and empowerment (Suri and Suri, 2009; Suri and Sushil, 2017). Similarly, there are a set of indicators used to measure the success of big data projects. Drawing from these indicators, a conceptualized set of indicators was developed to assess the 'Performance of e-governance projects using big data'. Macro variables influencing the 'Performance of e-governance projects using big data' were identified through a review of literature. Although there are limited studies on measuring the 'Performance of e-governance projects using big data', the study aims to explore the variables that may influence the performance of such e-governance projects that use big data.

1.2 Motivation for the Research

Over the years, numerous initiatives have been implemented by State governments and Central ministries to establish e-governance in India. Extensive efforts have been made at various levels to enhance the delivery of public services and simplify their accessibility (Chandra, 2016). The evolution of e-governance in India has progressed beyond the mere computerization of government departments, encompassing crucial aspects such as citizen centricity, service orientation, and transparency (Patil et al., 2016). Valuable lessons from previous e-governance endeavors have significantly influenced the country's progressive e-governance strategy. To expedite the implementation of e-governance across the different tiers of government—National, State, and Local—a programmatic approach guided by a shared vision and strategy should be adopted. This approach holds the potential for substantial cost savings through the utilization of common core and support infrastructure, fostering interoperability through standardization, and presenting citizens with a seamless view of the government. In essence, the objective of public organizations' e-governance initiatives is to enhance performance in terms of efficiency, transparency, accountability, and citizen participation, encompassing interactivity, decision-making support, and empowerment.

The emergence of big data brings forth the potential to revolutionize governance paradigms. However, despite its profound impact on strategy and operations, there is a scarcity of empirical research assessing the role of big data in global e-governance, particularly in India (Wamba et al., 2015). The utilization of big data in e-governance initiatives can bring about various benefits. Firstly, it enables the sharing of information, thereby reducing the gap between different regions and departments. Additionally, big data enhances the accuracy and efficiency of data transmission. Moreover, it plays a significant role in increasing public participation by providing more online government platforms. The analysis of large-scale data generated daily in e-governance projects contributes to the accuracy and effectiveness of decision-making for both the government and citizens, as it provides valuable information and knowledge (Naili and Lei, 2019). However, public participation in e-governance is currently imbalanced, making it challenging to popularize among citizens. Factors contributing to this imbalance include the significant gap between urban and rural areas, limited access to information technology, and insufficient infrastructure. Nevertheless, with the advancements in technology and the widespread availability of computers and mobile devices, e-governance has the potential to significantly improve efficiency through online services.

Recent research indicates that despite the widespread adoption of digital technologies, many e-governance initiatives fail to deliver their promised benefits and struggle to gain widespread citizen usage (Bindu et al., 2019). The challenges posed by these digital technologies are being increasingly recognized by individuals, civil rights groups, governments, and society as a whole (Körner et al., 2019). While the benefits of utilizing big data in e-governance are evident in developed countries, there is a lack of empirical studies focusing on success factors in India specifically within the context of big data and e-governance. Existing e-governance performance frameworks described in the literature often lack a foundation of data, particularly big data. This research aims to develop a conceptual framework that integrates the advantages of big data to enhance the performance of e-governance projects while addressing the challenges associated with its implementation. The primary objective of this research is to establish a framework by studying select e-governance initiatives in India, with a focus on leveraging big data to achieve improved performance. The study conceptualizes that the utilization of big data in e-governance projects is expected to result in enhanced e-governance performance. Through a conceptual research framework, the study seeks to analyze the influence of variables related to big data on the ‘Performance of e-governance projects using big data’.

1.3 Research Questions

The performance of e-governance projects in India, despite various government initiatives, has not fully realized the anticipated benefits for citizens (Suri, 2009). This situation has spurred the interest of researchers to investigate specific e-governance projects that leverage big data and propose a framework to enhance their performance. The research aims to address the following key questions:

1. What are the significant variables that constitute the ‘Performance of e-governance projects using big data’?
2. What are the variables that significantly influence the ‘Performance of e-governance projects using big data’?
3. In what manner these variables influence the ‘Performance of e-governance projects using big data’?

By exploring these questions, the research endeavors to shed light on the potential of big data and provide insights into enhancing the performance of e-governance initiatives in India.

1.4 Research Objectives

Governments across the world are offering better citizen services through e-governance with effective use of ICT. While developed countries have begun leveraging citizen transactional data to enhance the performance of e-governance services, developing countries are still in the early stages of utilizing big data for this purpose. This research aims to bridge that gap by exploring the relationship between variables related to big data and ‘Performance of e-governance projects using big data’. To conduct this research, five PAN India e-governance projects that utilize big data have been selected. Through the analysis of these projects, the research seeks to identify and understand the impact of big data on e-governance performance in the context of developing countries. The study has the following objectives:

1. To identify the significant variables constituting the ‘Performance of e-governance projects using big data’.
2. To identify the variables that significantly influence the ‘Performance of e-governance projects using big data’.
3. To explore the relationship between variables for ‘Performance of e-governance projects using big data’.
4. To propose an empirically validated framework for ‘Performance of e-governance projects using big data’.

1.5 Significance of the Research

This research aims to provide valuable insights into the varibales for use of big data to enhance the performance of e-governance projects. The findings of this study will be relevant to policy makers, planners, and implementers, as it will highlight the importance of considering big data variables during the conceptualization of new e-governance projects. Furthermore, it will enable them to identify and implement corrective measures to enhance the performance of ongoing e-governance projects. The proposed research framework has the potential to significantly improve the performance of e-governance projects by examining the influence of big data related variables on project outcomes. Through empirical validation of the conceptual framework, the results of this research are expected to offer practical guidance to practitioners in achieving better performance in e-governance projects. Ultimately, this research aims to benefit citizens by ensuring more effective and efficient e-governance services.

1.6 Scope of the Study

The research focuses on specific e-governance projects at the National level in India. The selection of these projects is based not only on their convenience but also on specific criteria. The chosen projects have been operational for more than five years and have been utilizing big data for at least the past two years. This selection criteria ensures that the research examines projects with a substantial operational history and a significant period of utilizing big data, allowing for a comprehensive analysis of their performance and the impact of big data integration. The study is designed within the following scope:

- Pilot study conducted for National level Aadhaar services by Unique Identification Authority of India (UIDAI) e-governance project.
- Main study for five National level PAN India e-governance projects, viz., services for Aadhaar card, Central Government Health Scheme (CGHS), Passport Service, Income Tax Return (ITR) filing and Indian Railway Catering and Tourism Corporation (IRCTC).
- The survey and data collection for this research will focus on two main groups: the implementers involved in the implementation of the selected e-governance projects, and the beneficiaries who have utilized these e-governance services.

1.7 Overall Methodology of the Research

The research builds upon a conceptual research framework developed through a thorough literature review and a pilot study of a National level e-governance project. The detailed study involves conducting surveys and collecting data from both implementers and beneficiaries of these selected e-governance projects. The collected data is then analyzed to draw meaningful conclusions and make recommendations within the context of the study. This comprehensive approach allows for a deeper understanding of the e-governance projects and facilitates the generation of informed recommendations based on the analysis of the survey data. This study is mainly divided into four stages:

Conceptual Research Framework and Hypotheses Formulation (Stage I): Extensive literature review has enabled the identification of variables associated with the ‘Performance of e-governance projects using big data’ and big data itself. To gain deeper insights into performance-related issues and gather inputs from domain experts, a pilot study focusing on Aadhaar services from the Unique Identification Authority of India (UIDAI) e-governance project was conducted. Based on the findings from the pilot study and expert inputs, a conceptual research framework has been formulated, taking into account the big data factors that influence ‘Performance of e-governance projects using big data’. Hypotheses have been developed to explore the potential relationships among the identified research variables. This systematic approach ensures a comprehensive understanding of the subject matter and provides a foundation for further analysis and investigation in the study.

TISM-P Analysis (Stage II): The study employs the Total Interpretive Structural Modeling with Polarity (TISM-P) technique to examine and validate the inter-relationships among the big data related factors and the factors influencing the ‘Performance of e-governance projects using big data’ within the proposed conceptual framework. To construct the TISM-P model, inputs were obtained from 10 domain experts through a questionnaire. The experts were asked to express their level of agreement or disagreement regarding the linkages between the factors using a five-point Likert-type scale. It is worth noting that the literature recommends involving a minimum of three and a maximum of twenty experts in this type of study (Tilden et al., 1990; Gable and Wolf, 1993).

Empirical Study for Hypotheses Testing (Stage III): A structured questionnaire survey was conducted to gather responses from individuals who have both utilized and implemented the services offered by the selected e-governance projects. The aim was to collect valuable insights regarding the proposed framework. To validate the framework, Partial Least Squares-Structural Equation Modeling (PLS-SEM) was employed. PLS-SEM is a statistical analysis technique used to assess and validate the relationships between variables in a structural model. By utilizing this methodology, the proposed framework was evaluated for its effectiveness and reliability in the context of the study.

Synthesis of Qualitative and Quantitative Analysis (Stage IV): The findings from both qualitative and quantitative analyses have been synthesized to provide a comprehensive understanding of the research topic. Based on this synthesis, recommendations and their implications have been identified. Furthermore, the research highlights its significant contributions and limitations, which in turn guide future research directions. Throughout the various phases of the study, different research techniques were employed to gather and analyze data. Table 1.1 provides a brief description of these techniques, including their key objectives, research methodologies, and techniques used.

Table 1.1: Description of Research Methodologies and Techniques Used

Study Phase	Study Objective	Research Approach	Research Technique Used
Pilot Study	• To conceptualize research framework for assessing 'Performance of e-governance projects using big data' • To explore the conceived influence of big data related research variables on 'Performance of e-governance projects using big data'	• Pilot study conducted for Aadhaar services e-governance project from UIDAI • Questionnaire-based survey conducted for implementers	• Literature Review • Univariate Analysis
Main Study	• To propose a conceptual research framework for 'Performance of e-governance projects using big data' in India • To empirically test and validate the conceptual research framework	• PAN India e-governance projects, viz. services for Aadhaar card from UIDAI, CGHS, Passport service, Income Tax Return Filing and IRCTC • A questionnaire-based survey of implementers as well as beneficiaries	• Total Interpretive Structural Modeling with Polarity (TISM-P) • Partial Least Squares-Structural Equation Modeling (PLS-SEM) • Independent Samples t-test for 'performance' perception difference between implementers and beneficiaries

1.8 Structure of Thesis

This thesis is organized into **seven** chapters. A brief overview of these chapters is as follows:

The first chapter is **Introduction to the Study** that serves as an Introduction, providing essential context and background information. It outlines the research motivation, research questions, objectives, scope, and significance. This chapter sets the foundation for the entire study, establishing the purpose and relevance of the research. It also outlines the overview of research methodology used in four stages, viz. conceptual research framework and hypotheses formulation, TISM-P analysis based on expert interviews and empirical study for hypotheses testing and validation.

The second chapter, **Literature Review**, provides a comprehensive review of existing literature related to the research topic, including the concept of e-governance, maturity models of e-governance, assessment frameworks of e-governance, Critical Success Factors (CSFs) for e-governance, challenges in implementing e-governance in developing countries, the evolution of e-governance in India, the definition and meaning of the 5Vs of big data, CSFs for big data, the use of big data in e-governance and related challenges and existing frameworks for analyzing the performance of e-governance projects. It enables to identify areas where further research is needed (research gaps) and provided support in developing the conceptual research framework.

The third chapter, **Use of Big Data in E-Governance Projects in India: A Pilot Study of Aadhaar Services from Unique Identification Authority of India (UIDAI)** dives deeper into Aadhaar, a citizen-centric e-governance project. The primary objective of this study is to assess the performance of select e-governance projects and explore the relationship between big data related variables and the performance of these projects. To achieve this objective, univariate statistical analysis has been conducted to examine the individual impact of each big data variable on e-governance performance. Additionally, based on the insights gained from a pilot study, a conceptual research framework is also proposed in this chapter.

The fourth chapter, **Research Design**, provides an overview of the research methodologies employed in conducting the study. The research design incorporates a combination of qualitative and quantitative methods to gather and analyze data. The chapter provides a concise explanation of the qualitative research method used, which is Total Interpretive Structural Modeling with Polarity (TISM-P), and the quantitative research method employed, which is Partial Least Squares-Structural Equation Modeling (PLS-SEM). The chapter also outlines the research hypotheses that will be tested in the study and serve as guiding principles to explore the relationships between variables of interest. Additionally, the chapter details the process of questionnaire development for the survey of implementers and beneficiaries, including pilot testing to ensure its effectiveness. It further describes the selection of specific e-governance projects for the study, the sample selection process, and the mechanisms for data collection. The tools and techniques utilized for data analysis are also briefly discussed. Furthermore, the chapter presents a conceptual research framework for validation, which serves as a basis for analyzing and interpreting the data collected. This framework provides a structure for examining the relationships between big data related variables and the ‘Performance of e-governance projects using big data’. Lastly, a brief description of the projects selected for the study is provided, highlighting their relevance and importance in the research context.

The fifth chapter, **Qualitative Validation of ‘Performance of E-Governance using Big Data’ Framework**, summarizes the analysis of the data. A questionnaire was developed to seek the opinion of the identified domain experts.The TISM-P method is used to study and model the interrelationship among the constituents of the hierarchical model for big data in e-governance. The suitability of the model is established based on data obtained from experts for the agreement of statements given in the questionnaire to measure the level of relationship for every link in the model.

The sixth chapter, **Empirical Validation of ‘Performance of E-Governance using Big Data’ Framework**, summarizes the empirical validation of the conceptual research framework introduced in chapter four. The validation process employs a quantitative research method, specifically Partial Least Squares-Structural Equation Modeling (PLS-SEM), to assess and validate the measurement and structural models proposed in the framework. Furthermore, the chapter discusses the testing and validation of the research hypotheses put forth in chapter four.

The seventh and final chapter is the **Synthesis of Learnings, Conclusions, Recommendations and Scope for Future Research**, serves as a culmination of the study, presenting a synthesis of the learnings, conclusions, recommendations, limitations and scope and suggestions for future research. This chapter highlights the key findings, contributions derived from the research and implications for the practitioners, beneficiaries and researchers.

1.9 Concluding Remarks

This chapter provides an introduction and overview of the study, outlining the research objectives, the significance and scope of the research. By doing so, it establishes clarity and focus for the study. The primary aim of this research is to analyze the performance of PAN India e-governance projects in India that utilize big data. To achieve this, a thorough examination of select e-governance projects will be conducted. The subsequent chapter will delve into a comprehensive review of literature, exploring and analyzing key areas that are relevant to the study. This literature review will cover significant topics and concepts related to e-governance, big data, and their intersection. It will provide a comprehensive understanding of the existing knowledge and research in these areas, setting the foundation for the subsequent chapters of the study. Overall, this chapter establishes the context and purpose of the research, setting the stage for a comprehensive examination of the select e-governance projects and their performance.

Chapter 2
Literature Review

2.1 Introduction

The rapid growth of information and the ever-evolving field of Information and Communication Technology (ICT) have paved the way for their integration in e-governance projects. However, there remains an unmet need to enhance the performance of these projects in order to meet the ever-increasing expectations of citizens. With millions of transactions taking place daily, e-governance projects are generating a vast amount of data, giving rise to the era of big data. Big data has been increasingly utilized in e-governance projects, particularly in developed countries, to improve their performance. However, the big data ecosystem in developing countries, such as India, is still in the process of maturing. More empirical research is required in these countries to understand the use of big data and its impact on enhancing e-governance performance. To gain a better understanding of the research context, an extensive literature review has been conducted. This review encompassed two main areas: big data and e-governance performance. It provided insights into the concept of e-governance, its global and Indian evolution, e-governance maturity models, implementation challenges in developing countries, big data, its definition, benefits, critical success factors (CSFs), challenges, and its application in e-governance. Additionally, relevant frameworks for assessing e-governance performance have been reviewed, considering the focus of this study. By conducting this thorough literature review, gaps in the existing body of knowledge have been identified, which in turn has helped shape the conceptualization of the study's context. This chapter concludes with the identification of these gaps, laying the foundation for further exploration and analysis in subsequent chapters.

2.2 E-Governance – An Overview

The term "governance" originates from the ancient Greek word "Kebernon," which denotes the act of controlling, governing, or steering from a position of authority (Corbett and Strawser, 2020; Joshi, 2020). According to Kofi A Annan, the former secretary-general of the United Nations, good governance plays a crucial role in eradicating poverty and promoting development (Goodwin, 2021; Kirchmair, 2022; Rathi, 2022). Annan defines good governance as encompassing respect for human rights, the rule of law, democracy, transparency, and capacity building in public administration (Chepkirui, 2021). The prefix "E/e" in governance stands for “E/electronic”, giving rise to the concept of e-governance. E-governance involves the provision of government services and information to citizens electronically, typically over the Internet. The term "e-government" was first coined in the United States in 1993 (Tat-Kei Ho, 2002; Heeks and Bailur, 2007; Kurfal et al., 2017). Different researchers have provided various definitions of e-governance. According to the World Bank (www.worldbank.org), e-governance involves the use of information technology (IT) by government agencies to transform their interactions with citizens, businesses, and other government entities. Mittal and Kaur (2013) define e-governance as the utilization of ICT to provide citizens and organizations with convenient access to government services and information. It aims to enhance government efficiency, effectiveness, transparency, accountability, service quality, democratic participation, and citizen-government relationships (Chen et al., 2006; Yildiz, 2007; Bertot and Jaeger, 2008; Suri and Sushil, 2011; Tripathi et al., 2012). By leveraging ICT, e-governance enables substantial reductions in time, efforts, and resources, leading to improved operational efficiency for governments (Schwester, 2009; Reddick and Turner, 2012). Overall, e-governance holds immense potential for driving positive change and improving the functioning of governments worldwide. The main characteristics of e-governance projects are summarized as follows:

- **Easy to use:** E-governance should provide a user-friendly and simple to use interface (Mittal and Kaur, 2013), with support for vernacular languages. This will encourage the citizens to use online services. There should be online as well as offline support to handle queries. For example, in India, The 'Dial.Gov' search engine serves as a centralized platform to facilitate the search and retrieval of relevant information related to government welfare programs.
- **Efficient and Effective:** E-governance should provide consistent and integrated access to data and information from anywhere in efficient (Schwester, 2009; Reddick and Turner, 2012) and effective manner (Chen et al., 2006; Yildiz, 2007; Bertot and Jaeger, 2008; Tripathi et al., 2012).
- **Participative:** The government should try to organize seminars or workshops, at regular intervals, to create awareness among the citizens. They may create training centers to train the citizens on how to use e-governance websites or portals. This will

help to bridge the gap between government and citizens, businessmen, and public-private sector to encourage their active participation.

- **Transparent:** E-governance should ensure transparency by providing real-time data to the citizens and with easy access to communicate with the government (Chen et al., 2006; Yildiz, 2007; Bertot and Jaeger, 2008; Suri and Sushil, 2011).
- **Responsive:** Public departments need to be responsive through e-governance systems (ARC, 2008).
- **Accountable:** E-governance should make the public departments more accountable towards their duties to the public at large (ARC, 2008; Bertot and Jaeger, 2008; Tripathi et al., 2012).
- **Empower the citizens:** E-governance should enlighten the citizens about their rights and duties (Verma and Suri, 2019). The citizens should be able to communicate to the government without any mediator. E-governance will then facilitate to preserve the essence of democracy in India.

The terms ‘e-governance’ and ‘e-government’ are used differently in various countries, reflecting their specific contexts and approaches (Verdegem and Verleye, 2009). While there may be variations in their definitions, e-governance generally encompasses a broader scope, involving the use and application of ICT in the entire spectrum of government relationships and networks. On the other hand, e-government is typically focused on the development of online services within the institutional framework of political operations (Sheridan and Riley, 2006). According to Sheridan and Riley (2006), e-government refers to the digitization of public functions and institutions, while e-governance encompasses all the relationships and factors, both governmental and non-governmental, that contribute to the services and policy-making functions of public institutions (Manoharan et al., 2021; Coe et al., 2001; Saxena, 2005). E-governance emphasizes the procedural aspects of cooperative administrative relations within the domain of public administration. The concept of e-governance in the Indian context, involves the application of ICT to government functioning, aiming to achieve "Simple, Moral, Accountable, Responsive, and Transparent (SMART)" governance (ARC, 2008). The goals of e-governance include delivering better services to citizens, ensuring transparency and accountability, empowering citizens through access to information, enhancing efficiency within governments, and improving interactions with the business and industry sectors. Throughout this research, the term e-governance has been predominantly used, considering the specific Indian context and the comprehensive scope it encompasses in relation to the application of ICT in government operations (Planning Commission, 2007).

E-governance has the potential to transform the relationship between the public, private sector, and government, leading to improved policy outcomes, high-quality services, and increased citizen engagement (Verma and Suri, 2019). In many cases, government departments operate independently, resulting in fragmented services for citizens. However, if these departments are virtually integrated through service providers, it can create an effective model for delivering citizen-centric e-governance solutions (Al-Khouri et al., 2011; Kietzmann et al., 2011). The implementation of e-governance is an ongoing process, often carried out in stages. Rather than a one-time development, it is a continuous effort to enhance government operations and service delivery through the application of ICT (Information and Communication Technology) and digital solutions. This staged approach allows for incremental improvements and adaptability to changing technological advancements and citizen needs.

2.3 Approaches of E-Governance: G2G, G2B, G2C and G2CS

E-governance encompasses various approaches, including e-administration, e-citizens, e-services, and e-society (Heeks, 1999; Jones et al., 2007). The e-administration approach focuses on improving the efficiency and coordination of government organizations by reducing redundancy and costs. It involves linking different government departments to streamline their operations and eliminate duplication of work. The e-citizens approach aims to foster citizen participation in public discussions, decision-making, and policy formulation, thereby bridging the gap between citizens and governments. It emphasizes engaging citizens in shaping public services and policies to better meet their needs. The e-services approach focuses on providing uninterrupted online services to citizens in an improved and innovative manner. It seeks to enhance convenience, accessibility, and efficiency in delivering government services through digital platforms. The e-society approach involves forging partnerships with non-profit organizations, building communities, and fostering collaborations within society. It emphasizes creating a cohesive and inclusive environment where government, civil society, and other stakeholders work together for collective development. These different approaches give rise to various types of interactions and e-governance projects, commonly known as government-to-government (G2G), government-to-business (G2B), government-to-citizen (G2C), and government-to-civil society (G2CS) interactions (Heeks, 2006), as depicted in Figure 2.1.

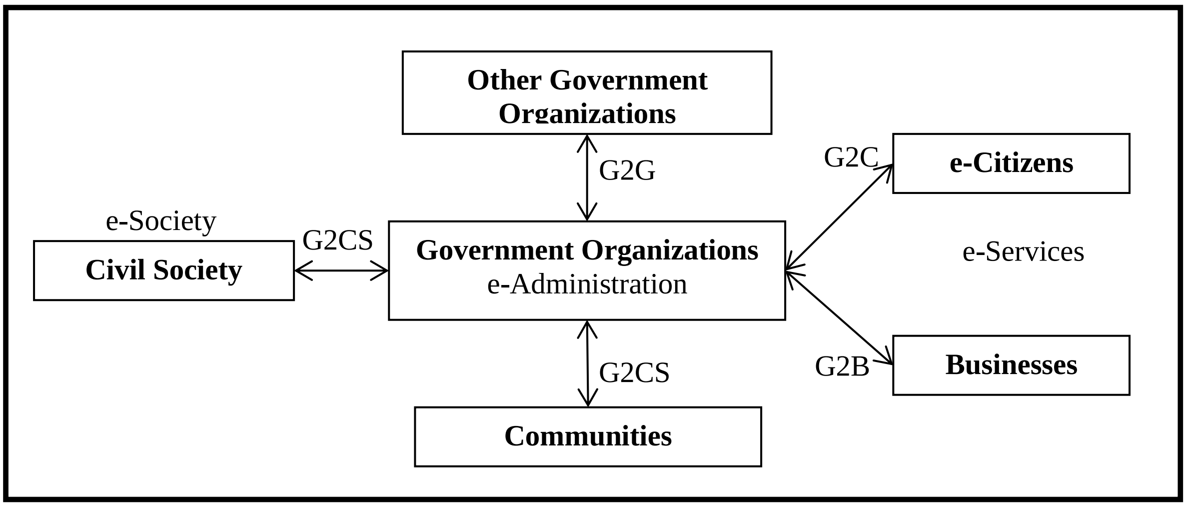

Figure 2.1: The Components of E-Government
[Source: Heeks (2006)]

G2G e-governance projects involve the electronic exchange of data and information between different government organizations or departments at the national, state, or local levels (United Nations, 2003). This exchange of information, both within and between government organizations, leads to improved coordination, reduced duplication of tasks, enhanced efficiency, and streamlined processes (Suri and Sushil, 2006). These interactions enable government organizations to deliver timely services to citizens (Reji and Vidyapeetham, 2021; Aziz and Sallow, 2022). In India, an example of G2G e-governance implementation is seen in the Ministry of External Affairs (MEA), which utilizes the Unique Identification Authority of India (UIDAI) database for their passport department through the portal www.passportindia.gov.in. This integration enables reliable and efficient verification of passport applicants. Similarly, the Ministry of Finance utilizes the UIDAI database for Income Tax Return (ITR) verification. By integrating data with UIDAI, these ministries have been able to provide efficient and effective services, which can potentially be centralized through a single point of contact for citizens.

G2B e-governance projects facilitate the smooth execution of business-related transactions by government organizations. These projects enable organizations to electronically obtain data and carry out specific business tasks such as invoice payment and procurement of goods and services in an efficient manner (United Nations, 2014; Aziz and Sallow, 2022). In India, the Department of Industrial Policy and Promotion (DIPP) has launched an integrated service project called eBay (www.services.ebiz.gov.in) as part of the Mission Mode Projects (MMPs) initiative, in collaboration with Infosys Technologies Limited (Infosys). This project aims to provide transparent, efficient, and convenient access to business-related information for stakeholders. By offering a user-friendly interface, the eBay project is expected to save time and effort by facilitating smooth interactions between the government and businesses.

G2C e-governance projects play a crucial role in bridging the gap between citizens and the government by providing electronic services. These projects aim to centralize online information and services, offering citizens a convenient and accessible platform to engage with the government (Aziz and Sallow, 2022). The objective is to encourage citizen participation in policy formulation, government processes, project implementations, and decision-making. G2C projects enable two-way communication between government organizations and citizens. Their purpose extends beyond service delivery to include gathering citizen feedback and promoting their active involvement in government processes, ultimately enhancing service delivery. An example of a G2C project in India is the citizen-centric website of the Municipal Corporation of Delhi (MCD), which enables citizens to access municipal services online.

There are certain e-governance projects that use all approaches like G2G, G2B and G2C. The Ministry of Road Transport and Highways (MoRTH) has implemented an e-governance project known as eTransport (https://www.nic.in/projects/etransport/), as part of the Transport Mission Mode Project (MMP). This project, executed by the National Informatics Centre (NIC), has effectively automated the operations of Regional Transport Offices (RTOs) throughout the country. A significant achievement of the project is the establishment of a consolidated nationwide transport database, which allows for real-time updates and availability of information. This milestone has greatly improved the efficiency and effectiveness of transport-related services provided by the government. The eTransport MMP project is an extensive array of G2G, G2B and G2C services, benefiting citizens, transporters, vehicle dealers, manufacturers, police and security agencies, banks, insurance companies, along with various state and Central government departments. It has reached a high maturity level, and centralised, web enabled versions: Vahan 4.0 and Sarathi 4.0 have already been implemented in almost all states, all RTOs of the country, except a few states like Andhra Pradesh, Telangana and Madhya Pradesh as they use a separate software.

G2CS e-governance projects focus on catering to specific sections of society, such as differently abled individuals, senior citizens, and rural communities. One such initiative is the 'Digital Village' project initiated by the Indian government. This project aims to provide essential services, including LED street lighting, Wi-Fi hotspots, healthcare, skill development, and tele-education, through a platform at the Gram Panchayat level in various states of the country (www.meity.gov.in).

Another example of G2CS e-governance is the 'Dial.Gov' search engine offered by the Indian government, specifically designed for the targeted beneficiaries of different welfare schemes. This service serves as a common platform to disseminate information about various schemes, ensuring that there are no information gaps related to these initiatives.

2.4 Evolution of E-Governance: Definitions and Literature

Malodia et al. (2021) provide a comprehensive analysis of various dimensions of e-government, as discussed in previous studies from diverse fields such as public administration, computer science, technology adoption, and marketing. They identified two issues from the existing literature. First there is no common definition (Abu-Shanab & Harb, 2019) as each domain dealt with it differently. The summary of these definitions are given in Table 2.1 below. According to Malodia et al. (2021), e-government can be defined as socially inclusive, hyper-integrated ICT platforms that are designed with evolutionary systems architecture. These platforms aim to ensure the efficient delivery of government services while promoting transparency, reliability, and accountability. However, the authors also highlight a significant challenge in the e-government literature, which is the lack of knowledge integration across multiple domains. This knowledge gap has impeded the development of a comprehensive theory or framework for e-government (Khanra & Joseph, 2019).

Table 2.1: Evolution of E-Government Definitions

Reference	Purpose and focus	Methodology	Definition of e-Government
Ho, 2002	Identify government restructuring challenges to deliver citizen services through IT Conceptualization: No Theoretical framework: No	Content analysis of official city websites	Government serving citizens electronically
Layne &Lee, 2001	Outline different stages of e-government development by proposing a four-stage model of e-government development Conceptualization: No Theoretical framework: No	Qualitative observational study with anecdotal references	Structurally transforming the government to enable electronic governance
Moon, 2002	Assess the effectiveness and identify barriers to e-government Conceptualization: No Theoretical framework: No	Survey-based research	IT use for government services
Node & Shkoder, 2004	Identify issues, opportunities and challenges developing countries face while implementing e-government Conceptualization: No Theoretical framework: No	Case study based observational study	Re-inventing the public sector using ICT
West, 2004	Measure effectiveness in service delivery, democratic responsiveness and public outreach Conceptualization: No Theoretical framework: No	Web-based survey and content analysis	Using the Internet for the delivery of government services
Scholta et al., 2019	Extend the stage model to include proactive government as the next stage Conceptualization: No Theoretical framework: No	Case study	Real-time delivery of customized services to citizens
Malodia et al., 2021	Conceptualise e-government as a multidimensional construct Conceptualization: Yes Theoretical framework: Yes	Grounded theory followed by triangulation using case studies	Socially inclusive, hyper-integrated ICT platforms for efficient government services with transparency, reliability and accountability

[Source: Malodia et al. (2021)]

According to Malodia et al. (2021), the evolution of the e-government literature has been categorized into five stages, as depicted in Figure 2.2. Initially, e-government primarily served as a platform for information dissemination and exchange. In the first two stages, research predominantly concentrated on technological aspects of e-government, such as information exchange and transaction automation (Aldrich et al., 2002; Schelin, 2003; Yildiz, 2007; Pérez-Morote et al., 2020). During the first stage, the primary focus of e-government was the adoption of modern ICT by governments to facilitate information exchange (Pérez-Morote et al., 2020).

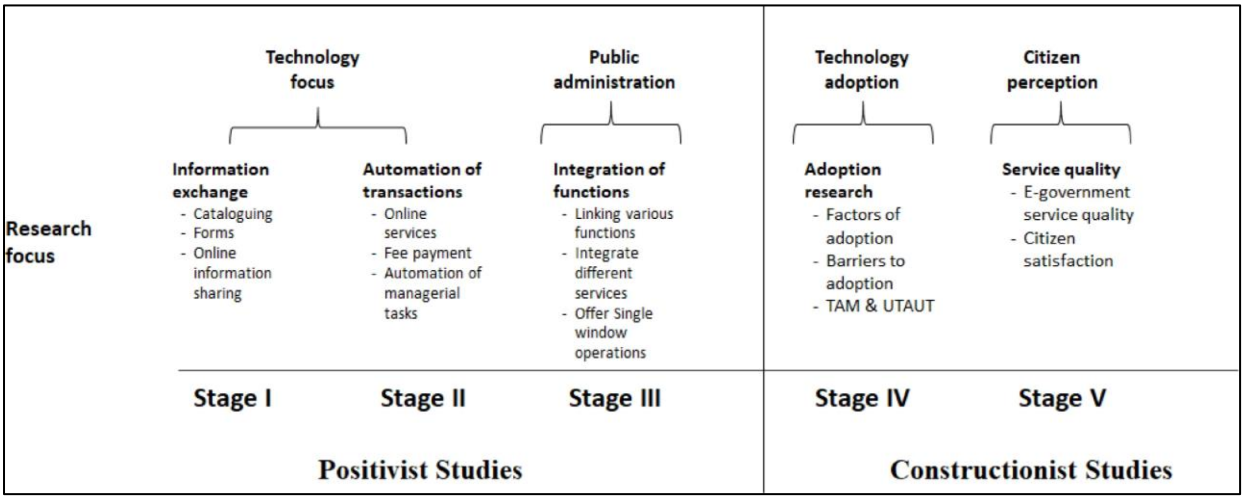

Figure 2.2. Evolution of E-Government Literature

[Source: Malodia et al. (2021)]

In the second stage, e-government evolved as a means to deliver a wide range of services to citizens. During this stage, the focus shifted towards utilizing e-government as a technological solution to automate non-managerial administrative tasks, including financial transactions, back-office operations, and clerical checks (Dawes, 2008; Schelin, 2003; Wirtz & Daiser, 2018). As computer usage and ICT became more widespread, the focus of e-government gradually shifted towards integrating IT with other core functions (King, 2004; Yildiz, 2007). This transition marked the third stage of e-government research, where technology served as a means of public administrative reforms and a tool for enhancing convenience in service delivery and information sharing (Doty & Erdelez, 2002; Halchin, 2004; Seifert and Relyea, 2004). In the fourth and fifth stages, e-government research delved into technology adoption and citizen perceptions, exploring issues related to user adoption (Gupta and Jana, 2003; Layne and Lee, 2001; Moon, 2002; West, 2004; Ebrahim and Irani, 2005; Sharif et al., 2010; Weerakkody et al., 2013) and service quality (Papadomichelaki and Mentzas, 2011; Weerakkody et al., 2019).

2.5 Maturity Models of E-Governance

The maturity model offers a framework for assessing the methods and processes employed by organizations, comparing them to established external benchmarks (MeitY, 2017). A maturity level assessment may provide the multiple benefits: (i) maturity level comparatives among multiple government ministry or departments; (ii) precise recommendations for improvement; (iii) independently held set of benchmarks for standardization. As per MeitY (2017) maturity models are used to assess as-is situations (to diagnose and eliminate deficient capabilities), to guide improvement initiatives (to map the way for improvement), and to control progress. A maturity model for e-governance consists of a series of stages that assess the level of maturity of an e-government portal, ranging from basic to advanced (Fath et al., 2014). These models play a significant role in ranking e-government portals and serve as a guide to improving their quality. Concha et al. (2012) categorized e-government maturity models into three types as follows:

- **Governmental:** Models created by governments, consultants, and academics to assist agencies in assessing and enhancing their level of e-government maturity.
- **Holistic approach:** Models that are specifically developed to be applied in public services development projects. These models serve as a valuable tool for agencies to determine the likelihood of success for an e-government project.
- **Evolutionary e-government:** Maturity models are designed to capture the evolution of e-government initiatives, progressing from initial stages of immaturity to more advanced and mature stages with improved quality. Among the renowned academic maturity models, the Layne and Lee (2001) model and the Andersen and Henriksen (2006) model stand out.

2.5.1 Layne and Lee Maturity Model

Layne and Lee (2001) proposed a four-stage maturity model for e-government, viewing it as an evolutionary process characterized by the stages of Cataloguing, Transaction, Vertical integration, and Horizontal integration, as depicted in Figure 2.3.

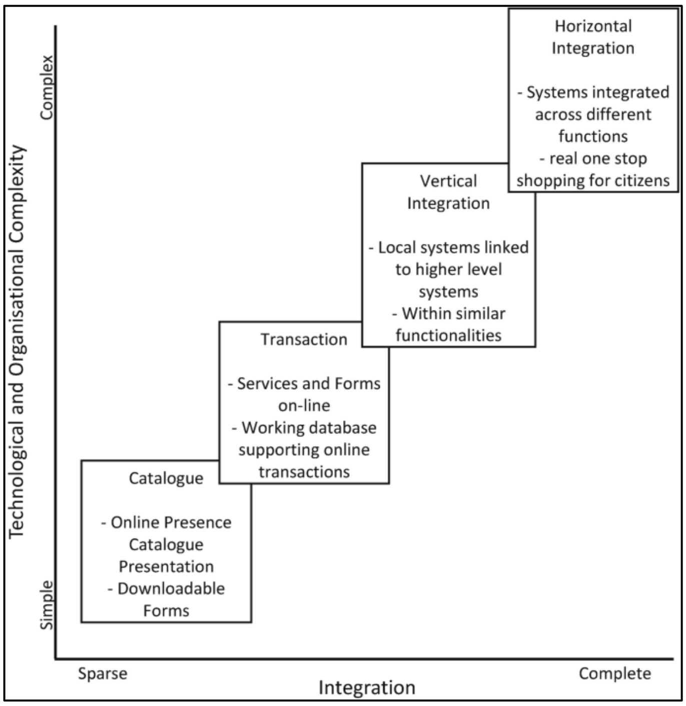

Figure 2.3: Layne and Lee Maturity Model
[Source: Layne and Lee (2001)]

This model was formulated based on an analysis of e-government initiatives in the United States, taking into account various service types and their quality (Sangki, 2017). The first stage, Cataloguing, involves the basic provision of information and services through government websites, essentially serving as online catalogs. The second stage, Transaction, focuses on enabling online transactions and interactions, allowing citizens to access and complete specific government processes electronically. The third stage, Vertical integration, entails the integration of services within specific government departments or agencies. This stage aims to streamline processes by connecting different units and facilitating the sharing of information and resources vertically across the organization. The final stage, Horizontal integration, signifies the highest level of e-government maturity. In this stage, there is a comprehensive integration of services and information horizontally across various government departments, enabling seamless collaboration and service delivery to citizens. Layne and Lee's maturity model provides a valuable framework for assessing and understanding the evolutionary progression of e-government initiatives. By categorizing e-government projects into distinct stages, the model aids in identifying the current level of development and guiding efforts to enhance the quality and effectiveness of e-government services.

2.5.2 Andersen and Henriksen Maturity Model

Andersen and Henriksen (2006) introduced the Public Sector Process Rebuilding (PPR) model as a complement to the maturity model, as depicted in Figure 2.3.

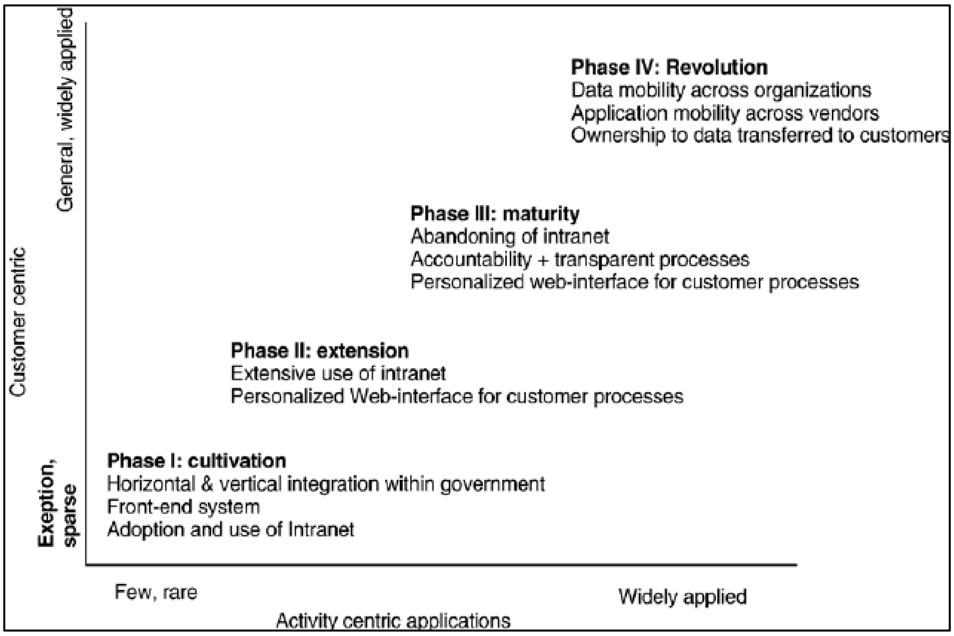

Figure 2.4: Andersen and Henriksen Maturity Model

[Source: Andersen and Henriksen (2006)]

They argued that the Layne and Lee model primarily focused on the conventional motives for IT adoption, such as improving information quality, efficiency, and effectiveness. However, they believed that e-government should also encompass strategic ambitions that go beyond these traditional rationales. The PPR model proposed by Andersen and Henriksen emphasizes the transformation of public sector processes through the use of IT. It recognizes that e-government initiatives should not solely aim to automate existing processes but should actively seek to restructure and redesign these processes for improved outcomes. By incorporating strategic ambitions into the model, Andersen and Henriksen highlight the importance of aligning e-government efforts with broader government objectives and goals. This approach encourages a more comprehensive and holistic view of e-government, considering its potential for driving innovation, citizen engagement, and societal transformation. The PPR model offers a valuable perspective for governments seeking to leverage IT in a more strategic and transformative manner. It expands the scope of e-government beyond mere efficiency gains, promoting the reimagining and rebuilding of public sector processes to achieve broader societal and organizational goals.

There are several maturity models in the literature that depict different stages of e-governance. These are generally evolutionary maturity models. While certain models may have similar stages, there are variations in the characteristics associated with each stage across different models. These staged models offer a high-level perspective of the progress of e-governance. It is important to note that organizations are not necessarily required to follow the stages sequentially in their journey towards achieving a mature level of e-governance. Depending on their e-preparedness level, an organization can transition across stages, bypassing certain steps if deemed appropriate.

Best practice e-governance models are characterized by their ability to enhance the efficiency of information dissemination, service delivery, and support public decision-making. These models represent standardized techniques, methods, or processes that have demonstrated their effectiveness in accomplishing tasks consistently over time. By adopting and implementing these best practices, governments can optimize their e-governance initiatives and improve overall performance. These models serve as benchmarks and provide valuable guidance to governments seeking to enhance their e-governance systems. The UN defines a best practice as successful initiatives towards improving people's standard of life. As per Sami et al. (2012) there are various e-government best practices models: (i) Variety and best practice (VBP) model by Owen et al. (2005). This states that process or operation should provide meaningful outcome to customers and citizens and can be graphically shown with use cases. They can be part of other operations. It highlights the use of Unified Modeling Language (UML) diagrams; (ii) Model by Ali et al. (2011) has phases like enable (the basic foundation for the service is laid), enhance (develop standards, infrastructure for the service), establish (increasing the demand of the service and also to extend support to other systems) and expansion (service is expanded to reach maximum coverage); (iii) Model by Abdelbaset and Eddy (2009), which includes the strategic framework for e-governance that is divided into modules like vision, strategic objectives, users, delivery modes, guiding principles, channels, priority area, major initiatives, infrastructure, organisation and guidelines. E-governance projects encompass a diverse array of organizational, legal, political, social, and technological elements, as highlighted in literature (Backus, 2001; Gil-Garcia and

Pardo, 2005; Ghapanchi et al., 2008). When it comes to planning and strategy formulation, a reflective, engaging, and emergent approach is favored over traditional analytical, directive, and strictly planned methods (Mintzberg, 1994; Suri and Sushil, 2012).

2.6 Sustainable E-Governance in Developing Countries: Challenges and Maturity Models

The gains offered by ICTs are too significant for any country to overlook, regardless of its development status or size. This is particularly crucial for developing countries, as they have the opportunity to leapfrog traditional development paths and harness the benefits of modern technologies (Subhajit, 2004). However, it is important to acknowledge that not only e-governance applications, but also information systems in general, face challenges in developing countries. According to Heeks (2003), a considerable number of e-governance implementations in developing countries encounter difficulties. Among these implementations, 35% are classified as total failures, where e-governance initiatives were either not implemented at all or were abandoned immediately after implementation. Additionally, 50% of the implementations are considered partial failures, as they fail to achieve major goals or result in undesirable outcomes. The aforementioned findings are indeed troubling, particularly considering the limited resources available to developing countries, making it impractical for them to allocate significant funds to projects that may result in wasteful spending (Dada, 2006). When implementing e-governance initiatives, developing countries encounter numerous challenges as they progress through the journey of maturity models. One of the primary reasons for these challenges is the relatively slower economic growth and lower standards of living in developing countries, which give rise to issues such as lack of transparency, inefficiency, corruption, and bureaucracy (Chen et al., 2007). These systemic problems can significantly hinder the successful implementation of e-governance initiatives. Developing countries often face challenges in attaining the same level of maturity in their democratic systems as compared to developed nations. As a result, achieving higher levels of e-governance maturity in these countries becomes relatively more challenging. In contrast, developed countries benefit from consistent economic growth, transparent processes, high production rates, and better living standards. Developing countries face following challenges for effective e-governance implementation:

- **Planning and Management:** Developing countries often encounter significant challenges in the planning and management (Sarrayrih and Sriram, 2015) of e-governance initiatives. One of the primary difficulties arises from the rapid advancements in technology, which adds complexity to the automation of outdated and intricate government legacy systems. Consequently, governments find it challenging to adapt to this uncertainty and develop systems that can effectively meet the rising expectations of stakeholders.
- **ICT Infrastructure:** One of the significant obstacles in the implementation of e-governance in developing countries is the inadequate ICT infrastructure. Insufficient IT infrastructure directly affects the development and successful implementation of e-governance initiatives (Tapscott, 1996; Chen et al., 2007). A robust and reliable ICT infrastructure is a prerequisite for the effective functioning of e-governance systems (Basu, 2004; Avgerou and Walsham, 2017). The key components of e-governance infrastructure include network and security infrastructure, tools for data management and application development, application servers, and systems management (Basu, 2004). However, developing countries often face challenges such as inconsistent power supply and limited or no access to the internet due to poor telecommunication infrastructure. These limitations create significant hurdles in establishing a conducive ecosystem for e-governance.
- **Creating Awareness among Citizens:** In addition to establishing the necessary ICT infrastructure, it is crucial to educate and motivate citizens about the benefits of e-governance applications. In developing nations, there is often a lower willingness among citizens to adopt e-governance applications (Chen et al., 2007). This discrepancy is particularly pronounced between educated and illiterate individuals in these countries (Basu, 2004). The lack of access to the internet and computers among the poor and uneducated creates a digital divide, exacerbating the challenges of e-governance implementation. Moreover, in comparison to developed countries, a significant proportion of the population in developing countries resides in rural areas and faces poverty (Gupta et al., 2008). This poses challenges for the government in providing online services to these areas. Additionally, the lack of citizen participation in government initiatives in developing countries often leads to issues such as ineffective policies, unmet expectations, and underutilization of resources.
- **Silo Structure of Government Departments:** One significant challenge faced by developing countries is the provision of a comprehensive, one-stop solution for

citizens. The fragmented structure of different government departments poses formidable obstacles when implementing cross-departmental initiatives. This siloed approach can hinder the free flow of communication and result in customer dissatisfaction. To ensure benefits for both citizens and organizations, it is essential to establish strategic alliances among these entities. Such alliances can help reduce costs and improve efficiency by avoiding duplicative tasks (Suri and Sushil, 2006, 2017). For the successful implementation of a one-stop e-governance solution, it is crucial to foster trust and cooperation among departments (UN, 2012). This involves breaking down organizational barriers and fostering a collaborative culture that encourages information sharing and joint decision-making.

- **Implementation Approach:** To ensure the successful implementation of e-governance initiatives, developing countries should adopt a standardized methodology that encompasses several key steps. These steps include social and educational development, developmental policies and strategies addressing ground realities and specific needs of the country, ICT infrastructure development, ICT literacy and public awareness and creating job opportunities. By following this methodology, developing countries can enhance their readiness for e-governance implementation and increase the likelihood of achieving the desired outcomes. It provides a structured approach that takes into account the social, educational, infrastructural, and economic aspects necessary for successful e-governance initiatives.

The successful implementation of e-governance in developing nations is often hindered by various challenges like insufficient supply of human resources, lack of familiarity with e-governance among citizens, lack of coordination among government departments at state and national level, poor planning and management in government departments, etc. Even after the successful implementation of e-governance projects, developing countries continue to face numerous challenges in delivering sustainable e-governance services (Joshi and Islam, 2018). The major issues for effective e-governance implementation are: (i) lack of technology; (ii) limited budgets; (iii) lack of skilled HR. In addition to the known challenges and issues, developing countries often face challenges related to the adoption and implementation of appropriate maturity models for deploying sustainable e-governance services (Joshi and Islam, 2018). The determinants crucial for sustainable e-governance services include a detailed process, streamlined services, agile accessibility, utilization of state-of-the-art technology, and fostering trust and awareness among stakeholders. These determinants and their effective implementation can be assessed through the application of a maturity model, as mentioned earlier (MeitY, 2017). Over time, various researchers have proposed different variants of e-governance maturity models, considering the advancements in technology. However, Joshi and Islam (2018) conducted research to understand why the existing e-governance maturity models did not align well with the assimilation processes of e-governance projects in developing countries. They argued that these maturity models presented e-governance development as a linear and progressive process, with the government achieving maturity at different stages. Despite their usefulness, e-governance maturity models faced criticism from researchers such as Coursey and Norris (2008), Debri and Bannister (2015), and Zahran et al. (2015). While these existing e-governance models have contributed significantly to e-governance implementation, several common limitations have been identified by various researchers, as noted by Joshi and Islam (2018) as follows:

- **Limitation1 - E-government assimilation occurred in a linear pattern:** While most e-governance maturity models follow a linear progression, where projects advance from simple to complex technologies (Abdelghany et al., 2016), some models, such as Layne & Lee, Gartner, UN, Reddick, and West, require an additional stage to be completed before moving on to the next stage. However, this linear progression may only be partially true, as modern technology enables governments to initiate multiple stages simultaneously. For example, governments can introduce e-governance while simultaneously integrating it into government departments (Rana et al., 2015). However, this simultaneous progression may be hindered if governments lack the necessary resources to support such initiatives.
- **Limitation2 - Transaction occurred before integration:** In all existing e-governance maturity models, the transaction stage was typically depicted as occurring before the integration stage. This sequencing was based on the understanding that transactions could not take place effectively without the integration of related services at the required levels. Integration was necessary to facilitate the authentication and verification processes involving multiple departments. Without integration, the delivery of services would not be as effective and efficient.
- **Limitation3 - Lack of state-of-the-art technology:** The existing e-governance maturity models did not incorporate advanced and modern technology in their developmental stages, primarily due to the rapid pace of technological advancements

in the last decade (Supriyanto and Mustofa, 2016). As a result, these models may not fully address current challenges and opportunities presented by the latest technologies. To ensure their relevance and effectiveness, it is crucial to develop and update maturity models at regular intervals, taking into account the evolving technological landscape and incorporating the latest technologies available. This will enable a more accurate assessment of e-governance maturity and help address contemporary issues in a timely manner.

- **Limitation4 - Lack of a detailed process:** Some existing e-governance maturity models were developed for ranking only without providing strategic solution (Shareef et al., 2011) for processes and activities. These were without any technical plan as well.
- **Limitation5 - Lack of adoption perspectives:** The maturity models using sophisticated technology were rated higher (Napitupulu and Sensuse, 2014). As per Debri and Bannister (2015) e-governance success should not be measured by sophistication of technology but on whether those services are being used by the stakeholders.

The limitations mentioned above can be effectively addressed in the design of sustainable e-governance services, as they are key factors that influence the overall success of e-governance projects. E-governance maturity models play a crucial role in this process by assessing the project implementation context and providing strategic plans for execution (Joshi and Islam, 2018). Sustainable e-governance services should be designed to achieve their goals, ensure operational simplicity, provide high-quality services, encourage widespread acceptance and adoption, minimize costs, and enhance efficiency. Such services should also embrace state-of-the-art technology to deliver cost-saving, resilient, and effective solutions, while promoting active participation and satisfaction from all user levels. When designing sustainable e-governance services in developing countries, two dimensions need to be considered. First, the implementation dimension addresses aspects such as technology, human resources, and budget allocation. Second, the adoption dimension focuses on encouraging wider user participation and adoption. Figure 2.5 illustrates the sustainability determinants derived from the aforementioned limitations.

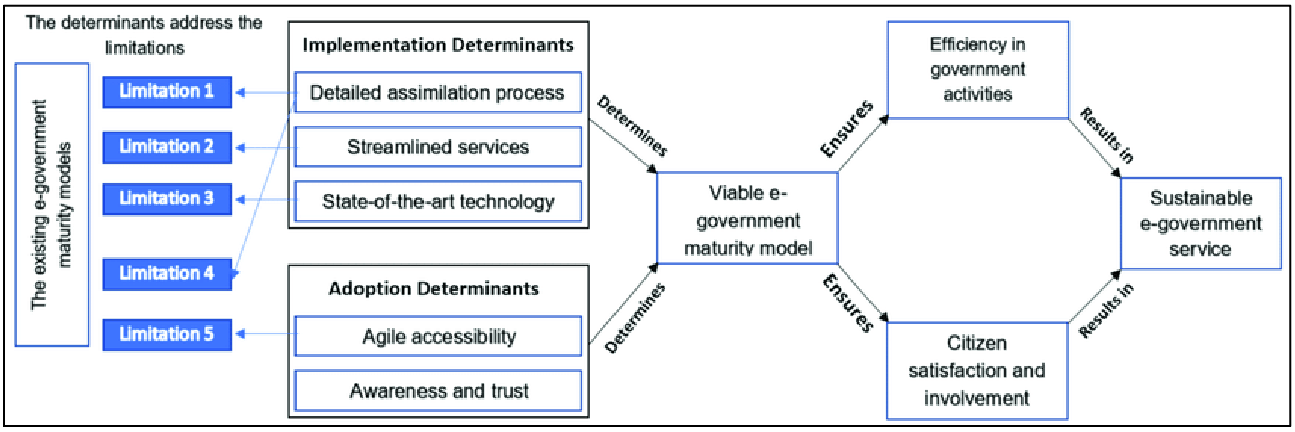

Figure 2.5: Determinants of Sustainable E-Governance Maturity Model
[Source: Joshi and Islam (2018)]

By incorporating these considerations into the design of e-governance services, developing countries can enhance the sustainability and effectiveness of their e-governance initiatives, leading to improved governance outcomes and increased stakeholder satisfaction. The implementation determinants of e-governance maturity involve the establishment of clearly defined stages and the corresponding activities needed to achieve those stages. The focus is on enabling governments in developing countries to deliver streamlined e-governance services through the use of state-of-the-art technology. On the other hand, the adoption determinants emphasize the active participation of citizens in e-governance initiatives. This includes ensuring accessibility to the services in an agile manner and fostering trust and awareness among users.

The aim is to make the services easily accessible and user-friendly, thereby encouraging wider adoption and active engagement from citizens. By addressing these implementation and adoption determinants, developing countries can enhance the effectiveness and sustainability of their e-governance initiatives. This, in turn, can lead to improved service delivery, increased citizen participation, and greater trust in the e-governance system. The determinants in Figure 2.5 are used for the sustainable e-governance maturity model (Figure 2.6).

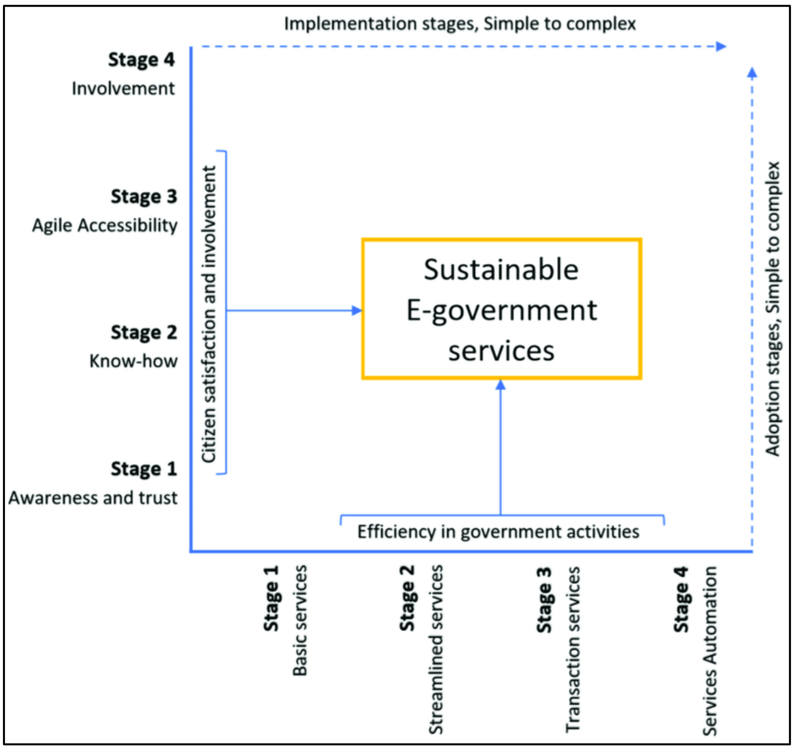

Figure 2.6: Sustainable E-Governance Maturity Model
[Source: Joshi and Islam (2018)]

The first implementation determinant, which is a detailed assimilation process, was addressed by providing comprehensive activities for each stage and defining how these activities contribute to achieving maturity at each stage. The subsequent determinants, streamlined services and the use of state-of-the-art technology, were addressed by prioritizing the integration stage before the transaction stage. The integration stage outlined how state-of-the-art technology can be leveraged to integrate disparate e-governance systems, resulting in streamlined services. The adoption determinants, including agile accessibility, trust, and awareness, were incorporated into the adoption stages. These stages outlined various channels of service delivery to ensure agile accessibility. Furthermore, the activities under the adoption stages provided a plan to foster trust and awareness, aiming for wider participation from users. A key differentiating factor from existing models is the inclusion of adoption stages, which aim to engage stakeholders and provide a roadmap for governments to achieve broader acceptance from stakeholders. This approach acknowledges the importance of stakeholder participation and aims to foster wider acceptance of e-governance initiatives.

2.7 Evolution of E-Governance in India

Governments worldwide have recognized the advantages of e-governance and have become increasingly aware of its benefits. While developed countries have successfully enhanced their e-services through the effective and efficient use of ICT, developing nations continue to face challenges in achieving comprehensive digitalization across all government departments. In the context of India, e-governance pertains to the utilization of electronic technologies to deliver government services, facilitate information exchange, and engage with citizens. Over the years, India has made remarkable strides in adopting e-governance, driven by the objective of offering improved, streamlined, and easily accessible services to its populace. The Indian government consistently strives to enhance the operational efficiency of its various departments (Suri and Sushil, 2017). The Indian government has undertaken several noteworthy initiatives in the development of e-governance in the country as follows:

- **Establishment of National Informatics Centre (NIC):** One of the pivotal steps taken by the Indian government to advance e-governance in India was the establishment of the National Informatics Centre (NIC) in 1976. This significant initiative aimed to integrate information technology into various internal government processes. Initially, during the 1980s, computer usage was primarily limited to internal functions, particularly in areas that required handling extensive data, such as tax administration, census, elections, and large-scale surveys. Subsequently, computers were also employed for strategic national purposes like defense, research, planning, and more.
- **NICNET Programme by Planning Commission of India (now NITI Aayog):** The NICNET program, initiated by the former Planning Commission of India (now NITI Aayog), was launched in 1987. This program aimed to establish a satellite and computer-based communication system for networking districts, states, and central governments. Its primary objective was to facilitate the digital exchange of government information. The program focused on automating internal government functions rather than primarily concentrating on enhancing citizen service delivery mechanisms (ARC, 2008).
- **Enhanced use of IT after World Wide Web (WWW):** Following the emergence of the World Wide Web (WWW) in the early 1990s, there was a significant increase in the utilization of IT within government departments. This development presented new avenues for the implementation of e-governance initiatives. Subsequently, numerous

government departments began taking steps towards e-governance. However, these initiatives were often implemented in isolation, lacking a cohesive and integrated approach.

- **IT National Task Force (NTF):** In 1998, the Indian government established the IT National Task Force (NTF) with the aim of promoting the adoption of IT across various government departments. As per the recommendations put forth by the NTF, government departments were directed to allocate 2-3% of their total budget towards the advancement of IT initiatives.
- **High Powered Committee:** In 2000, a High-Powered Committee was formed, which mandated all central government departments to appoint an IT manager within their respective departments. The primary objective of this directive was to facilitate the promotion and advancement of IT within the government.
- **12 points Minimum Agenda of E-Governance:** In the year 2000, the Department of Administrative Reforms and Public Grievances (DARPG) issued the 'Minimum Agenda of E-Governance,' which was to be implemented by all central government departments. This agenda consisted of twelve key points, including the establishment of essential ICT infrastructure, imparting IT training to staff members, and initiating the utilization of ICT for enhanced interactions. It was mandatory for all departments to formulate a five-year 'IT Vision' accompanied by annual 'Action Plans' in support of this agenda.
- **E-governance initiatives in Silos:** In their eagerness to adopt ICT, government departments often overlooked critical factors such as process re-engineering, standardization, and interoperability. As a result, while they pursued e-governance, they often operated independently, without proper coordination. Each department initiated its own e-governance projects as part of their individual plans, neglecting the need for a cohesive approach. However, despite these challenges, some of these initiatives showcased notable benefits by improving accessibility, reducing corruption, and providing support to marginalized sections of society (Harris, 2007).
- **IT Act 2000:** The Indian government enacted the IT Act 2000 as a means to facilitate the promotion of e-governance in the country. This legislation granted legal recognition to digital transactions, thereby establishing a framework for conducting electronic transactions with validity and enforceability (www.legalserviceindia.com).
- **RTI Act 2005:** The government undertook significant initiatives, one of which was the formulation of the Right to Information (RTI) Act in 2005. The introduction of the RTI

Act empowered citizens to access government information pertaining to their interests. This step aimed to foster transparency, promote openness, and ensure accountability within public organizations. By enabling citizens to obtain relevant information, the RTI Act played a crucial role in strengthening the democratic fabric of the country (www.rti.gov.in).

- **Administrative Reforms Commission (ARC):** The government also took the initiative to establish the second Administrative Reforms Commission (ARC) in 2005. In its eleventh report, the ARC emphasized the importance of incorporating government reforms alongside the utilization of technological tools in e-governance initiatives. The report highlighted the need for fundamental changes in the functioning of government organizations through the effective implementation of technology. Furthermore, the latest report recommended the development of a clear roadmap with defined milestones to achieve the transformation of citizen-government interfaces at all levels of government by 2020 (ARC, 2009).
- **State Wide Area Networks (SWANs):** In March 2005, the government approved the implementation of the State Wide Area Networks (SWANs) scheme. The primary objective of this initiative is to establish high-bandwidth connectivity, linking all states, union territories (UTs), district headquarters, subdivisions, and block levels. Currently, SWANs are operational in 34 states and are utilized to enhance user connectivity within various government offices across the states (DIT, 2015).
- **Common Services Centre (CSC) under the NeGP:** In September 2006, the government approved the implementation of the Common Services Center (CSC) scheme under the National e-Governance Plan (NeGP). NeGP is a comprehensive e-governance initiative focused on enhancing the delivery of government services to citizens and businesses (https://www.meity.gov.in/). It encompasses various Mission Mode Projects (MMPs) such as e-District, CSCs, and the National Portal of India. The objective of the CSC scheme was to establish one lakh ICT-enabled front-end service centers across India, ensuring at least one CSC for every six villages to cover all six lakh villages in the country. However, following an evaluation of the CSC scheme, the CSC 2.0 scheme was launched in 2015 to expand the reach of CSCs to Gram Panchayats (GPs). As part of the CSC 2.0 scheme, the aim was to establish a minimum of one CSC in each of the 2.5 lakh GPs across the country by 2019 (www.csc.gov.in).
- **BharatNet:** BharatNet is an ambitious initiative to establish a high-speed broadband

network that aims to connect all gram panchayats (village councils) across India. Its primary objective is to provide broadband connectivity to all citizens, with a special emphasis on rural areas. The project initially began as the National Optical Fibre Network (NOFN) in October 2011 and was later renamed the BharatNet Project in 2015. The key goals of BharatNet are as follows: (i) enabling the delivery of e-governance, e-health, e-education, e-banking, Internet, and other essential services to rural India, (ii) connecting all 2,50,000 gram panchayats in the country and providing 100 Mbps connectivity to each gram panchayat, and (iii) leveraging the existing unused fibers (dark fiber) of public sector undertakings (such as BSNL, Railtel, and Power Grid) and laying additional fiber connections to connect gram panchayats where needed. This initiative seeks to bridge the digital divide and enhance connectivity in rural areas.

- **Aadhaar (2009):** Aadhaar is a unique identification number provided to Indian citizens, serving as a valid proof of identity and address. This unique identification is generated based on biometric and demographic data. Aadhaar plays a crucial role in various applications, including the opening of bank accounts, availing government subsidies, and filing tax returns, among others. It serves as a secure and reliable means of establishing an individual's identity and facilitating efficient service delivery across multiple sectors.
- **JAM trinity:** JAM, an acronym for Jan Dhan Yojana (financial inclusion scheme), Aadhaar, and Mobile, represents a unified approach to offer comprehensive services to all citizens. The JAM trinity is designed to provide universal access to banking services, identity authentication through Aadhaar, and mobile connectivity. This integrated approach aims to ensure that every individual can avail the benefits of banking, possess a unique identification, and have access to mobile services, thereby promoting financial inclusion and empowering citizens.
- **The Digital India Bill**: It is a key pillar of an overarching framework of technology regulations the Centre is building which also includes the draft Digital Personal Data Protection Bill, 2022, Indian Telecommunication Bill, 2022, and a policy for non-personal data governance.

Table 2.2: List of Central, State and Integrated Mission Mode Projects (MMPs)

Central MMPs	**State MMPs**	**Integrated MMPs**
Banking	Agriculture	CSC
Central Excise & Customs	Commercial Taxes	e-Biz
Income Tax (IT)	e-District	e-Courts
Insurance	Employment Exchange	e-Procurement
MCA21	Land Records (NLRMP)	EDI For e-Trade
Passport	Municipalities	National e-governance Service Delivery Gateway
Immigration, Visa and Foreigners Registration & Tracking	e-Panchayats	India Portal
Pension	Police (CCTNS)	Financial Inclusion
e-Office	Road Transport	Roads and Highways Information System
Posts	Treasuries Computerization	Social benefit
UID	PDS	National GIS
Central Armed Para Military Forces	Education	Urban Governance
e-Sansad	Health	
e-Bhasha	e-Vidhaan	
NMEICT - National Mission on Education through ICT	Agriculture 2.0	
	Rural Development	
	Women and Child development	

[Source: https://www.meity.gov.in/]

In July 2015, the Indian Government launched the Digital India Programme (DIP) with the aim of preparing the nation for a knowledge-based transformation. Digital India is a flagship initiative focused on transforming India into a digitally empowered society and knowledge economy. It encompasses various objectives, including the promotion of universal digital literacy, empowering citizens through digital means, and facilitating online delivery of government services. The programme is based on three key vision areas:

- **Digital Infrastructure:** Ensuring the availability of digital infrastructure and connectivity to all citizens.
- **Governance and Services on Demand:** Making government services accessible as per citizen demand and improving governance through digital means.
- **Digital Empowerment of Citizens:** Empowering citizens with digital tools and knowledge.

The ongoing Mission Mode Projects (MMPs) have now become part of the National e-Governance Plan 2.0 (NeGP 2.0) or e-Kranti, which is a component of the Digital India Programme. The programme emphasizes several principles, including transformative changes, integrated services, re-engineering of government processes for each MMP, demand-driven ICT infrastructure, mobile accessibility of services, language localization, and more (www.digitalindia.gov.in). The Digital India programme revolves around these three vision areas to drive the country's digital transformation as shown in Table 2.3 below.

Table 2.3: Vision Areas of Digital India

S. No.	Vision Area	Key Points
1.	Digital Infrastructure as a core utility to Every Citizen	• Availability of high speed Internet as a core utility for delivery of services to citizens • Cradle to grave digital identity that is unique, lifelong, online and authenticable to every citizen • Mobile phone and bank account enabling citizen participation in digital and financial space • Easy access to a CSC • Shareable private space on a public cloud • Safe and secure cyber-space
2.	Governance and Services on Demand	• Seamlessly integrated services across departments or jurisdictions • Availability of services in real time from online and mobile platforms • All citizen entitlements to be portable and available on the cloud • Digitally transformed services for improving ease of doing business • Making financial transactions electronic and cashless • Leveraging Geospatial Information Systems (GIS) for decision support systems and development
3.	Digital	• Universal digital literacy

	Empowerment of Citizens	• Universally accessible digital resources • Availability of digital resources and services in Indian languages • Collaborative digital platforms for participative governance • Citizens not required to physically submit Government documents and certificates

[Source: www.digitalindia.gov.in]

E-governance in India holds great promise for enhancing the efficiency, transparency, and citizen engagement within government services while combating corruption. However, it is essential to address certain challenges such as data privacy, cyber security, and bridging the digital divide to ensure widespread access to the benefits of e-governance for all citizens. By prioritizing these concerns, India can create a robust and inclusive e-governance ecosystem that empowers its people and fosters trust in digital governance initiatives.

2.8 E-Governance Performance

The assessment of e-governance performance has traditionally focused on analyzing the content of e-governance initiatives and measuring their usage. But it is not an appropriate indicator for the e-governance performance (Kaylor et al., 2001). There should be other indicators based on the user perception like response time, easy navigation, download time for data, service delivery speed and process, availability of current and relevant information, security, privacy, trustworthiness of the site and most importantly the complete functionality (Voss, 2000). Though the e-governance performance has been now assessed on multiple set of evaluation criteria and factors but initially the most important criterion was to evaluate the website performance through ease of navigation, design of user interface, quality and reliability of the content, and the technology used (Merwe and Bekker, 2003). Researchers have identified various features or characteristics for assessing e-governance performance, viz., efficiency and effectiveness (Heeks, 2001b), service delivery (Bekker & Zouridis, 1999), transparency, decentralization (La Porte, De Jong, & Demchak, 1999), interactivity (DiCaterino and Pardo, 1996), interconnectivity (McClure, 2000), and accountability (Ghere & Young, 1998; Heeks, 1998, 1999b). The assessment of performance in e-governance services lacks appropriate metrics, as highlighted by Steyaert (2004). Hung et al. (2006) proposed a set of nine performance indicators, including ‘perceived usefulness’, ‘perceived ease of use', 'trust', 'compatibility', 'external influence', 'interpersonal influence', 'self-efficacy', and 'facilitating condition'. These indicators can be prioritized based on the specific needs of an organization. Verdegem and Verleye (2009) identified fifteen performance indicators for e-government, such as 'reduction of administrative burden', 'reliability', 'usability', 'cost-effectiveness', 'ease of use', 'security', 'content readability," "privacy/personal information protection," "courtesy," "content quality', 'transparency', 'responsiveness', 'accessibility', 'flexibility', and 'personal contact'. These indicators serve as benchmarks to assess and evaluate the performance of e-governance initiatives.

The emergence of new perspectives in e-governance, such as citizen participation and interactivity, has prompted researchers to propose additional indicators for assessing e-governance performance. These indicators include transparency and accountability (Carter and Bélanger, 2005; Ciborra and Navarra, 2005; Bertot et al., 2012; Gupta et al., 2016a), simplification of procedures, improved office management, and positive staff attitudes (Monga, 2008; Gupta et al., 2017; Gupta et al., 2018), efficiency in terms of time and effort savings (Dhillon et al., 2008; Suri and Sushil, 2017; Gupta et al., 2018), cost reduction, and the quality of information and services (Suri and Sushil, 2011; Suri, 2014; Gupta et al., 2018). Other important performance indicators identified by researchers include citizens' trust (PytlikZillig et al., 2012) in e-governance services, satisfaction with services, and their effectiveness (Candiello et al., 2009; 2012). Additionally, reliability is highlighted as a key performance indicator as it contributes to improving e-governance performance both internally and externally (Collier and Bienstock, 2006; Kim et al., 2006; Shareef et al., 2011; Gupta et al., 2017). Suri (2009), in an analysis of gaps in planning and implementation of e-governance, proposed efficiency, transparency, interactivity, and decision support as key performance indicators. These diverse indicators provide a comprehensive framework for assessing and evaluating the performance of e-governance initiatives.

Singh et al. (2020) have identified five key indicators for measuring e-governance performance: beneficiaries, technology usage, policy formulation, institutional parameters, and economic parameters. The indicators related to beneficiaries include ease of use, usefulness, user awareness, satisfaction, and adoption and social benefits and influence. Technology usage indicators focus on accessibility, infrastructure, reliability, and website maturity. Policy formulation indicators encompass laws and policies, privacy and security, transparency and user trust, and effectiveness and empowerment. Economic parameters consider affordability and cost of service, as well as funding sustainability. Institutional parameters cover availability and performance, management support, quality (system, service, and information), and operational efficiency. In complex financial systems, the performance of e-governance can be enhanced by addressing budgetary challenges (Lulaj et al., 2022). Factors to focus on may include lack of resources (staff, funds, infrastructure, tools, etc.), political stability, rule of law, and control, as well as regulations and guidelines from developed countries. Trust in e-governance is highlighted as an important parameter for predicting e-governance performance, as noted by Abdulkareem and Ramli (2022). Trust is influenced by information quality, service quality, and actual use, while quality dimensions predict actual use and user satisfaction with e-governance.

2.9 E-Governance Performance Assessment

In recent years, there has been a rapid increase in the use of ICT in the public sector, commonly referred to as e-governance. The adoption of e-governance is driven by the potential to improve the efficiency and effectiveness of public service delivery, promote transparency and accountability, and encourage citizen participation in decision-making processes (Suri and Sushil, 2014). This literature review aims to provide an overview of research conducted on e-governance performance assessment, with a focus on measuring its effectiveness, examining its benefits, addressing challenges (Lulaj et al., 2022), and exploring future prospects. Evaluating the performance of e-governance is essential for understanding its impact on public service delivery and identifying areas that require improvement. Various frameworks and methodologies can be used to measure e-governance performance, including the United Nations' 'E-Government Survey', the 'E-Governance Performance Index' (EGPI), and the 'E-Government Maturity Model' (EGMM). These assessment tools provide valuable insights for policymakers and practitioners in enhancing e-governance practices.

The assessment of e-governance performance relies on various frameworks and methodologies that provide valuable insights into the effectiveness of e-governance initiatives. One widely used framework is the UN e-government survey, which evaluates countries based on online service delivery, telecommunication infrastructure, and human capital. Another commonly employed framework is the EGPI, which measures e-governance effectiveness through indicators such as citizen participation, service delivery, and information dissemination. Additionally, the EGMM offers a comprehensive assessment of e-governance maturity across six stages, ranging from basic implementation to full integration. E-governance utilizes ICT to enhance public services and improve government operations' efficiency and effectiveness. Assessing e-governance performance is crucial to ensure that the intended objectives of such initiatives are achieved, and the associated benefits are realized (Abdulkareem and Ramli, 2022). This literature review provides an overview of the research conducted on e-governance performance assessment, including the approaches used, the benefits observed, the challenges faced, and the future prospects. However, it is important to acknowledge that evaluating e-governance performance can be a complex task, and there are several challenges associated with it. Addressing these challenges will be vital in unlocking the full potential of e-governance performance assessment.

2.9.1 Benefits of E-Governance Performance Assessment

Evaluating the performance of e-governance is essential in comprehending its impact on public service delivery and pinpointing potential areas for enhancement. E-governance performance assessment has several benefits, including enhancing transparency and accountability, identifying areas for improvement, and facilitating benchmarking. The assessment of e-governance performance has several benefits (Abdulkareem and Ramli, 2022), including:

- **Identifying Areas for Enhancement:** Assessing the performance of e-governance aids in the identification of areas that require improvement, thereby enhancing the quality and efficiency of public service delivery.
- **Enhancing Service Delivery:** Performance assessments contribute to the improvement of public services by identifying shortcomings in e-governance initiatives and addressing them to enhance effectiveness and efficiency.
- **Promoting Transparency and Accountability:** Evaluating e-governance performance fosters transparency and accountability, as it facilitates citizen access to government data, promotes its understanding, and establishes mechanisms for monitoring and evaluating government performance.

- **Facilitating Benchmarking:** Assessing e-governance performance enables countries to compare their performance with that of others, facilitating benchmarking and the identification of best practices.
- **Supporting Evidence-based Decision-making:** Performance assessments provide decision-makers with reliable information, reducing the risk of basing decisions on incomplete or inaccurate data and promoting evidence-based decision-making.

Various approaches have been used to assess e-governance performance, including:

- **The E-Governance Maturity Model (EGMM):** This methodology evaluates the maturity level of e-governance initiatives by considering factors such as the availability of online services, citizen participation, and integration among government agencies.
- **The Balanced Scorecard:** This approach evaluates e-governance performance from four perspectives: financial, customer, internal processes, and learning and growth.
- **The Stakeholder Approach:** This method assesses e-governance performance by considering the needs and expectations of diverse stakeholders, including citizens, businesses, and government agencies.

Numerous challenges (Lulaj et al., 2022) are linked to assessing e-governance performance, including issues with data quality, capacity and skills, and cost. Overcoming these challenges is crucial for harnessing the complete potential of e-governance performance assessment. The specific details of the challenges related to assessing e-governance performance are outlined below:

- **Data Deficiency:** Evaluating e-governance performance necessitates reliable and precise data, which is often either unavailable or challenging to obtain.
- **Data Quality:** The quality of data used in e-governance performance assessment is crucial, and inaccurate or incomplete data can lead to incorrect conclusions and decisions
- **Capacity and Skills:** The assessment of e-governance performance requires significant capacity and skills, including data scientists, analysts, and engineers
- **Cost:** The assessment of e-governance performance can be expensive, requiring significant resources and funding

- **Complexity:** E-governance initiatives can be complex, involving multiple government agencies, citizens, and other stakeholders, which can make the assessment of performance challenging
- **Subjectivity:** The assessment of e-governance performance can be subjective, as different stakeholders may have different views on what constitutes effective e-governance.

The future outlook for e-governance performance assessment appears promising, as numerous governments across different countries are investing in it to enhance their operations, services, and the overall quality and efficiency of service delivery. However, there are still significant challenges to overcome. These include the development of reliable and accurate data sources, building the required capacity and skills, ensuring transparency, accountability, and data quality, addressing the complexities and subjectivity of e-governance initiatives, and resolving cost-related issues.

2.9.2 Frameworks for E-Governance Performance Assessment

To identify a suitable e-government assessment framework for a developing country, multiple frameworks are analyzed. Considering their contextual suitability and citizen-centric approach, a hybrid framework is proposed by amalgamating the earlier proposed frameworks (Otieno and Omwenga, 2016). Table 2.4 provides a summary of various e-governance performance assessment frameworks.

Table 2.4: E-Government Assessment Frameworks

S. No.	Author (Year)/ Framework	Approach/Description	Key Concepts/Indicators
1.	Kaylor et al. (2001)	The core essence of e-governance can be defined as "achieving transformation to deliver enhanced value for stakeholders."	When assessing e-governance performance, it is crucial to consider the following factors: security and privacy, trustworthiness, response time, ease of navigation, data download time, delivery of promised services, availability of current and comprehensive information, and full functionality.
2.	Merwe and Bekker (2003)	A framework and methodology are proposed for the evaluation of e-	E-governance performance includes characteristics such as “User interface

		commerce websites.	design, Navigational ease, Quality contents, Reliability and Technology”.
3.	Hung et al. (2006)	Determinants of user acceptance of e-government services, focusing specifically on the online tax filing and payment system.	Organizational requirements can be used to prioritize performance indicators for e-governance that are as follows: “Perceived usefulness, Perceived ease of use, Trust, Compatibility, External influence, Interpersonal influence, Self-efficacy, and Facilitating condition”.
4.	E-Government Economic Project (e-GEP) in EU from 2005-2010	Key value drivers of efficiency, democracy and effectiveness used in benchmarking.	**Focus:** Outcome /Impact (Citizen and Agency) Application of mix approaches (quantitative and qualitative) for public value assessment through multiple dimensions.
5.	Yildiz (2007)	E-government research “literature review, limitations, and ways ahead”.	Assessment of key features of e-governance performance: “Communication, Transparency, Accountability, Effectiveness, Efficiency, Standardization of information and services and Productivity”.
6.	Liu et al. (2008)	Analysis on three levels: value (financial, social, operational and strategic), Key Performance Areas (KPAs), and Key Performance Indicators (KPIs).	**Focus:** Outcome /Impact (Citizen-Centred) Use of KPAs and KPIs for multiple stakeholders on public value and from user perspective.
7.	Verdegem and Verleye (2009)	User satisfaction measured through comprehensive model.	Key e-governance performance indicators are: “Reduction of administrative burden, Reliability, Usability, Cost-effective, Ease of use, Security, Content readability, Privacy/personal information protection, Courtesy, Content quality, Transparency, Responsiveness, Accessibility, Flexibility, and Personal contact”.

8.	Verdegem et al. (2010)	The inputs of financial and non-financial costs contribute to the production of outputs leading to outcomes and impacts. This framework provides specific measurement and evaluation indicators, including contextual variables. It incorporates key, sub, and composite indicators.	**Focus:** Outcome /Impact (Agency, Citizen, Business) The public value chain encompasses input, output, outcome, and impact. The relationship between these variables is influenced by contextual factors. There has been a paradigm shift from prioritizing efficiency to emphasizing effectiveness in the evaluation of public value.
9.	E-Governance Assessment Framework (EAF)	Methodological approach for developing countries based on important attributes: service orientation, technology, sustainability, cost-effectiveness and replicability, each with sub indicators and respective weights.	**Focus:** Outcome /Impact (Citizen-Centred) Summary and detailed assessment of services offered: G2C, G2B and G2G, with more weightage to service-orientation.
10.	Bhatnagar and Singh (2010)	Impact assessment for clients, government agencies and citizens considering project ratings with defined indicators for developing countries.	**Focus:** Outcome /Impact (Citizen-Centred) The approach utilizes assisted "service" centers instead of "self-use" centers for developing countries, incorporates both qualitative and quantitative indicators with strong emphasis on assessing the impact from the perspectives of clients and the community.
11.	PytlikZillig et al. (2012)	Public input methods impacting confidence in the government	Key performance indicators in terms of public trust have factors such as “Perceived satisfaction, Level of trust, Lawfulness and Loyalty”.
12.	Suri (2009)	Strategic planning, implementation and e-governance performance	E-governance performance includes: • ‘Efficiency’ (fast execution of the core process, simplification of government procedures, reduced paperwork and decreased communication cost),

			• ‘Transparency’ (service is easily accessible and delivered fairly), • ‘Interactivity’ (within and across actors and beneficiaries) and • ‘Decision support’ (improved planning and decision making and better monitoring and control).
13.	Singh et al. (2020)	Service innovation implementation “A systematic review and research agenda”	Five key indicators for measuring the e-governance performance are: “Beneficiaries, Technology-usage, Policy-formulation, Institutional and Economic parameters”.
14.	Georgios and Nikolaos (2021); UN (2020)	Benchmarking with global indicators so as to assess the current e-governance implementation	Key indicators by OECD: Digital by design, Data-Driven Public Sector, Government as a platform, Open by default, User driven and Reactiveness. UN criteria: The Online Services Index, Telecommunications Infrastructure Index, Human Capacity Index and Normalized Composite Index.
15.	Lulaj et al., 2022	E-governance in complex financial systems	Factors to focus on: • lack of resources (staff, funds, infrastructure, tools, etc.) • having political stability, rule of law, and more control • considering regulations and guidelines from the developed countries

[Source: Suri (2009); Otieno and Omwenga (2016); Singh et al. (2020); UN (2020); Georgios and Nikolaos (2021); Lulaj et al., 2022]

2.10 Big Data – Definition, Values and Challenges

Big data is commonly defined in terms of the 3Vs: "Volume," referring to the vast amount of data that requires substantial storage or consists of a large number of records; "Velocity," representing the speed at which data is generated or delivered; and "Variety," indicating the diverse sources and formats of data, including structured and unstructured data fields (Russom, 2011). Subsequently, "Value" was added to emphasize the importance of extracting economic benefits from big data (IDC, 2012; Oracle, 2012), and "Veracity" was introduced to highlight the significance of data quality and the level of trust in various data sources (Forrester, 2012; White, 2012). The value derived from big data can be manifold (Wamba et al., 2015), encompassing: (i) Creating transparency; (ii) Facilitating need discovery; (iii) Enabling performance improvement; (iv) Enhancing customization for different population segments; (v) Informing data-driven decisions; (vi) Facilitating the development of new business models; (vii) Generating new products; (viii) Providing new services. However, there are also challenges and issues associated with the use of big data (Wamba et al., 2015). Some of these challenges include:

- **Data Policies:** Field (2009) describes that early policies were driven by the need to manage long-term data sets (those accrued over 30 or more years), such as those in the social and environmental sciences. More recently, policies have emerged in response to increased funding for high-throughput approaches in major fields.
- **Technology and techniques:** Frederiksen (2012) called big data as new repository of information that can be used for data driven decisions for natural disasters like Tsunami to save loss of lives. But Technology and techniques pose a major challenge in case of big data.
- **Department change (organizational change) and talent:** Frederiksen (2012) considers organizational change as a major challenge for use of the big data. Talent is also very important to make success out of this big data initiative.
- **Access to data:** Gorton et al. (2008) gave importance to the access of data which can later pose the greatest challenge for big data implementation.
- **Industry structure:** Brown et al. (2011) gave importance to the Industry structure for the big data projects.

2.11 Evolution of Big Data

The innovation of big data plays a crucial role in creating new business opportunities, which in turn fuels the economic and social development of a country (Saheb and Saheb, 2020). Governments have traditionally stored and codified information for legal and administrative purposes (Henninger, 2013). However, they have faced significant challenges in managing and disposing of large volumes of data, often resorting to manual processes for essential tasks (Liu and Yuan, 2015). As data increasingly becomes integral to policy-making and implementation, governments have prioritized data integration as a key concern (Jordan, 2015). With advancements in computer science and related technologies, governments have started utilizing tools for decision-making (Ko† et al., 2013). Consequently, the availability of numerous data sources has resulted in the emergence of big data, which is now being used for decision-making, even in critical processes like R&D management (Liu and Yuan, 2015). The term big data first appeared in the early 2000s (Alexander et al., 2017) during experiments conducted in high-energy physics involving particle colliders and accelerators. This led to the development of grid computing, which comprises highly distributed infrastructures used for data storage, processing, and access. Subsequently, the rise of buzzwords such as cloud computing, machine learning, and social media became associated with big data. Some experts refer to big data as "uncomfortable data," as its size and complexity surpass the capabilities of traditional tools and methods used by organizations. Trnka (2014) defines big data as data that requires more sophisticated hardware and software tools than usual to be captured, managed, and processed within a specific timeframe. Another definition suggests that big data exceeds the handling capacity of typical databases, software, or analysis tools. Big data is generally characterized by three attributes: volume, speed of processing, and diversity (Russom, 2011). In terms of volume, some experts consider petabytes as the starting point of big data. Velocity refers to the speed at which data is generated, such as data from video cameras installed at airports. Diversity pertains to the variety of data, for example, musical files on YouTube versus movies on Netflix. Kamilaris et al. (2017) discuss the application of big data in understanding complex agricultural ecosystems. They emphasize the importance of analyzing big data to enable farmers and companies to extract value from the data generated in agricultural systems. The authors state smart farming comes from this big data analysis. The authors also discuss the characterization of big data based on five key aspects: volume, velocity, variety, veracity, and valorization. Veracity refers to the quality, accuracy, reliability, and potential of the data, while valorization refers to the ability of the data to create value through knowledge and innovation. They highlight an important point that big data is not solely about volume but also about the capacity to search, aggregate, and visualize significantly large datasets within a reasonable timeframe. The era of big data has empowered the current boom in AI and the field of cognitive computing (Gupta et al., 2018). The big data era has added types of data that were not previously used in analysis, such as that from social media (Martínez-Rojas et al., 2018; Ragini et al., 2018). The utilization of automated techniques helps make sense of big data, as manual analysis can be extremely time-consuming (Gupta et al., 2018). Further research is needed to explore the unique advantages that the increased availability of big data with its volume, variety, and velocity can provide (Duan et al., 2019).

2.12 Use of Big Data in E-Governance

Information overload is a significant concern in both general and research contexts. The exponential growth of data can be attributed to access to vast amounts of research data from diverse sources through various modes such as crowd sourcing and automated data engines. While data is readily available through numerous freely accessible sources, the challenge lies in analyzing these massive datasets, visualizing them, and deriving meaningful insights to address specific problems. The concept of big data has emerged as a response to the challenges involved in gathering, cleaning, analyzing, sharing, transforming, and processing large datasets across organizations. The government sector, in particular, holds immense potential for value creation in decision-making by harnessing the power of big data (McKinsey & Co, 2011). Big data has the potential to revolutionize decision-making processes, both in planning and execution. Alexander et al. (2017) discuss the implications of big data for planning, emphasizing its ability to provide valuable insights. They provide examples of companies like Rolls-Royce Aerospace and Tesla, who leverage big data generated from sensors to make informed decisions about their next products, product enhancements, and areas of improvement. Additionally, they mention the use of big data from electronic health records to analyze the impact of prescribed medicines on patients, leading to improved future prescriptions. Wang et al. (2018) highlight the potential benefits of big data analytics for healthcare organizations, including the reduction of system redundancy, improved decision quality and accuracy, enhanced cross-functional communication, and collaboration within the organization. These benefits are applicable to various types of organizations, not just healthcare. Cattell et al. (2013) emphasize the significance of big data in pharmaceutical R&D. The huge value can be achieved by optimizing the innovation process, improving the efficiency of clinical trials, and developing new tools for professionals. The authors also discuss the use of predictive modeling in identifying candidate molecules with a higher likelihood of successful development into drugs. Alexander et al. (2017) highlight that the successful utilization of big data relies on the timely updating of skills and knowledge within teams, acquiring appropriate technology and systems, and achieving new capabilities through the use of big data. This perspective is equally relevant for government institutions, as they play a central role in knowledge creation and management. According to Jordan (2015), governments have dual roles in knowledge work: knowledge production and knowledge management. Effective government decision-making involves the participation of various stakeholders, necessitating extensive information exchange, knowledge sharing, and improved coordination of activities (Viehland, 2005). The importance of big data lies in its ability to enable flexible management of information assets within organizations, thereby enhancing supply chain performance (Birasnav et al., 2015), system flexibility (Palanisamy and Foshay, 2013), and corporate agility (Singh, 2013). This understanding is crucial for institutions to make informed decisions about which projects to undertake, continue, ignore, or abandon (Alexander et al., 2017).

Big data encompasses various types of datasets, including text, audio, video, images, and more (Pencheva et al., 2020). The 5V concept of big data highlights its characteristics in terms of volume, velocity, value, veracity, and variety (Pencheva et al., 2020). The three 'V's, volume, velocity, and variety, were initially introduced to distinguish big data from conventional data (Eaton et al., 2012). However, different stakeholders have different interpretations of the concept (Stough and McBride, 2014). Some view big data as a cultural, technological, and scholarly phenomenon (Boyd and Crawford, 2012), while others see it as a multidimensional concept encompassing technology, decision-making, and public policy (McNeely and Hahm, 2014). Due to the challenge of defining such a broad concept, several attempts have been made to clarify its meaning. For example, the 4Vs model suggests including concepts like veracity, validity, value, and viability (Kimble and Milolidakis, 2015). The exponential growth of data has transformed it into big data. Big data analytics refers to the tools used to study and analyze big data with speed and accuracy. Understanding the role of big data in the public sector has become crucial due to its increasing prominence (Pencheva et al., 2020). Big data analytics can significantly contribute to enhancing e-governance performance by facilitating data-driven decision-making, improving service delivery, and promoting transparency and accountability. Here are some ways in which big data can be utilized in e-governance:

- **Predictive analytics:** Analysis of vast amounts of data, enables government agencies to forecast service demand and allocate resources strategically. This approach enhances service delivery by promoting efficiency and effectiveness.
- **Fraud detection:** Through the utilization of big data analytics, patterns and anomalies in data can be analyzed to detect instances of fraud and corruption in government programs. By examining large volumes of data, this approach enables the identification of irregularities and suspicious activities that may indicate potential cases of waste, fraud, and abuse (McNeely and Hahm, 2014).
- **Performance monitoring:** By harnessing big data, government agencies can monitor the performance of their programs and operations in real-time. This proactive approach allows for the timely identification of areas that require improvement, ensuring that services are delivered efficiently and effectively.
- **Citizen feedback:** Social media and other digital channels offer a rich source of data that can be leveraged to gather valuable feedback from citizens regarding government services (Pencheva et al., 2020). This feedback serves as a valuable resource for identifying areas that require improvement and ensuring that services align with the needs and expectations of citizens.
- **Open data:** Government agencies have the ability to release datasets to the public, allowing citizens, researchers, and businesses to access and analyze the data. This open data approach provides opportunities for various stakeholders to harness the data and develop innovative solutions to address public issues.

The application of big data analytics in government agencies holds the potential to enhance decision-making, enhance service delivery, and promote transparency and accountability. However, it is crucial to prioritize ethics, security, and citizen privacy when leveraging big data. Safeguarding the ethical use of data, maintaining robust security measures, and respecting the privacy rights of citizens are paramount considerations. By adhering to these principles, government agencies can harness the benefits of big data analytics while upholding the trust and confidence of the public.

2.13 Big Data and E-Governance Performance

In recent years, there has been a growing interest in leveraging big data to enhance the performance of e-governance. The utilization of big data in e-governance holds immense potential to revolutionize the delivery of public services. By harnessing the power of big data, governments can enhance the efficiency and effectiveness of their operations, promote transparency and accountability, and enable data-driven decision-making (McNeely and Hahm, 2014). The application of big data analytics empowers governments to uncover valuable insights and identify patterns and trends within vast datasets. These insights can be utilized to improve policy-making processes and enhance the delivery of public services. For instance, big data analytics can aid in the prediction and prevention of fraudulent activities, the identification of crime patterns, the optimization of public transportation services, and the enhancement of disaster management. By effectively utilizing big data in e-governance, governments can drive transformative changes that lead to more streamlined and citizen-centric service delivery. The integration of big data analytics enables governments to make informed decisions, respond promptly to emerging challenges, and ultimately enhance the overall well-being of their constituents.

The utilization of big data in e-governance holds numerous potential benefits, which include:

- **Improved Service Delivery:** Big data analytics can enhance the efficiency and effectiveness of public services. By analyzing vast datasets, governments can identify areas where services can be optimized, make data-driven predictions to prevent potential problems, and ensure a more seamless delivery of services.
- **Increased Transparency and Accountability:** Big data promotes transparency and accountability in government operations. Through the accessibility and comprehensibility of government data, citizens can easily access and comprehend information. Moreover, the use of big data makes it more challenging for government officials to manipulate or distort data, ensuring greater integrity and trust in governance.
- **Evidence-based Decision-making:** Big data analytics enables evidence-based decision-making. By leveraging the insights obtained from comprehensive data analysis, decision-makers have access to reliable information. This reduces the risk of basing decisions on incomplete or inaccurate data, leading to more informed choices and policies.

By embracing big data in e-governance, governments can unlock significant opportunities to enhance service delivery, foster transparency, and make decisions grounded in robust evidence. This paves the way for more efficient, accountable, and responsive governance that addresses the needs of citizens effectively.

2.14 Critical Success Factors (CSFs) and Challenges for Big Data in E-Governance

With advancements in computational power and the growing significance of big data and analytics (BDA), organizations are recognizing the value that can be derived from their vast data volumes (George et al., 2014). Studies have shown that firms adopting data-driven strategies tend to be more productive and profitable compared to their competitors (Brynjolfsson et al., 2011; LaValle et al., 2010). Predictive analytics of big data offer strategic advantages for business transformation (Wamba et al., 2015). Critical Success Factors (CSFs) and strategies for implementing "Big data in e-governance in India," considering the challenges and different ecosystems, have been compiled from relevant literature (*Chapter 4, Section 4.3*). Concerns regarding big data, such as data security, privacy, digital infrastructure resilience, risks related to identity management, circumvention of democracy, social exclusion, and ensuring rights to equality and access, are of utmost importance. Key Performance Indicators (KPIs) are used to assess the impact of utilizing big data on the performance of e-governance, exploring the role of big data in this domain. The future prospects of big data in e-governance are promising, as many governments are investing in big data analytics to enhance their operations and services. However, there are challenges that need to be addressed. These include:

- **Privacy and Security Concerns:** The use of big data in e-governance raises significant concerns regarding privacy and security, particularly due to the collection and processing of large amounts of personal data.
- **Data Quality:** The quality of data used in big data analytics is crucial. Inaccurate or incomplete data can lead to erroneous conclusions and decisions, highlighting the importance of ensuring data accuracy and completeness.
- **Capacity and Skills:** Effectively utilizing big data in e-governance requires a significant level of capacity and expertise, including skilled data scientists, analysts, and engineers.

Overcoming these challenges and developing the necessary capacity and skills, ensuring privacy and security, and addressing data quality issues are critical for the successful implementation of big data in e-governance. Despite the obstacles, the potential benefits of leveraging big data in this domain make it a worthwhile endeavor for governments seeking to enhance their governance practices and outcomes. Leveraging big data in e-governance has the power to revolutionize public service delivery, leading to enhanced efficiency, effectiveness, transparency, accountability, and evidence-based decision-making. Nevertheless, substantial challenges must be overcome to fully unlock the benefits of big data in e-governance and maximize its potential.

2.15 Learning from Literature and Research Gaps

The learning from literature are as follows:

- E-governance presents public organizations with opportunities to enhance their interactions with citizens. The progress in ICT and the dedicated endeavors of both the Centre and State governments have played a pivotal role in the successful establishment and strengthening of e-governance in India (Salwan and Maan, 2021).
- E-governance has emerged as an innovative approach to disseminating information and delivering services to citizens. It offers governments the opportunity to bring services closer to citizens in a cost-effective, efficient, and transparent manner. However, despite the potential, studies suggest that the actual benefits of e-governance projects for citizens are yet to be fully realized. Furthermore, there is limited research conducted in the context of developing countries to assess and measure the impact of e-government initiatives on target groups.
- E-governance projects generate vast amounts of data on a daily basis, with data taking various forms and sizes depending on the application. Raw data, in its unprocessed state, does not provide meaningful information (Stuart MacDonald, 2011). However, once the raw data is processed, it yields valuable insights that can serve as a crucial input for decision-making. To facilitate effective decision-making, governments, in collaboration with public and private sectors, are promoting interoperability among organizations. This encourages the central storage and processing of data, thereby enhancing the decision-making process (Salwan and Maan, 2021).
- With the growing utilization of e-governance datasets, citizens have higher expectations for faster and more accurate analysis and processing of these datasets. Big data insights offer a means to analyze complex data in a simplified and accessible manner. These insights provides real-time insights into the current status and, based on data patterns, facilitates future forecasting and trend analysis. This capability

supports organizations and governments in the decision-making process, enabling them to make informed choices based on data-driven insights (Mahmoud et al., 2019).

- Big data plays a crucial role in the transformation of digital government services (Verma and Suri, 2019), facilitating interaction among all stakeholders including governments, citizens, and the business sector (Tianshu, 2016). In the realm of digital government, big data serves as a catalyst for collaboration among stakeholders, enabling the creation of real-time solutions in various domains such as agriculture, public and mental health, transportation, citizen services, policy and decision-making, legislation, and regulations (K and K, 2017; Rahaman et al., 2021).
- As the use of big data in e-governance becomes more widespread, the next challenge lies in measuring its impact through the development of Key Performance Indicators (KPIs). Currently, there is limited research conducted in developing countries to benchmark and evaluate the influence of big data utilization in e-governance. Assessing the impact is crucial to justify the allocation of public funds and provide insights for future projects. Existing studies evaluating e-governance performance after implementing big data have primarily focused on developed countries, which have different contextual factors compared to developing countries. Therefore, there is a need to develop frameworks that are specifically tailored to the context of developing countries.

The following research gaps have been identified based on a review of literature:

- Although some studies suggest that the full benefits of e-governance projects have yet to be fully realized in terms of citizen benefits, there is a lack of research conducted in the context of developing countries to assess and measure the impact of e-governance on target groups.
- Currently, e-governance studies can be broadly categorized into two domains: those focused on information systems and those focused on public administration. However, there is a lack of integration between these two domains, with very few studies that combine knowledge from both areas.
- The existing literature on e-governance, particularly in developing countries like India, has yet to fully embrace the multidimensional and multi-level framework proposed by recent studies (Bannister & Connolly, 2015; Khanra & Joseph, 2019). This framework is essential for comprehending the complexity of e-governance. However, achieving a comprehensive understanding of e-governance requires incorporating the

perspectives of multiple stakeholders, including citizens, policymakers, and various implementation partners. Unfortunately, such a comprehensive view is currently lacking in the literature.

- The majority of studies assessing e-governance performance after the use of big data have primarily focused on developed countries, which have distinct contexts compared to developing countries. Consequently, there is a pressing need to develop frameworks that are specifically tailored to the unique context of developing countries.
- Previous research on the use of big data to enhance e-governance performance has predominantly taken an information technology (IT) perspective, relying mainly on macro-level strategic management theories to support their hypotheses (Gunther et al., 2017).
- The utilization of big data has the potential to significantly enhance e-governance performance by facilitating data-driven decision-making, enhancing service delivery, and fostering transparency and accountability (Pencheva et al., 2020). However, there is a limited body of research that specifically examines the impact of big data in the public sector, both globally and particularly in developing countries like India.
- The value derived from insights obtained through big data relies heavily on the presence of a suitable IT infrastructure, an organizational culture that supports data-driven decision-making, and a skilled workforce (Wamba et al., 2015). Additionally, the effective utilization of big data requires organizations to shift their focus from internal operations to the external organizational environment. It is essential to understand and respond to the ever-changing global demands by reshaping and aligning business operations (Gunasekaran et al., 2017).
- While existing literature indicates that the use of big data can enhance organizational performance, it is important to note that many studies have primarily focused on a narrow perspective related to information systems and technology (Gunther et al., 2017; Wamba et al., 2015). As a result, there is a lack of comprehensive studies that thoroughly analyze the influence of various factors associated with big data, such as information and data, information technology, organization and management, law and regulation, and institution and environment, on the 'Performance of e-governance projects using big data'.
- Previous studies have primarily focused on the positive aspects and benefits of big data in e-governance, while overlooking significant concerns related to data security, privacy, digital infrastructure resilience, risks of identity management, circumvention

of democracy, social exclusion, and the rights to equality and access. These concerns are crucial to address as they can have far-reaching implications on the ethical and societal implications of utilizing big data in e-governance initiatives.

The future prospects of big data in e-governance are indeed promising, as governments worldwide recognize its potential and invest in big data to enhance their operations and services. However, there are several crucial areas that require attention and progress. First and foremost, developing the necessary capacity and skills within government agencies is essential to effectively utilize big data. This includes training personnel in data analysis, interpretation, and decision-making based on insights derived from big data. Furthermore, ensuring privacy and security of the data is paramount. Governments must establish robust frameworks and protocols to protect sensitive information and maintain public trust. Additionally, addressing data quality issues is crucial to ensure accurate and reliable analysis. Efforts should be made to enhance data collection, verification, and cleaning processes to minimize errors and biases in the datasets. The use of big data in e-governance has the potential to revolutionize public service delivery. It can lead to improved efficiency and effectiveness by identifying areas for optimization and streamlining processes. Furthermore, big data can enhance transparency and accountability by providing real-time insights into government operations and facilitating evidence-based decision-making. Nevertheless, significant challenges exist in maximizing the benefits of big data in e-governance. It requires a comprehensive approach that addresses technical, organizational, and regulatory aspects. Governments must foster a culture that embraces data-driven decision-making and invest in the necessary infrastructure to support the collection, storage, analysis, and dissemination of big data. In conclusion, while the potential of big data in e-governance is promising, there is still a long way to go. Overcoming challenges related to capacity building, privacy and security, and data quality is crucial to harness the full potential of big data and unlock its transformative power in improving public services and governance.

2.16 Concluding Remarks

Big data has the potential to greatly support democratic processes by enhancing transparency, efficiency, and effectiveness in government operations. While privacy concerns associated with big data analytics exist, the implications for democracy are still relatively unexplored (Mavriki and Karyda, 2022). Understanding the assessment of e-governance performance and the use of big data to enhance such performance is a key focus of this study. To gain insights, various e-governance performance assessment frameworks developed by researchers have been compared, presented, and analyzed. Through a comprehensive review of the literature, research gaps have been identified, providing a foundation for the conceptualization of a conceptual framework. This framework incorporates relevant macro and micro variables to guide the study. It is noteworthy that existing research suggests the use of big data to enhance e-governance performance has been proposed and empirically tested primarily in developed countries, with limited empirical studies conducted in developing countries like India. Thus, it has become essential to develop a conceptual framework that specifically utilizes big data to enhance the performance of e-governance projects. The subsequent chapter presents this conceptual framework, encompassing the relevant macro and micro variables.

Chapter 3

A Pilot Study of E-Governance Project: Aadhaar card services from Unique Identification Authority of India (UIDAI)[1]

3.1 Introduction

A few studies have been conducted for measuring the conventional e-governance projects in terms of outcomes like reduced costs, speed of delivery, effectiveness of implementation, etc. or others measuring the performance directly in terms of transparency, accountability and citizen participation (Carter and Bélanger, 2005; Ciborra and Navarra, 2005; Dhillon at el., 2008; Bertot et al., 2012; Gupta et al., 2016a; Suri and Sushil, 2017; Gupta et al., 2018). But there is dearth of empirical studies which explore the variables influencing the 'Performance of e-governance projects using big data'. This pilot study explores these variable for developing the conceptual model of inquiry for the detailed study. Macro variables influencing the 'Performance of e-governance projects using big data' have been explored through review of literature. Experts from the domain were interviewed for further inputs. A questionnaire was designed and survey conducted to measure the 'Performance of e-governance projects using big data' and big data related variables in the context of Aadhaar card services from Unique Identification Authority of India (UIDAI). This UIDAI e-governance project was selected for the pilot study because of the big data collected through huge set of transactions on daily basis. Survey data have been analyzed to study the influence of big data related variables on 'Performance of e-governance projects using big data'. The analysis revealed that the 'e-governance projects using big data' with high value of conceptualized big data related variables are characterized by high performance. This implies that conceptualized variables for big data do influence the 'Performance of e-governance projects using big data'.

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3.2 Methodology

Literature review was conducted for understanding the indicators for measuring the performance of e-governance projects with or without use of big data. There were very few studies on assessing the use of big data in e-governance projects. Macro variables influencing the 'Performance of e-governance projects using big data' were identified through extensive and comprehensive review of literature. Experts from the domain were interviewed for further inputs. Macro variables expected to influence the 'Performance of e-governance projects using big data' were compiled and categorised as different constructs. A questionnaire was designed and survey conducted to measure the 'Performance of e-governance projects using big data' and big data related variables in the context of Aadhaar card services from UIDAI. Survey data have been analyzed to study the influence of big data related variables on the 'Performance of e-governance projects using big data'. The study is exploratory in nature, and a pilot survey was conducted to develop better insights about conceptual variables and refining them further before conducting a detailed study with a larger sample size and multiple projects to validate relationships between e-governance performance and big data related variables of 'e-governance projects using big data'. Hence, before conducting the main study, it was felt appropriate to conduct univariate analysis to develop better insights about the conceptualized research variables. The approach has helped in providing a better foundation for formulating research hypotheses for the main study.

3.2.1 Conceptual Research Variables

Based on an extensive review of literature, 'Performance of e-governance projects using big data' is viewed as consisting of four macro variables, viz., 'Efficiency' (EF), 'Transparency' (TR), 'Interactivity' (IN) and 'Decision support' (DS) (Suri, 2009) in the context of this study. The conceptualized variables to measure the 'Performance of e-governance projects using big data' are shown in Table 3.1 below.

Table 3.1: Conceptualized Variables to Measure 'Performance of E-Governance Projects using Big Data'

Macro variables	**Micro variables**	**Author(s)**
Efficiency (EF)	Fast execution of core process,	Maio et al. (2000); Heeks (2001); Bannister (2002); Vassilakis et al. (2003); Evans & Yen (2006); Harris (2007); Esteves & Joseph

	Simplification of processes, Reduced paperwork and Reduced cost	(2008); ARC (2008); UN (2008); Mofleh et al. (2009); Andersen et al. (2010); Scott et al. (2011); Karunasena & Deng (2012); Lindgren (2013); Planning Commission, UNESCO (2013)
Transparency (TR)	Reliable information, Comprehensive information, Easy access to information and Fairness/ Reduced corruption	World Bank (2000); Bannister (2002): Danziger & Andersen (2002); OECD (2003); Bhanagar (2004); Tan et al. (2005); Harris (2007); Planning Commission (2007a, b); DeitY (2008); Esteves & Joseph (2008); Andersen et al. (2010); Harrison et al. (2011); Scott et al. (2011); Suri and Sushil (2011); Karunasena & Deng (2012); Alawneh et al. (2013); UNESCO (2013)
Interactivity (IN)	Improved interaction, Participative and Consensus-oriented	Heeks (2001); Bannister (2002); OECD (2003); Bhatnagar (2004); Jaeger (2005); Tan et al. (2005); Evans & Yen (2006); Mofleh et al. (2009); DeitY (2008); Esteves & Joseph (2008); UN (2008); Gauld et al. (2010); Andersen et al. (2010); Valdes et al. (2011); Karunasena & Deng (2012); Lindgren (2013); UNESCO (2013); Napitupulu et al. (2014)
Decision support (DS)	Improved planning, Improved decision-making, Better Monitoring & control and Accountability	Bannister (2002); Bhatnagar (2004); Evans & Yen (2006); DeitY (2008); UN (2008); Andersen et al. (2010); Wieder & Ossimitz (2015)

[Source: Adapted from Suri (2009)]

The critical success factors (CSFs) that influence ‘Performance of e-governance projects using big data’ (EGP) are categorized into five macro constructs including: ‘Information and data’, ‘Information technology’, ‘Organization and management’, ‘Law and regulation’ and ‘Institution and environment’ (Gil-Garcia Ramon, J., and Pardo Theresa, A., 2005; Bierig et al., 2014 and Al-Sai et al., 2020). The CSFs affecting the ‘Performance of e-governance projects using big data’ are shown in Table 3.2 below. The pilot study is designed to explore the linkage between these big data related variables and the ‘Performance of ‘e-governance projects using big data’. For this purpose, a survey of citizen-centric e-governance projects was conducted.

Table 3.2: CSFs affecting 'Performance of E-Governance Projects using Big Data'

Macro variable	**Micro variables**	**Author(s)**
Information and data (ID)	Accuracy; consistency; completeness; appropriateness, data standards, structures, privacy and security	Dawes (1996); Ballou and Tayi (1999); Kaplan et al. (1998); Redman (1998); Tayi & Ballou (1998); Brown (2000); Ambite et al. (2002); Burbridge (2002); Brown & Brudney (2003); Gorton, et al. (2008); Field (2009); Bierig et al. (2014); Napitupulu et al. (2014); Wamba, et al. (2015)
Information technology (IT)	Infrastructure; accessibility; availability; privacy and security; usability; interoperability; training and capacity building; information, system and service quality	Davis (1989); DeLone & Mclean (1992); Barki et al. (1993); Dawes & Nelson (1995); Dawes (1996); Caffrey (1998); Chengalur-Smith & Duchessi (1999); Brown (2000); Milner (2000); Irvine (2000); Brown (2001); Landsberg & Wolken (2001); West & Berman (2001); Burbridge (2002); Dawes & Pardo (2002); Ho (2002); Joshi et al. (2002); Moon (2002); DeLone & Mclean (2003); Garson (2003); Holden et al. (2003); Luna-Reyes and Gil-Garcia (2003); Mahler & Regan (2003); Roy (2003); ARC (2008); Sukyoung et al. (2008); Frederiksen (2012); Wamba et al. (2015)
Organization and management (OM)	Management support; leadership; vision, objectives, targets and outcomes; skilled resources; project planning and management; BPR; training to resources	McFarlan (1989); Davis (1982); Barki et al. (1993); Dawes and Nelson (1995); Dawes (1996); Best (1997); Caffrey (1998); Bellamy (2000); Heintze & Bretschneider (2000); Jiang & Kleing (2000); Barret & Green (2001); Gagnon (2001); Smith et al. (2001); Burbridge (2002); Dawes & Pardo (2002); Ho (2002); Brown (2003); Brown & Brudney (2003); Edmiston (2003); Kim and Kim (2003); Rocheleau (2003); Roy (2003); ARC (2008); Sukyoung et al. (2008); Almarabeh and AbuAli (2010); Frederiksen (2012); Ziemba et al. (2013); Napitupulu et al. (2014)
Law and regulation (LR)	Political will and support; budget allocation and disbursement; coordination between government agencies; flexible policy and legal frameworks	Dawes & Nelson (1995); NGA (1997); Landsbergen & Wolken (1998); Chengalur-Smith & Duchessi (1999); Bellamy (2000); Harris (2000); Fountain (2001); Landsberg & Wolken (2001); Burbridge (2002); Dawes & Pardo (2002); Mahler & Regan (2002); Rocheleau (2003); Almarabeh and AbuAli (2010); Ziemba et al. (2013); Napitupulu et al. (2014)

Institution and environment (IE)	Project Mode: PPP; standardization and benchmarking; reduced dependencies on multiple departments	Andersen & Dawes (1991); Dawes (1996); Caffrey (1998); Bajjaly (1999); Heintze &Bretschneider (2000); Milner (2000); Fountain (2001); Landsberg & Wolken (2001); Dawes & Pardo (2002); Ho (2002); Joshi et al. (2002); La Porte et al. (2002); Mahler & Regan (2002); Moon (2002); Brown & Brudney (2003); Duncan & Roehrig (2003); Edmiston (2003); Holden et al. (2003); Rocheleau (2003); Roy (2003); Almarabeh and AbuAli (2010); Ziemba et al. (2013); Napitupulu et al. (2014); Wang (2019); Sahani & Thakur (2021)

[Source: Adapted from Gil-Garcia Ramon, J., & Pardo Theresa, A. (2005); Bierig et al. (2014)]

Figure 3.1 depicts the conceptual model for set of variables influencing 'Performance of e-governance projects using big data'.

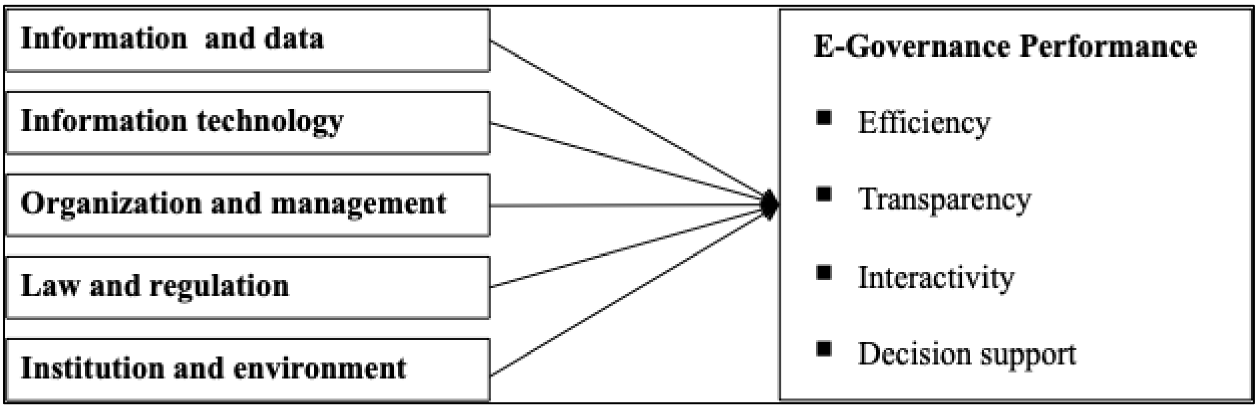

Figure 3.1: Conceptual Model for Set of Variables influencing 'Performance of E-Governance Projects using Big Data'

3.3 A Brief Description of Pilot Project: Aadhaar card services from Unique Identification Authority of India (UIDAI) [https://uidai.gov.in/]

Aadhaar, a unique identification number issued to residents of India, is a part of the digital identity systems that have been gaining popularity in recent years. The system has over one billion registrants and is designed to provide a unique identity to every resident of India, irrespective of their socio-economic status, religion, caste, or creed. The biometric and demographic data of an individual are linked to the Aadhaar number, which is stored in a centralized database maintained by the Unique Identification Authority of India (UIDAI). The UIDAI is a statutory authority established under the Aadhaar Act, 2016, which is responsible for the enrolment and authentication of Aadhaar numbers. The biometric data includes fingerprints and iris scans, while the demographic data includes name, address, date of birth, and gender. Digital identity systems consist of identification, authentication, and authorization components critical for accessing online services such as e-commerce and e-governance. Aadhaar is an online, digital, and paperless identity system that facilitates the delivery of various government subsidies and services to the citizens. It also enables financial inclusion by providing a means of identification for opening bank accounts and availing other financial services. The system was created in 2009 as part of the National e-Governance Plan (NeGP) to provide a platform for identification and eliminate fake identity issues while facilitating the delivery of government benefits based on demographic and biometric data available with the Authority. Centralized and decentralized identity models are two different types of digital identity systems. Centralized Identity models include state-issued electronic identity and monolithic identity providers, such as Google and Facebook logins. On the other hand, decentralized identity models include identity brokers, personal identity provider models, and blockchain identity providers. Aadhaar is an example of a centralized identity architecture model that has been designed to promote financial inclusion, reduce fraud, provide efficient service delivery, enable political empowerment, and facilitate economic growth and security in India.

Big data initiatives at UIDAI

The UIDAI has been involved in several big data initiatives since its establishment. UIDAI's big data initiatives have been instrumental in handling, managing and analyzing the vast amount of data generated by the Aadhaar system. These initiatives have helped UIDAI to enhance the security, accessibility, and effectiveness of Aadhaar, and they have had a significant impact on the lives of millions of people in India. Table 3.3 below describes a chronological sequence of some of the key initiatives at UIDAI.

Table 3.3: Description of Key initiatives at UIDAI

Year	**Initiative/ Launch**	**Description**
2010	Aadhaar Enrollment	Aadhaar enrollment process, which involved the collection of biometric and demographic data of residents of India and the issuance of a unique 12-digit identification number called Aadhaar.
2010	Aadhaar Authentication	Aadhaar authentication initiated, which allowed individuals to use their Aadhaar number to authenticate their identity for various purposes, such as

		opening bank accounts, availing government subsidies, and accessing government services.
2011	Aadhaar Enabled Payment System (AEPS)	AEPS launched, which enabled Aadhaar-linked bank accounts to be used for financial transactions, promoting financial inclusion and made it easier for people to access financial services.
2012	Central ID Repository (CIDR)	CIDR, central database that stores the biometric and demographic data of all Aadhaar holders, using distributed computing and storage systems to handle the massive amount of data generated by the Aadhaar system.
2013	Aadhaar Dashboard	Aadhaar Dashboard launched, which is an interactive web-based platform that provides real-time information on the number of Aadhaar enrollments and authentication transactions across India. The dashboard provides insights into Aadhaar usage patterns, such as the number of transactions per state and the types of authentication methods used.
2015	Aadhaar Analytics	Aadhaar Analytics launched, which is an analytics platform that uses big data technologies to analyze Aadhaar usage patterns and demographics. The platform provides insights into Aadhaar usage for different government programs, helping policymakers to make data-driven decisions.
2017	mAadhaar Mobile App	mAadhaar mobile app launched, which allowed individuals to download and carry a digital copy of their Aadhaar card on their mobile phones. This initiative aimed at making Aadhaar more accessible and convenient for people, especially those who may not have a physical copy of their Aadhaar card.
2017	Aadhaar Data Vault	Aadhaar Data Vault launched, which is a secure digital locker that allows Aadhaar holders to store their personal documents such as PAN card, driving license, voter ID, and educational certificates. The data is encrypted and stored securely, and Aadhaar holders can access it using their Aadhaar number and biometric authentication.
2018	Aadhaar Intelligence	Aadhaar Intelligence launched, which is an analytics platform that uses artificial intelligence and machine learning algorithms to analyze Aadhaar data. The platform can detect patterns and anomalies in the data, helping UIDAI to identify potential fraud and misuse of Aadhaar data.
2018	Aadhaar Paperless Offline eKYC	Aadhaar Paperless Offline eKYC launched, which allowed individuals to authenticate their identity without the need for an Internet connection or biometric authentication. This initiative was aimed at promoting ease of use and reducing the dependency on physical documents.
2018	Virtual ID	VID system launched, which allowed individuals to generate a temporary 16-

	(VID)	digit number instead of sharing their Aadhaar number for authentication purposes. This initiative aimed to enhance the security and privacy of Aadhaar by reducing the need to share the actual Aadhaar number.
2018	Face authentication	Face authentication introduced as an additional mode of authentication in October 2018, to enhance the security of Aadhaar authentication. This feature enables residents to authenticate their identity using their face as an additional factor along with their biometric and demographic details.
2019	Aadhaar authentication history	In January 2019, UIDAI launched the Aadhaar Authentication History service, which enables residents to check the history of their Aadhaar authentication requests. This feature helps residents keep track of their Aadhaar authentication requests and identify any unauthorized usage of their Aadhaar number.
2019	QR code-based e-Aadhaar	QR code-based e-Aadhaar introduced in October 2019, which enables residents to download their Aadhaar card with a QR code that can be used for offline verification of identity.

[Compiled from: https://uidai.gov.in/; https://en.wikipedia.org/wiki/Aadhaar; Krishna (2020)]

Roadmap

The UIDAI is continuously striving to improve the Aadhaar system through various initiatives. Some of the recent and ongoing initiatives include the launch of Aadhaar Authentication version 2.0 with enhanced security features, the introduction of a PVC-based Aadhaar card with better durability and security, and the development of an Aadhaar-based health ID that will provide digital access to health records and prescriptions. In addition, the UIDAI has also launched a service for Non-Resident Indians (NRI) to apply for an Aadhaar card using their Indian passport, regardless of their current residency. The UIDAI is also working on enabling Aadhaar-based payments using the UPI platform, which will allow individuals to make payments using their Aadhaar number instead of their bank account details.

3.4 Questionnaire Development and Data Collection

Questionnaire was designed and developed based on the inputs from expert interviews and understanding developed through a review of literature. The draft questionnaire was again given to four experts for their inputs and feedback. After making necessary improvements, it was further distributed to a few respondents to get their feedback with respect to understanding of the contents of the questionnaire. Feedback was further incorporated before distributing the questionnaire to the respondents.

The survey was conducted in Delhi, India in August 2015. The survey was conducted online through Google form. Around 74 implementers were approached but a few of them were not willing to fill the questionnaire due to lack of time or other reasons. The questionnaire was given to around 60 respondents but was completed by 51 respondents. The response rate was about 85% which is considered acceptable for the pilot study. Data was collected by using a five-point Likert-type scale. In the five-point Likert-type scale used in this study, the value ‘1’ represents ‘Strongly Disagree’, and the value ‘5’ represents ‘Strongly Agree’.

3.4.1 Reliability and Validity Analysis

The internal consistency of items in a construct is measured using Cronbach alpha. The Cronbach alpha values of constructs, i.e., ‘Performance of e-governance projects using big data’ and big data related variables were found to be more than 0.85 respectively. The values above 0.6 are considered acceptable for this kind of empirical research (Hair et al., 2006; George and Mallery, 2011).

3.5 Analysis and Discussion

The descriptive statistics in Table 3.4 below shows the values of range, mean and standard error of the study variables. The relatively higher values of observed mean for ‘Decision support’ (DS) and ‘Information and data’ (ID) indicate their higher significance. This may be because of the use of big data in e-governance project that may have influenced the ‘Performance of the e-governance projects using big data’. The next higher value of observed mean is for ‘Institution and environment’ (IE), that shows that the issues and challenges related to institutional framework and the policy environment are taken care of. The next set of variables with values of observed means higher than the medium level are ‘Law and regulation’ (LR) and ‘Efficiency’ (EF) that is also a positive sign that shows that the e-governance projects are able to increase the efficiency of the government processes that is enhancing the ‘Performance of e-governance project using big data’ for the citizens.

Table 3.4: Univariate Statistical Analysis

Pilot Study Descriptive Statistics							
	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
EGP	51	3.653	1.000	4.653	3.183	0.967	0.938
EF	51	3.600	1.000	4.600	3.217	0.911	0.831
TR	51	3.450	1.000	4.450	3.179	0.959	0.921
IN	51	3.562	1.000	4.562	3.067	0.999	1.000
DS	51	4.000	1.000	5.000	3.269	0.998	0.998
ID	51	4.000	1.000	5.000	3.273	1.067	1.140
IT	51	3.742	1.000	4.742	3.195	1.022	1.045
OM	51	4.000	1.000	5.000	3.180	1.081	1.170
LR	51	4.000	1.000	5.000	3.218	1.116	1.246
IE	51	4.000	1.000	5.000	3.261	1.085	1.178
Valid N (listwise)	51						

- Variables: EGP = 'E-Governance Performance'; EF = 'Efficiency'; TR = 'Transparency'; IN = 'Interactivity'; DS = 'Decision support'; ID = 'Information and data'; IT = 'Information technology'; OM = 'Organization and management'; LR = 'Law and regulation'; IE = 'Institution and environment'
- N = Sample size
- 1=Strongly Disagree, 2=Disagree, 3=Can't Say, 4=Agree, 5=Strongly Agree

The observed average (3.183) of 'E-Governance Performance' (EGP) in the context of Aadhaar card services e-governance project is found to be above the medium level. This shows that the perception of implementers in terms of the 'Performance of e-governance project using big data' is quite positive that is enhanced through use of big data. The variable that has the least value of observed means is 'Interactivity' (IN) that is still a concern for the citizens'. E-governance systems may provide improved interaction among different set of stakeholders like staff within same department, staff from related departments and interaction with the citizens. E-governance systems may be made more participative and consensus-oriented. The values of observed means for all constituents of 'e-governance performance' (EGP) are above medium level that shows that there is improvement in 'Efficiency', 'Transparency', 'Interactivity' and 'Decision support' because of the use of big data. There is positive relationship between variables constituting 'e-governance performance' and big data related variables that influence the 'Performance of e-governance projects using big data'. This shows that big data related variables may influence the ‘Performance of e-governance projects using big data’. The observed mean of all big data related variables, ‘Information and data’ (ID), ‘Information technology’ (IT), ‘Organization and management’ (OM), ‘Law and regulation’ (LR) and ‘Institution and environment’ (IE) are above the medium level. This shows that these variables do influence the ‘Performance of e-governance projects using big data’. ‘Information and data’ (ID) has the maximum value of observed mean (3.273) out of all big data related variables, that shows that information and data are very important for the successful implementation of e-governance projects using big data. ‘E-governance projects using big data’ provides quality support for accurate, relevant, and up-to-date information and data, along with privacy and security following compliance guidelines. Similarly the ‘Decision support’ (DS) has the maximum value of observed means (3.269) out of all variables constituting the ‘Performance of e-governance projects using big data’, this shows that the decision support capability is improved extensively because of the use of big data in e-governance proejcts. This falls in line with the trends in the Aadhaar card services from UIDAI where the decision support for all stakeholders is improved because of use of big data in Aadhaar card services. This includes improved planning for citizens, departments, policy-makers, etc. They are able to take timely, fast, accurate, informed and data-driven decisions that facilitate better monitoring and control by government and related deaprtments. This makes the governments more accountable for easy access to effective services, meeting stated objectives with increased response safeguarding the citizens’ interests.

3.6 Pilot Study Findings

The study proposed a framework for assessing the performance of a citizen centric e-governance project. The research proposed the big data related variables that may influence the ‘Performance of e-governance projects using big data’ measured in terms of conceptualized variables ‘Information and data’ (ID), ‘Information technology’ (IT), ‘Organization and management’ (OM), ‘Law and regulation’ (LR) and ‘Institution and environment’ (IE). One citizen centric e-governance project on Aadhaar card services from UIDAI was selected to conduct the pilot study. A survey of respondents was conducted to measure the performance of Aadhaar project and influencing variables. As per the univariate analysis performed the ‘Performance of e-governance projects using big data’ and the associated big data related variables are expected to have a positive relationship. As per the results of the pilot study, Aadhaar has high value of performance as well as big data related variables. This reflects that we need to have a citizen centric approach in G2C e-governance projects for better performance. The pilot study suggests that it may be possible that big data related variables may be influencing the ‘Performance of e-governance projects using big data’.

3.7 Concluding Remarks

The pilot study, conducted as a precursor to the main study, has helped in developing a better understanding of the ‘Performance of e-governance projects using big data’ and big data related variables that influence the performance of e-governance projects. The univariate analysis of a citizen-centric e-governance project selected in the pilot study has revealed that big data related variables may be influencing the ‘Performance of e-governance projects using big data’. The study has provided the required insights for enriching research variables which form part of the main study design as discussed in the next chapter.

Chapter 4

Research Design

4.1 Introduction

Citizens avail multiple services offered by government organizations. These government organizations may or may not be within same location or State. Data is generated through the extensive set of transactions within and across the government organizations and hence measuring the performance of e-governance projects that use big data is a major subject area in itself. The purpose of this study is to analyze 'e-governance performance' for the e-governance projects that use big data. To achieve this objective, a research framework is conceptualised. This chapter highlights the research background for developing the proposed research framework. This framework hypothesizes that 'e-governance performance' is composed of four macro variables and these four macro variables, in turn, further comprise fifteen micro variables.

This chapter has been divided into two sections. A conceptual research framework is presented in the first section. The framework is supported by a literature review of variables related to use of big data and the 'Performance of e-governance projects using big data'. The literature review of study variables is presented in the form of tables. The research methodology that has been followed to conduct the study is presented in the second section of this study. This section proposes research hypotheses followed by detailed description of conceptual framework that has been used to identify the research variables. Two sets of hypotheses, i.e., one for the macro variables and the other for micro variables are formulated. This is followed by an overview of the different research methodologies used for the study, i.e., qualitative and quantitative techniques. For the qualitative research analysis, Total Interpretive Structural Modeling with Polarity (TISM-P) and for the quantitative research analysis, Partial Lease Squares-Structural Modeling (PLS-SEM) have been used. Further, a flow chart depicting the steps of research adopted to conduct this study has been presented. Finally, brief description of projects selected for study has been presented followed by the development of the questionnaire for survey, pilot testing, sampling method, the collection of data and tools used to analyze the data.

4.2 Research Variables constituting the ‘Performance of E-Governance Projects using Big Data’ (EGP)

‘Performance of e-governance projects using big data’ (EGP) is viewed as consisting of four macro variables, viz., ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS) (Suri, 2009). Processes in e-governance projects are expected to simplify procedures, execute faster, minimize use of papers and save costs while communicating with the government. This is captured by this ‘Efficiency’ (EF) macro variable and related micro variables as explained above and depicted in Table 4.1 below. Government process using ICT, i.e., e-governance projects are expected to ‘execute faster’ by reducing the duplicate tasks, improving the service delivery, improving the work efficiency, service quality by faster delivery and response to the queries (Maio et al., 2000; Heeks, 2001; Bannister, 2002; Evans & Yen, 2006; Esteves & Joseph, 2008; UN, 2008; Mofleh et al., 2009; Andersen et al., 2010; Scott et al., 2011; Lindgren, 2013; Planning Commission, UNESCO, 2013; Dhanasekaran et al., 2018; Rahaman et al*.,* 2021). ‘Simplification of processes’ means that the processes are simple to understand for the user, simple to follow, user-centric, sustainable, improved and flexible with minimal data loss during processing (Maio et al., 2000; Bannister, 2002; Harris, 2007; ARC, 2008; UN, 2008; Mofleh et al., 2009; Karunasena & Deng, 2012; UNESCO, 2013). ‘Reduced paperwork’ may be there through the reduced dependencies on multiple departments, reduced number of documents required to fill for availing the e-governance services, and automatic integration with aadhaar without any extra effort separately (Heeks, 2001; Evans & Yen, 2006; Altameem et al., 2006; Planning Commission, 2007a, b; UN, 2008; Rahaman et al., 2021). ‘Reduced cost’ is there by using the e-governance project as use of IT is there to reduce the time, money and effort in offline processes (Heeks, 2001; Vassilakis et al., 2003; Evans & Yen, 2006; Karunasena & Deng, 2012; Planning Commission, 2013; Rahaman et al., 2021).

‘Transparency’ (TR) variable encompasses transparency aspect of a service. An e-governance service is expected to bring transparency in government-controlled operations. A government service has to be trustworthy, thorough, unbiased and accessible without any difficulty to end users. This will require the e-governance services to have ‘Reliable Information’ that is clear with no ambiguity, trustworthy, credible and from genuine sources (Bannister, 2002: OECD, 2003; DeitY, 2008; Andersen et al., 2010; Suri and Sushil, 2011; Karunasena & Deng, 2012; Wang, 2019; Al-Bahri et al., 2020;

Brinch et al., 2020; Rahaman et al., 2021). ‘Comprehensive Information’ means that the e-governance projects share the policies, processes, expenses, agreements, tenders, data and relevant information for the e-governance services, the policies are clear, information is thorough and relevant (World Bank, 2000; Bhanagar, 2004; DeitY, 2008; Harrison et al., 2011; Dhanasekaran et al., 2018; Brinch et al., 2020; Rahaman et al., 2021). ‘Easy access to information’ will include information that is easily accessible from anywhere, is current and distributed to public in an effective manner (Bannister, 2002; Danziger & Andersen, 2002; Harris, 2007; DeitY, 2008; Esteves & Joseph, 2008; Scott et al., 2011; Suri and Sushil, 2011; Karunasena & Deng, 2012; Alawneh et al., 2013; UNESCO, 2013; Dhanasekaran et al., 2018; Rahaman et al., 2021). ‘Fairness’ means that there is reduced corruption as there are no middlemen involved, information is unbiased, there is overall transparency in the processes and information is of high quality (Bannister, 2002; OECD, 2003; Tan et al., 2005; Planning Commission, 2007a, b; Harris, 2007; DeitY, 2008; UNESCO, 2013; Rahaman et al., 2021).

‘Interactivity’ (IN) variable is conceptualized to capture various types of interactions at different levels while availing an e-governance service. An e-governance service targeting citizens is expected to facilitate interactions at various levels, i.e., within constituting units of a government department, with other departments associated with the service and with recipient of the service. ‘Improved interaction’ is assessed by the size and number of transactions by the beneficiaries, improved interaction of beneficiary with internal staff within same department, interaction among staff, interaction with officials of related departments and interactions of officials with citizens or beneficiaries (Heeks, 2001; Bannister, 2002; OECD, 2003; Bhatnagar, 2004; Jaeger, 2005; Tan et al., 2005; Evans & Yen, 2006; Mofleh et al., 2009; DeitY, 2008; Esteves & Joseph, 2008; UN, 2008; Gauld et al., 2010; Andersen et al., 2010; Valdes et al., 2011; Karunasena & Deng, 2012; Lindgren, 2013; UNESCO, 2013; Napitupulu et al., 2014; Dhanasekaran et al., 2018; Al-Bahri et al., 2020; Rahaman et al., 2021). ‘Participative’ means that for beneficiaries there is more particiaption in government processes, provision to submit proposals on government plans, participation in government decision-making, free and open dialogue with government through online platforms and user-friendly systems (DeitY, 2008; UN, 2008; Napitupulu et al., 2014; Dhanasekaran et al., 2018; Al-Bahri et al., 2020; Rahaman et al., 2021). ‘Consensus-oriented’ means the government decisions are made with deep understanding of the community considering cultural, social and historical diversity (UN, 2008; Dhanasekaran et al., 2018).

Table 4.1: Mapping with Literature: Variables constituting 'Performance of E-Governance Projects using Big Data'

Macro Variable	Micro Variable	Items	Author(s)
'Efficiency' (EF)	'Fast execution of core process'	Improved service delivery	Maio et al. (2000); Heeks (2001); Bannister (2002); Evans & Yen (2006); Esteves & Joseph (2008); UN (2008); Mofleh et al. (2009); Andersen et al. (2010); Scott et al. (2011); Lindgren (2013); Planning Commission, UNESCO (2013); Dhanasekaran et al. (2018); Rahaman et al. (2021)
		Reduction in duplicate tasks	
		Improved work efficiency	
		Improved service quality	
		Speed of response to queries	
		Speed of delivery	
	'Simplification of processes'	Simple to understand processes	Maio et al. (2000); Bannister (2002); Harris (2007); ARC (2008); UN (2008); Mofleh et al. (2009); Karunasena & Deng (2012); UNESCO (2013); Al-Sai et al. (2020)
		Simple to follow processes	
		User-centric processes	
		Sustainable processes	
		Improved and flexible work processes	
		Minimal data loss during processing	
	'Reduced paperwork'	Reduced dependencies on multiple departments	Heeks (2001); Altameem et al. (2006); Evans & Yen (2006); Planning Commission (2007a, b); UN (2008); Rahaman et al. (2021)
		Reduced number of documents required to fill	
		Reduced number of supporting documents required to submit	
		Reduced dependence on printed material	
		Automatic integration with Aadhaar	

	'Reduced cost'	Reduced proportion of cost to citizen	Heeks (2001); Vassilakis et al. (2003); Evans & Yen (2006); Karunasena & Deng (2012); Planning Commission (2013); Rahaman et al. (2021)
		Reduced proportion of cost to government	
		Reduced communication cost	
		Use of IT to reduce cost	
		Reduced time for service	
'Transparency' (TR)	'Reliable information'	No ambiguity	Bannister (2002): OECD (2003); DeitY (2008); Andersen et al. (2010); Suri and Sushil (2011); Karunasena & Deng (2012); Wang (2019); Al-Bahri et al. (2020); Brinch et al. (2020); Rahaman et al. (2021)
		Trustworthy	
		Improvement in citizens' opinion collection and reflection	
		Credible	
		Genuine source	
	'Comprehensive information'	Sharing: Policies, processes, expenses, agreements, tenders, data and relevant information	World Bank (2000); Bhanagar (2004); DeitY (2008); Harrison et al. (2011); Dhanasekaran et al. (2018); Brinch et al. (2020); Rahaman et al. (2021)
		Clear policies	
		Thorough information	
		From all possible sources	
		Relevant	
	'Easy access to information'	Easily accessible	Bannister (2002); Danziger & Andersen (2002); Harris (2007); DeitY (2008); Esteves & Joseph (2008); Scott et al. (2011); Suri and Sushil (2011); Karunasena & Deng (2012); Alawneh et al. (2013); UNESCO (2013); Dhanasekaran et al. (2018); Rahaman et al. (2021)
		Access anywhere	
		Better distribution of public information/Information disbursement	
		Current information	
		Accessible without difficulty	
	'Fairness'	Reduced corruption as online	Bannister (2002); OECD (2003); Tan et al. (2005); Planning Commission (2007a, b); Harris (2007); DeitY (2008); UNESCO (2013); Rahaman et al. (2021)
		No middlemen	
		Unbiased information	
		Overall transparency level in government process	
		Quality of information	

'Interactivity' (IN)	'Improved interaction'	Size and number of transactions executed electronically	Heeks (2001); Bannister (2002); OECD (2003); Bhatnagar (2004); Jaeger (2005); Tan et al. (2005); Evans & Yen (2006); Mofleh et al. (2009); DeitY (2008); Esteves & Joseph (2008); UN (2008); Gauld et al. (2010); Andersen et al. (2010); Valdes et al. (2011); Karunasena & Deng (2012); Lindgren (2013); UNESCO (2013); Napitupulu et al. (2014); Dhanasekaran et al. (2018); Al-Bahri et al. (2020); Rahaman et al. (2021)
		Improved interaction with internal staff within same department	
		Improved interaction among internal staff within same department	
		Improved interaction with officials from related departments	
		Improved interaction with citizens	
		Improved interaction with government	
	'Participative'	Participation in government processes	DeitY (2008); UN (2008); Evers, 2014; Napitupulu et al. (2014); Eybers and Hattingh (2017); Dhanasekaran et al. (2018); Al-Bahri et al. (2020); Al-Sai et al. (2020); Rahaman et al. (2021)
		Provision for submission of proposals on government plans	
		Participation in government major decisions/decision-making	
		Free and open dialogues with government through various online platforms	
		Responsiveness/user-friendly system functioning	
	'Consensus-oriented'	Meeting expectations of diverse set of citizens	UN (2008); Dhanasekaran et al. (2018); Al-Sai et al. (2020)
		Decisions made with deep understanding of community	
		Cultural diversity taken into consideration	
		Social diversity taken into consideration	

		Historical diversity taken into consideration	
'Decision support' (DS)	'Improved planning'	Improved planning for citizens	Bannister (2002); Evans & Yen (2006); UN (2008); Andersen et al. (2010); Suri & Sushil (2017); Al-Sai et al. (2020); Sahani & Thakur (2021)
		Improved planning for departments	
		Improved planning for policy makers	
		Improved planning for staff	
		Improved planning for country	
	'Improved decision-making'	Timely decision-making	Bannister (2002); Evans & Yen (2006); UN (2008); Andersen et al. (2010); Wieder & Ossimitz (2015); Suri & Sushil (2017); Sahani & Thakur (2021)
		Fast decision-making	
		Accurate/correct decision-making	
		Rationale decision-making	
		Informed decision-making	
	'Better monitoring and control'	Better monitoring and control by internal officials/staff	Bhatnagar (2004); Al-Sai et al. (2020); Sahani & Thakur (2021)
		Better monitoring and control by beneficiaries	
		Better monitoring and control by government	
		Better monitoring and control by monitoring departments	
		Better monitoring and control by monitoring committees	
	'Accountability'	System Availability	DeitY (2008); UN (2008); Rahaman *et al.* (2021); Sahani & Thakur (2021)
		Easy access to services	
		Met stated objectives	
		Effective	
		Increased response	
		Safeguard interests	

[Source: Adapted from Suri (2009), Suri & Sushil (2017)]

'Decision support' (DS) means that the digitization of services and online transactions contribute to improved planning for citizens, departments, policy-makers, and staff (Bannister, 2002; Evans & Yen, 2006; UN, 2008; Andersen et al., 2010; Suri & Sushil, 2017; Sahani & Thakur, 2021). It facilitates better decision-making that is timely, fast, correct, rationale and informed (Bannister, 2002; Evans & Yen, 2006; UN, 2008; Andersen et al., 2010; Wieder & Ossimitz, 2015; Suri & Sushil, 2017; Sahani & Thakur, 2021). It makes the governments more accountable because of easy access to services that are more effective with increased response, meeting stated objectives with high system availability (DeitY, 2008; UN, 2008; Rahaman et al., 2021; Sahani & Thakur, 2021). It improves monitoring and control at the level of officials as well as beneficiaries (Bhatnagar, 2004; Sahani & Thakur, 2021), which is captured through this variable. For example, a beneficiary who has online access to list of wellness centers and doctors' information can schedule an appointment with the relevant specialist for the medical treatment. This micro-variable reflects better decision support in terms of improved planning and decision-making. The macro variables and respective micro variables for measuring the e-governance performance are mapped with the author(s) from the extensive literature review and are shown in Table 4.1 above.

4.3 Research Variables influencing the 'Performance of E-Governance Projects using Big Data' (EGP)

The critical success factors (CSFs) that influence the 'Performance of e-governance projects using big data' (EGP) are categorized into five macro constructs including: 'Information and data' (ID), 'Information technology' (IT), 'Organization and management' (OM), 'Law and regulation' (LR) and 'Institution and environment' (IE) (Gil-Garcia Ramon, J., and Pardo Theresa, A., 2005; Bierig et al., 2014 and Al-Sai et al., 2020). Information and data' (ID) are key for e-governance projects. E-governance initiatives involve capture, use, management, dissemination and sharing of data as well as the information. There are multiple perspectives of information and data that influence their effective and efficient usage. Researchers like Ballou and Tayi (1999), Kaplan et al. (1998), and Redman (1998) worked with their research focus on issues related to data quality and data accuracy. According to Redman (1998), 'data quality' issues include inaccuracies, incompleteness and inconsistencies of data. Kaplan et al. (1998) emphasize that 'data quality' is of utmost important not only for interorganizational usage but also for reporting to different set of stakeholders. Tayi and Ballou (1998) identify lack of appropriate data as a major challenge for IT initiatives like e-governance. Brown (2000) cautions that information quality problems should be properly addressed and should not be taken for granted. E-governance has extensive set of information and data that makes the information dynamic. Dawes (1996) address the issues of data structure and data definitions for getting better results. According to Dhanasekaran et al. (2018) use of big data allows governance a competitive advantage so the data from multiple heterogeneous government sources are combined to create the dynamic informtion. This further improves the services to citizens and businesses and even fraud detection and tax control activities. Wang (2019) highlighted that privacy and security concerns are of utmost importance as in era of big data, e-governance needs safer infrastructure, information storage and data application. Security threats may pose a bottleneck for e-governance development. Data preservation and curation become equally important. According to Wang (2019) information encryption ensures confidentiality and identity authentication to handle the privacy and security issues. According to Rahaman (2021) big data is the most applicable and critical factors for making e-government run. As per him the major challenge is to manage the privacy, security, data recovery and disaster management.

'Information technology' (IT) includes 'System usability' as an important factor to consider. 'System usability' would mean that whether the e-governance online system is user-friendly in making online transactions, it is usable from all operating systems or browsers like Chrome, Safari, Firefox, Edge, etc., system has high availability and is available 24X7 for the users, is easy to access, easy to use, does not have errors during the use, and finally it has online help and demonstrations for user to refer to (Davis, 1989; DeLone & Mclean, 1992; Caffrey, 1998; Brown, 2000; DeLone & Mclean, 2003; Garson, 2003; Mahler & Regan, 2003; Al-Bahri et al., 2020; Sahani & Thakur, 2021). 'Technology incompatibility' has also been defined as a major challenge for the IT-intensive projects like e-governance (Dawes, 1996; Chengalur-Smith & Duchessi, 1999; Brown, 2001; Landsberg & Wolken, 2001; Burbridge, 2002; Dawes & Pardo, 2002; Holden et al., 2003; ARC, 2008). This means the systems that are very different and old, increase the complexity of the projects and may make the systems difficult for beneficiary to use, especially when it comes to information integration (Barki et al., 1993; Dawes & Nelson, 1995; Caffrey, 1998; Chengalur-Smith and Duchessi, 1999; West & Berman, 2001; Ho, 2002; Garson, 2003; Roy, 2003; Sahani & Thakur, 2021). 'Complexity and newness of technology' are also important constraints for the 'Performance of e-governance projects using big data'. The relevant 'Technical skills' within the e-governance projects teams or the shortage of qualified technical human resources can hamper the project (Caffrey, 1998; Brown, 2001; Dawes & Pardo, 2002; Ho, 2002; Moon, 2002; Holden et al., 2003). On same lines the 'Techniques, algorithms and scalability' of project is very important form the future enhancements and overall maintenance (Barki et al., 1993; Sukyoung et al., 2008; Frederiksen, 2012; Wamba et al., 2015; Rahaman et al., 2021; Sahani & Thakur, 2021).

'Organization and management' (OM) factors play an important role as well for the 'Performance of e-governance projects using big data'. The 'project size' and the diversity of the users (McFarlan, 1989; Davis, 1982; Smith et al., 2001; Dawes & Pardo, 2002; Brown & Brudney, 2003; Roy, 2003; Napitupulu et al., 2014; Rahaman et al., 2021) and organizations involved are two major issues in this category (McFarlan, 1989; Barki et al., 1993; Sukyoung et al., 2008; Ziemba et al., 2013; Napitupulu et al., 2014). Planning and coordination majorly depend on the managers' attitudes and behaviour (Heintze & Bretschneider, 2000; Gagnon, 2001; Rahaman et al., 2021; Abanumay & Mezghani, 2022). There are other problems related to goals and objectives of the project (Dawes and Nelson, 1995; Dawes & Pardo, 2002; Brown, 2003; Kim and Kim, 2003; Frederiksen, 2012; Napitupulu et al., 2014; Brinch et al., 2020; Rahaman et al., 2021; Sahani & Thakur, 2021; Abanumay & Mezghani, 2022). First, there should be alignment between the organizational goals and the project. Especially in case of government, inter organizational challenges are difficult to handle. Second, individual interest, and associated behaviours lead to resistance to change, internal conflicts and other coordination issues (Barki et al., 1993; Dawes & Nelson, 1995; Dawes, 1996; Best, 1997; Caffrey, 1998; Jiang & Kleing, 2000; Bellamy, 2000; Barret & Green, 2001; Burbridge, 2002; Ho, 2002; Edmiston, 2003; Rocheleau, 2003; Roy, 2003; Brinch et al., 2020; Abanumay & Mezghani, 2022). It is very important to have 'qualified personnel' that possess the technical knowledge of the project, have technology management capabilities, efficient in learning new and latest technologies through training, and also have business and related knowledge for the successful implementation of the e-governance project (ARC, 2008; Sukyoung et al., 2008; Almarabeh and AbuAli, 2010; Frederiksen, 2012; Rahaman et al., 2021).

Most of the time government organizations are created and operate by virtue of specific rules. While taking any kind of decision, including the ones in e-governance projects, public managers and officers must take into account a large number of restrictive laws and regulations (Dawes & Nelson, 1995; NGA, 1997; Landsbergen & Wolken, 1998; Chengalur-Smith & Duchessi, 1999; Harris, 2000; Dawes & Pardo, 2002; Mahler & Regan, 2002; Napitupulu et al., 2014; Sahani & Thakur, 2021), e.g., till 2017 there were five year planned projects with provision of yearly budgets disbursement (Dawes & Nelson, 1995; Fountain, 2001; Dawes & Pardo, 2002; Almarabeh and AbuAli, 2010; Ziemba et al., 2013). This type of planning and budgeting impacts the project implementation as well. Federal systems as in the United States has additional constraints of relationships between different levels of governments (Bellamy, 2000; Harris, 2000; Landsberg & Wolken, 2001; Burbridge, 2002; Dawes & Pardo, 2002; Rocheleau, 2003) and formal checks and balances among the executive, legislative and judicial branches. This makes 'Law and regulation' (LR) variables important in terms of their impact on the e-governance projects.

Table 4.2: Mapping with Literature: Variables influencing the 'Performance of E-Governance Projects using Big Data'

Macro Variable	**Micro Variable**	**Items**	**Author(s)**
'Information and data' (ID)	Information and data quality	Complete	Dawes (1996); Ballou and Tayi (1999); Kaplan et al. (1998); Redman (1998); Tayi & Ballou (1998); Brown (2000); Ambite et al. (2002); Burbridge (2002); Napitupulu et al. (2014); Pradhan & Shakya (2018); Wang (2019); Al-Bahri et al. (2020); Rahaman et al. (2021)
		Accurate/correct	
		Consistent	
		Appropriate/relevant	
		Transparent/trust	
		Valid/ current/up-to-date	
	Dynamic information	Data standards followed	Brown & Brudney (2003); Gorton, et al. (2008); Field (2009); Wamba, et al. (2015); Eybers and Hattingh (2017); Dhanasekaran et al. (2018)
		Access to data/ Historical data	
		Data structures/formats	
		Compliance guidelines	
		Continuous feedback from users and partners	
	Privacy and security Open data	Anonymity maintained	Bierig et al. (2014); Cato (2015); Halaweh and Massry (2015); Mikalef et al., (2016);
		Preservation and curation (value from data)	

		Data not shared across users	Saltz and Shamshurin (2016); Kim and Park (2017); Félix et al. (2018); Wang (2019); Rahaman et al. (2021)
		Secure system with passwords	
		Data ownership	
'Information technology' (IT)	Usability	System is user-friendly in making transactions	Davis (1989); DeLone & Mclean (1992); Caffrey (1998); Brown (2000); DeLone & Mclean (2003); Garson (2003); Mahler & Regan (2003); Al-Bahri et al. (2020); Al-Sai et al. (2020); Sahani & Thakur (2021)
		Usable from all operating systems or browsers	
		High availability	
		Easy to access	
		Ease of use	
		No errors during use	
		Training, demonstrations, online help available	
	Security issues	Ownership	Milner (2000); Irvine (2000); Joshi et al. (2002); Moon (2002); Holden et al. (2003); Luna-Reyes and Gil-Garcia (2003); Roy (2003); ARC (2008); Wang (2019); Rahaman et al. (2021); Sahani & Thakur (2021)
		Open standards used	
		Secure technology	
		Sharing	
		Legal issues	
		Privacy issues	
	Technological compatibility/ interoperability	Clear cut interfaces	Dawes (1996); Chengalur-Smith & Duchessi (1999); Brown (2001); Landsberg & Wolken (2001); Burbridge (2002); Dawes & Pardo (2002); Holden et al. (2003); Arc (2008)
		Integrated with different systems	
		Different and old systems integration issues in complex systems	
		Different and old systems information integration issues in complex systems	
	Technology complexity/ newness	Simplification	Barki et al. (1993); Dawes & Nelson (1995); Caffrey (1998); Chengalur-Smith and Duchessi (1999); West & Berman (2001); Ho (2002); Garson
		Old systems	
		Complex systems	
		Integration issues	

			(2003); Roy (2003); Sahani & Thakur (2021)
	Technical skills and experience	Lack of relevant skills within project team	Caffrey (1998); Brown (2001); Dawes & Pardo (2002); Ho (2002); Moon (2002); Holden et al. (2003)
		Skilled and trained staff	
		Lack of experience	
		Lack of knowledge	
		Shortage of qualified staff	
	Techniques, algorithms & scalability	System is scalable	Barki et al. (1993); Sukyoung et al. (2008); Frederiksen (2012); Wamba et al. (2015); Rahaman et al. (2021); Sahani & Thakur (2021)
		Changes in work process/BPR	
		Uses faster algorithms	
		Simple algorithms	
		Best techniques/BPR	
'Organization and management' (OM)	Project size	Management Support	McFarlan (1989); Barki et al. (1993); Sukyoung et al. (2008); Ziemba et al. (2013); Napitupulu et al. (2014)
		Government Support	
		Project planning and management	
		Policy makers support	
	Manager's attitudes & behaviour	Planning	Heintze & Bretschneider (2000); Gagnon (2001); Rahaman et al. (2021); Abanumay & Mezghani (2022)
		Investment	
		Coordination	
		Control	
	Users or organizational diversity	Strong Leadership	McFarlan (1989); Davis (1982); Smith et al. (2001); Dawes & Pardo (2002); Brown & Brudney (2003); Roy (2003); Napitupulu et al. (2014); Rahaman et al. (2021)
		Diversity of users involved	
		Diversity of organizations involved	
		Flexible and efficient structure	
	Alignment & Awareness of organizational goals	Clear cut vision and milestones/targets/outcomes	Dawes and Nelson (1995); Dawes & Pardo (2002); Brown (2003); Kim and Kim (2003); Frederiksen (2012); Napitupulu et al. (2014); Brinch et al. (2020); Rahaman
		Measurable deliverables	
		Well-defined Goals	
		Well-defined objectives	

			et al. (2021); Sahani & Thakur (2021); Abanumay & Mezghani (2022)
	Resistance to change/internal conflicts	Individual interest	Barki et al. (1993); Dawes & Nelson (1995); Dawes (1996); Best (1997); Caffrey (1998); Bellamy (2000); Jiang & Kleing (2000); Barret & Green (2001); Burbridge (2002); Ho (2002); Edmiston (2003); Rocheleau (2003); Roy (2003); Brinch et al. (2020); Abanumay & Mezghani (2022)
		Conflicting attitude	
		Internal conflicts	
		Reluctant to change	
	Qualified Personnel/ Talent	Technical knowledge	ARC (2008); Sukyoung et al. (2008); Almarabeh and AbuAli (2010); Frederiksen (2012); Rahaman et al. (2021)
		Service-oriented	
		Technology Management Capability	
		Efficient	
		Training to resources	
		Skilled resources	
		Business Knowledge	
		Relational Knowledge	
'Law and regulation' (LR)	Conducive laws and regulations	State/Central conflict	Dawes & Nelson (1995); NGA (1997); Landsbergen & Wolken (1998); Chengalur-Smith & Duchessi (1999); Harris (2000); Dawes & Pardo (2002); Mahler & Regan (2002); Napitupulu et al. (2014); Kim and Park (2017); Sahani & Thakur (2021)
		Flexible Policy/legal Frameworks Information technology policies and standards	
		Formal checks	
		Integration between stakeholders	
		Big data evaluation & benchmarking	
		Executive, judicial and legislation	
		Supportive costing	

	Cost structures, Budgeting, Budget allocation & disbursement	Subsidized facilities	Dawes & Nelson (1995); Fountain (2001); Dawes & Pardo (2002); Almarabeh and AbuAli (2010); Ziemba et al. (2013); Al-Sai et al. (2020)
		Standardization and Bench marking	
		Sufficient/ Adequate budget	
		Timely disbursement	
	Intergovernmental relationships	IT to communicate with other departments	Bellamy (2000); Harris (2000); Landsberg & Wolken (2001); Burbridge (2002); Dawes & Pardo (2002); Rocheleau (2003); Al-Sai et al. (2020)
		Policies to integrate	
		Standards	
		Seamless integration	
'Institution and environment' (IE)	Privacy and related security concerns	Public policy/ Executive leadership or sponsorship	Andersen & Dawes (1991); Caffrey (1998); Milner (2000); Joshi et al. (2002); Moon (2002); Duncan & Roehrig (2003); Edmiston (2003); Holden et al. (2003); Wang (2019)
		Well-defined privacy rules/ Legislative support	
		Security as per defined laws	
		Well-stated privacy and security laws/rules	
	Autonomy of agencies	Executive leadership support	Dawes (1996); Caffrey (1998); Fountain (2001); Landsberg & Wolken (2001); Dawes & Pardo (2002); Al-Sai et al. (2020)
		Sponsorship	
		Legislative support	
		Freedom but not silos	
	Policy and political pressures	Public-private partnerships	Bajjaly (1999); Heintze & Bretschneider (2000); Mahler & Regan (2002); Brown & Brudney (2003); Edmiston (2003); Rocheleau (2003); Roy (2003); Almarabeh and AbuAli (2010); Sahani & Thakur (2021)
		Political will and support	
		Skilled HR to overcome	
		Transparent systems	
		Conducive policies	
	Environmental	Strategic outsourcing	Heintze & Bretschneider (2000); Ho (2002); La Porte et al. (2002); Edmiston (2003); Holden et al. (2003); Brown & Brudney (2003
		Social	
		Economic	
		Demographic	

[Source: Adapted from Gil-Garcia Ramon, J., & Pardo Theresa, A. (2005); Bierig et al. (2014) & Al-Sai et al. (2020)]

‘Institution and environment’ (IE) variables are related to more general institutional framework and the policy environment in which the government organizations operate. This is apart from the laws and the regulations that include norms, actions, or behaviours that people accept as good or take for granted. ‘Privacy and related security concerns’ should be properly addressed (Andersen & Dawes, 1991; Caffrey, 1998; Milner, 2000; Joshi et al., 2002; Moon, 2002; Duncan & Roehrig, 2003; Edmiston, 2003; Holden et al., 2003; Wang, 2019). ‘Agency autonomy’ is not there in legal framework but agencies act as autonomous bodies and act independently that affects the technology integration and information sharing across multiple government agencies (Dawes, 1996; Caffrey, 1998; Fountain, 2001; Landsberg & Wolken, 2001; Dawes & Pardo, 2002). External pressures like policy agenda also play role in affecting the e-governance projects (Bajjaly, 1999; Heintze & Bretschneider, 2000; Mahler & Regan, 2002; Brown & Brudney, 2003; Edmiston, 2003; Rocheleau, 2003; Roy, 2003; Almarabeh and AbuAli, 2010; Sahani & Thakur, 2021). The success depends not only on selecting right technology but also managing these regulatory constraints and environmental pressures (Heintze & Bretschneider, 2000; Ho, 2002; La Porte et al., 2002; Edmiston, 2003; Holden et al., 2003; Brown and Brudney, 2003). The macro variables and respective micro variables that are expected to influence the e-governance performance are mapped with the author(s) based on literature review and summarized in Table 4.2 above.

4.4 Conceptual Research Framework

Based on a review of the literature and keeping the research objectives in view, a conceptual framework to assess the ‘Performance of the e-governance projects using big data’ (EGP) in India is presented in Figure 4.1 below. The proposed conceptual framework is constituted of nine macro variables and thirty seven micro variables. Figure 4.1 depicts the possible linkages of the main dimensions with the constituents of outcome variable, i.e., ‘Performance of e-governance projects using big data’ (EGP). The macro variables along with their micro variables have been summarized in Table 4.1. It is conceptualized that big data related variables may be influencing ‘Performance of e-governance projects using big data’.

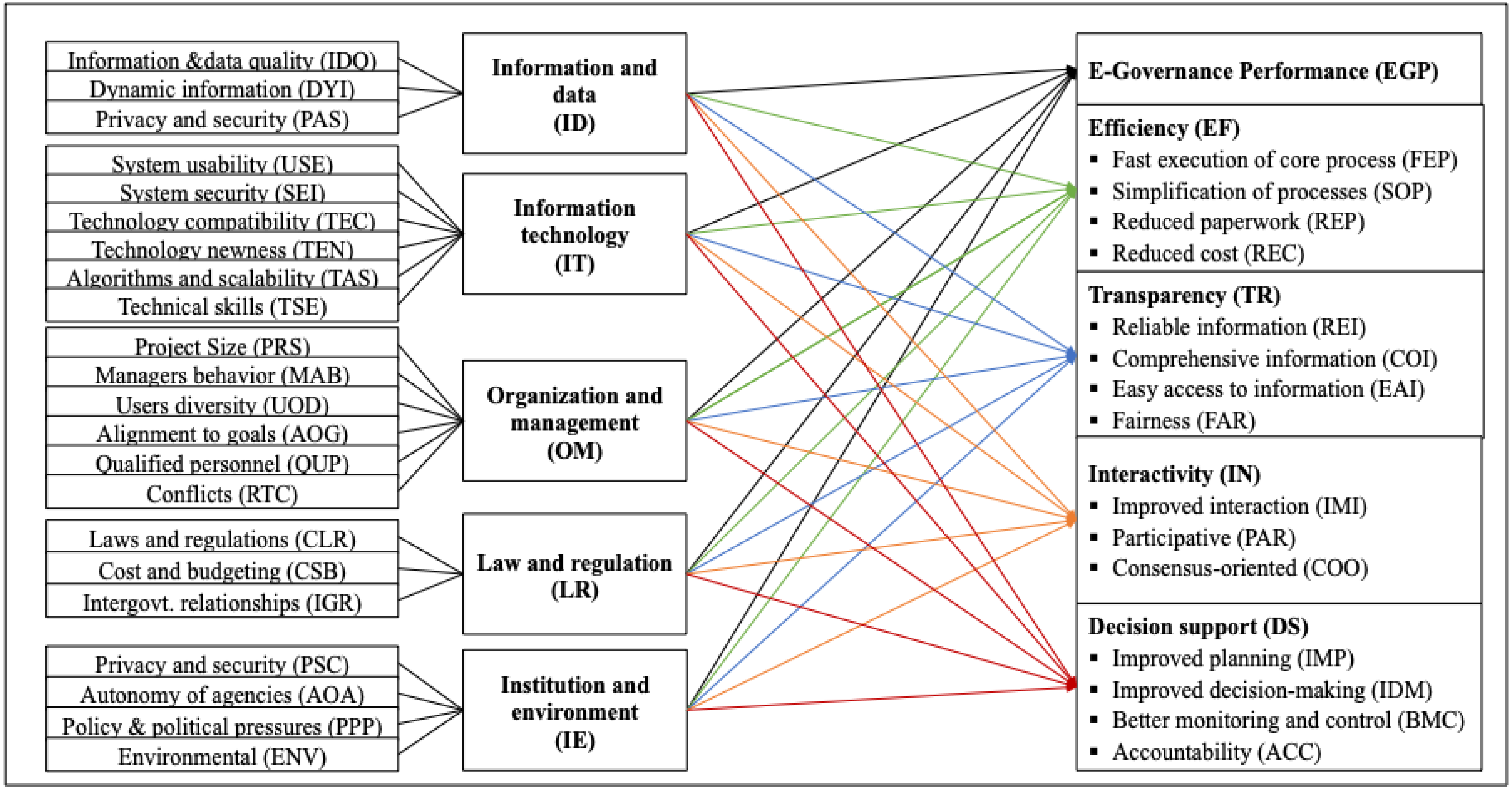

Figure 4.1: Conceptual Research Framework

4.5 Formulation of Research Hypotheses

An extensive review of literature helped in identification of research variables. These include variables to assess the 'Performance of e-governance projects using big data' and big data related variables that are expected to influence the 'Performance of e-governance projects using big data'. A conceptual research framework has been developed (Figure 4.1) based on these identified variables. Conceptual variables that constitute e-governance performance are: 'Efficiency' (EF), 'Transparency' (TR), 'Interactivity' (IN) and 'Decision support' (DS). The big data related variables identified in the study context are: 'Information and data' (ID), 'Information technology' (IT), 'Organization and management' (OM), 'Law and regulation' (LR) and 'Institution and environment' (IE). In view of the research objectives and the conceptual framework, a set of null as well alternate hypotheses are formulated for empirical testing of the conceptual framework. These hypotheses are described in Table 4.3 below.

4.6 Research Methodology for Qualitative Study

The research methodology applied for conducting research acts as a skeleton around which a study accomplishes its research objectives (Creswell, 2009). A qualitative research methodology seems to be appropriate for the research through which expert opinion can be obtained.

4.6.1 Qualitative Research

The qualitative research technique involves an interpretive attitude of the investigator who focuses on the subject within the perspective and employs a promising plan where groups or classes are recognized during the action (Collis and Hussey, 2013). The benefit of using the qualitative research is due to the features like flexibility, which allows it to respond to the changing environment, it has a relatively small number of participants mostly domain experts and it has a great involvement of the researcher who has own functional experience. Qualitative data collected from the respondent for research can be analyzed using different techniques like SAP-LAP (Sushil, 2000), ISM (Warfield, 1974), TISM (Sushil, 2012), TISM-P (Sushil, 2018), etc. For this study, TISM-P has been used.

Table 4.3: Null and Alternate Hypotheses for the Research

Null Hypotheses		Alternate Hypotheses	
S. No.	**Description**	**S. No.**	**Description**
H01	‘Information and data’ does not influence the ‘Performance of e-governance projects using big data’.	HA1	‘Information and data’ influence the ‘Performance of e-governance projects using big data’.
H02	‘Information technology’ does not influence the ‘Performance of e-governance projects using big data’.	HA2	‘Information technology’ influences the ‘Performance of e-governance projects using big data’.
H03	‘Organization and management’ does not influence the ‘Performance of e-governance projects using big data’.	HA3	‘Organization and management’ influence the ‘Performance of e-governance projects using big data’.
H04	‘Law and regulation’ does not influence the ‘Performance of e-governance projects using big data’.	HA4	‘Law and regulation’ influence the ‘Performance of e-governance projects using big data’.
H05	‘Institution and environment’ does not influence the ‘Performance of e-governance projects using big data’.	HA5	‘Institution and environment’ influence the ‘Performance of e-governance projects using big data’.
H06	‘Information and data’ does not influence the ‘Efficiency’ of ‘e-governance projects using big data’.	HA6	‘Information and data’ influence the ‘Efficiency’ of ‘e-governance projects using big data’.
H07	‘Information technology’ does not influence the ‘Efficiency’ of ‘e-governance projects using big data’.	HA7	‘Information technology’ influences the ‘Efficiency’ of ‘e-governance projects using big data’.
H08	‘Organization and management’ does not influence the ‘Efficiency’ of ‘e-governance projects using big data’.	HA8	‘Organization and management’ influence the ‘Efficiency’ of ‘e-governance projects using big data’.
H09	‘Law and regulation’ does not influence the ‘Efficiency’ of ‘e-governance projects using big data’.	HA9	‘Law and regulation’ influence the ‘Efficiency’ of ‘e-governance projects using big data’.

H010	‘Institution and environment’ does not influence the ‘Efficiency’ of ‘e-governance projects using big data’.	HA10	‘Institution and environment’ influence the ‘Efficiency’ of ‘e-governance projects using big data’.
H011	‘Information and data’ does not influence the ‘Transparency’ of ‘e-governance projects using big data’.	HA11	‘Information and data’ influence the ‘Transparency’ of ‘e-governance projects using big data’.
H012	‘Information technology’ does not influence the ‘Transparency’ of ‘e-governance projects using big dat’a.	HA12	‘Information technology’ influences the ‘Transparency’ of ‘e-governance projects using big data’.
H013	‘Organization and management’ does not influence the ‘Transparency’ of ‘e-governance projects using big data’.	HA13	‘Organization and management’ influence the ‘Transparency’ of ‘e-governance projects using big data’.
H014	‘Law and regulation’ does not influence the ‘Transparency’ of ‘e-governance projects using big data’.	HA14	‘Law and regulation’ influence the ‘Transparency’ of ‘e-governance projects using big data’.
H015	‘Institution and environment’ does not influence the ‘Transparency’ of ‘e-governance projects using big data’.	HA15	‘Institution and environment’ influence the ‘Transparency’ of ‘e-governance projects using big data’.
H016	‘Information and data’ does not influence the ‘Interactivity’ of ‘e-governance projects using big data’.	HA16	‘Information and data’ influence the ‘Interactivity’ of ‘e-governance projects using big data’.
H017	‘Information technology’ does not influence the ‘Interactivity’ of ‘e-governance projects using big data’.	HA17	‘Information technology’ influences the ‘Interactivity’ of ‘e-governance projects using big data’.
H018	‘Organization and management’ does not influence the ‘Interactivity’ of ‘e-governance projects using big data’.	HA18	‘Organization and management’ influence the ‘Interactivity’ of ‘e-governance projects using big data’.
H019	‘Law and regulation’ does not influence the ‘Interactivity’ of ‘e-governance projects using big data’.	HA19	‘Law and regulation’ influence the ‘Interactivity’ of ‘e-governance projects using big data’.
H020	‘Institution and environment’ does not influence the ‘Interactivity’ of ‘e-governance projects using big data’.	HA20	‘Institution and environment’ influence the ‘Interactivity’ of ‘e-governance projects using big data’.
H021	‘Information and data’ does not influence the ‘Decision support’ of ‘e-governance projects using big data’.	HA21	‘Information and data’ influence the ‘Decision support’ of ‘e-governance projects using big data’.

H022	‘Information technology’ does not influence the ‘Decision support’ of ‘e-governance projects using big data’.	HA22	‘Information technology’ influences the ‘Decision support’ of ‘e-governance projects using big data’.
H023	‘Organization and management’ does not influence the ‘Decision support’ of ‘e-governance projects using big data’.	HA23	‘Organization and management’ influence the ‘Decision support’ of ‘e-governance projects using big data’.
H024	‘Law and regulation’ does not influence the ‘Decision support’ of ‘e-governance projects using big data’.	HA24	‘Law and regulation’ influence the ‘Decision support’ of ‘e-governance projects using big data’.
H025	‘Institution and environment’ does not influence the ‘Decision support‘ of ‘e-governance projects using big data’.	HA25	‘Institution and environment’ influence the ‘Decision support’ of ‘e-governance projects using big data’.

4.6.2 Total Interpretive Structural Modeling with Polarity (TISM-P)

The TISM (Sushil, 2009; 2012) is an innovative extension of Interpretive Structural Modeling (ISM) (Warfield, 1974) that is used to develop a hierarchical structure of the set of variables of interest. The TISM deals with the interpretation of embedded objects by a systematic iterative application of graph theory. This results in the development of a directed graph for the complex system depicting linkages among the set of variables. This helps transform the poorly articulated mental models into a well-systematic form that can be used for many interpretations. This is a novel qualitative modelling technique that has been used by researchers in diverse fields of investigation (Nasim, 2011; Prasad and Suri, 2011; Wasuja et al., 2012; Srivastava and Sushil, 2013). TISM is largely used at the preliminary stage of problem-solving as a tool to help those examining the forces to make sense of complex relations (Nasim, 2011). The procedure of implementing the qualitative approach began with the selection of a group of experts who are knowledgeable about the construct. The objective behind it is to ensure the adequacy of items and dimensions (Tojib et al., 2008) of the 'e-governance performance'. TISM-P is an enhanced methodology with polarity of relationships (Sushil, 2018). In all, four content experts participated in the study. Two experts were from professional positions within the government organisation and two from academia.

The experts from academia are well known in their respective fields and were able to provide feedback about different disciplines including e-governance, management and public administration. The experts from the government organisation held leadership positions within their respective professions. Four experts are regarded as acceptable for model building. The literature advises a minimum of three and a maximum of twenty experts (Tilden et al., 1990; Gable and Wolf, 1993). The domain experts' feedback was individually collected. Ten experts were involved in validating the model.

4.6.3 Model Assessment and Synthesis

TISM is much more demanding than ISM in terms of time required from the domain experts but a TISM model is more meaningful than an ISM. TISM-P gives added knowledge regarding polarity of relationships. Experts not only need to define the contextual relationships among each pair of dimensions but are also expected to provide the logic behind each response along with the polarity of relationships. For example, while developing the TISM-P model for dimensions constituting 'e-governance performance' with four (n) dimensions, an expert had to define and provide a reason for 12 [i.e., n(n-1)] pairs of relations. Scarcity of time being a general constraint for experts across all domains, it is not easy to find enough experts to volunteer for this stage. However, after the models are developed, it becomes easier to find enough experts to evaluate the pictorial representation of relations (digraphs), also the number of valid relations gets smaller. TISM-P model has been developed based on the responses from four domain experts. The developed model has been further assessed by another ten domain experts so that the validity of the developed models can be established. The essential eleven-step process of TISM-P is described and presented in Chapter 5. A graphical representation of the eleven steps of TISM-P is presented below in Figure 4.2.

4.7 Research Methodology for Quantitative Study

The quantitative research methodology allows measurable and quantifiable hypotheses through logic and analysis. An empirical survey under quantitative research is conducted through questionnaires, interviews and functional observations (Cresswell et al., 2009; Saunders et al., 2012). The empirical survey has been conducted by getting responses through structured questionnaires from the respondents who have used e-governance services through select e-governance projects for the study. The proposed research framework has been tested and validated using Partial Least Squares-Structural Equation Modeling (PLS-SEM). The findings of the study through qualitative and quantitative techniques have been synthesized to present a validated research framework for 'Performance of e-governance projects using big data'.

4.7.1 Development of Survey Questionnaire

Conceptual research framework is empirically tested through data collected from a survey of implementers. To conduct the survey, a closed-ended questionnaire is developed. It is convenient to assign codes to prospect answers in case of a closed-ended questionnaire and also it is easy to analyze the responses (Bailey, 1994). Respondents also feel comfortable to respond to the questions by understanding it through the options provided. Hence, the extent of non-response to the survey questionnaire is reduced due to a better understanding of the questionnaire (Bailey, 1994). The research questionnaire (Appendix I and Appendix II), is divided into three parts: (i) A non-disclosure undertaking and instructions for respondents for filling up the

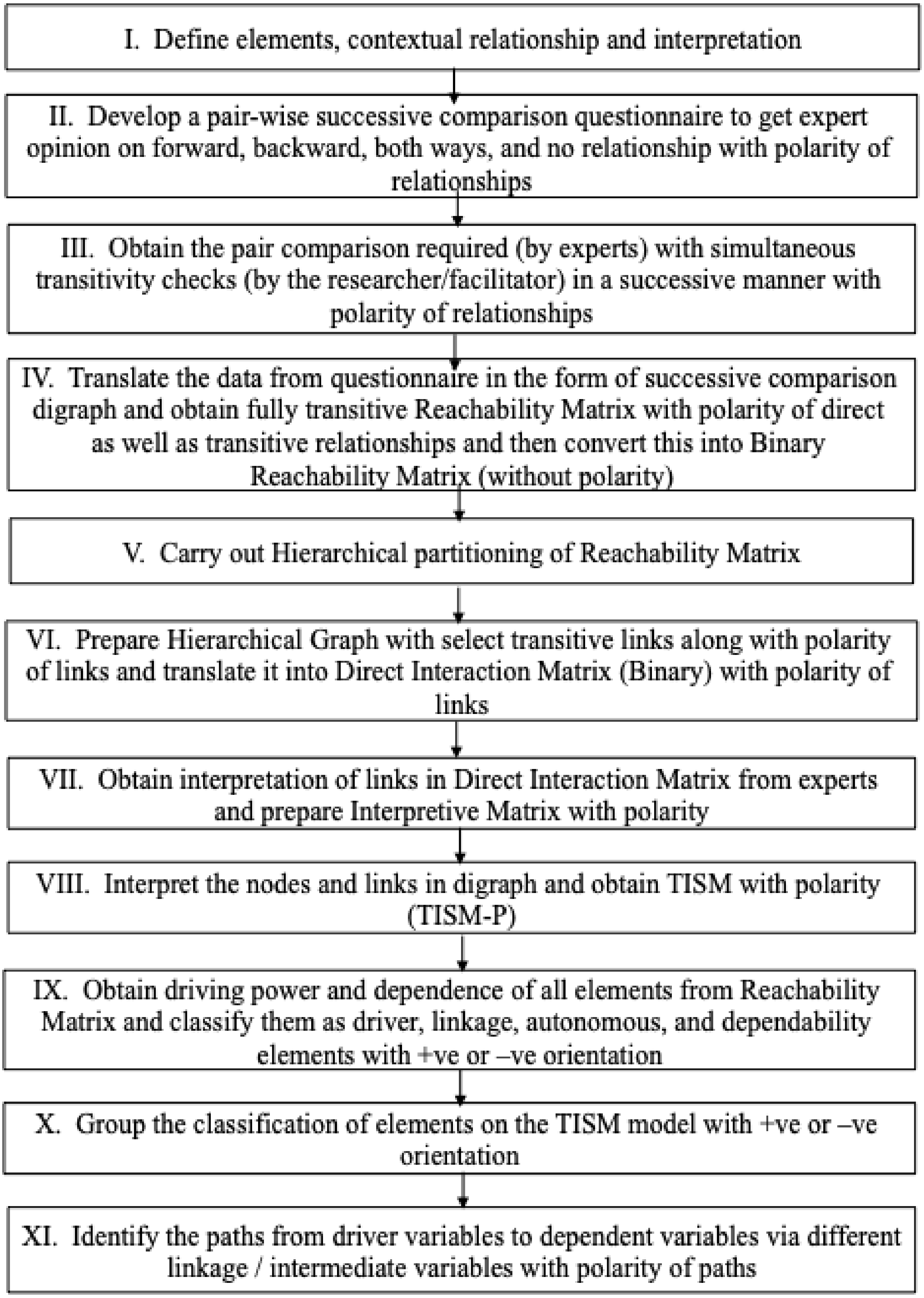

Figure 4.2: TISM-P: Process and Broad Steps

[Source: Sushil (2018)]

questionnaire; (ii) Demographic information of the respondents; (iii) Questions to capture the data required to test and validate the conceptual research framework. A total of one hundred and seventy two questionnaire items are developed. Questions Nine to Twenty-three are designed to capture 'Performance' perceived in terms of 'Efficiency' (EF), 'Transparency' (TR), 'Interactivity' (IN) and 'Decision support' (DS). Table 4.4 shows the mapping of questionnaire numbers with macro and micro variables for 'Performance of e-governance projects using big data'.

Table 4.4: Mapping of Macro and Micro Variables of 'Performance of E-Governance Projects using Big Data' and Questionnaire Items

Macro Variables	**Micro Variables**	**Questionnaire Numbers**
'Efficiency' (EF)	Fast execution of core process (FEP)	9a to 9e
	Simplification of processes (SOP)	10a to 10e
	Reduced paperwork (REP)	11a to 11e
	Reduced cost (REC)	12a to 12e
'Transparency' (TR)	Reliable information (REI)	13a to 13e
	Comprehensive information (COI)	14a to 14e
	Easy access to information (EAI)	15a to 15e
	Fairness/Reduced corruption (FAR)	16a to 16e
'Interactivity' (IN)	Improved interaction (IMI)	17a to 17f
	Participative (PAR)	18a to 18e
	Consensus-oriented (COO)	19a to 19e
'Decision support '(DS)	Improved planning (IMP)	20a to 20e
	Improved decision-making (IDM)	21a to 21e
	Better Monitoring & control (BMC)	22a to 22e
	Accountability (ACC)	23a to 23e

Further, to get the data from respondents about big data related variables to 'Performance of e-governance projects using big data', responses have been collected for 'Information and data' (ID), 'Information technology' (IT), 'Organization and management' (OM), 'Law and regulation' (LR) and 'Institution and environment' (IE). Questions from twenty-four to forty-five have been formulated to get the response on these big data related variables. Table 4.5 shows the mapping of questionnaire numbers with macro and micro variable to capture responses in terms of big data related variables.

Table 4.5: Mapping of Macro and Micro Variables of Big Data Influencing ‘Performance of E-Governance Projects using Big Data’ and Questionnaire Items

Macro Variables	**Micro Variables**	**Questionnaire Numbers**
‘Information and data’ (ID)	Information and data quality (IDQ)	24a to 24f
	Dynamic information (DYI)	25a to 25e
	Privacy and security (PAS)	26a to 26e
‘Information technology’ (IT)	Usability (USE)	27a to 27f
	Security issues (SEI)	28a to 28f
	Technological compatibility (TEC)	29a to 29e
	Technology complexity/Newness (TEN)	30a to 30d
	Technical skills and experience (TSE)	31a to 31e
	Techniques, Algorithms & scalability (TAS)	32a to 32e
‘Organization and management’ (OM)	Project size (PRS)	33a to 33d
	Manager’s attitudes & behavior (MAB)	34a to 34d
	Users or organizational diversity (UOD)	35a to 35d
	Alignment & Awareness of organizational goals (AOG)	36a to 36d
	Resistance to change/internal conflicts (RTC)	37a to 37d
	Qualified Personnel/ Talent (QUP)	38a to 38f
‘Law and regulation’ (LR)	Conducive laws and regulations (CLR)	39a to 39f
	Cost structures, Budgeting, Budget allocation & disbursement (CSB)	40a to 40e
	Intergovernmental relationships (IGR)	41a to 41d
‘Institution and environment’ (IE)	Privacy and related security concerns (PSC)	42a to 42d
	Autonomy of agencies (AOA)	43a to 43d
	Policy and political pressures (PPP)	44a to 44e
	Environmental (ENV)	45a to 45d

The response to questions nine to forty-five, presented in part three of the questionnaire, is captured through a five point Likert-type scale. It is a commonly used scale which makes it easy for respondents to provide their feedback on each item depending on its intensity (Millar, 1970). In the survey questionnaire used in present study, ‘1’ represents ‘Strongly Disagree’, ‘2’ represents ‘Disagree’, ‘3’ represents Can't Say’, ‘4’ represents ‘Agree’ and ‘5’ represents ‘Strongly Agree’.

Reliability Analysis

The reliability of the questionnaire is tested using Cronbach's alpha measure (Nunnally, 1978; George and Mallery, 2011). Fornell and Larcker (1981) suggest that Cronbach's alpha value should be greater than 0.7 to be considered adequate, while Bagozzi et al. (1991) believe that Cronbach’s alpha value greater than 0.6 is desirable. Values of construct reliability below 0.6 indicate a lack of reliability (Hair et al., 2011).

4.7.2 Pilot Testing of Questionnaire

It is important to pilot test the questionnaire before using it for data collection. The main aim of the pilot test is to refine the questionnaire and enable the researcher to obtain an assessment of the validity and reliability of the questions. Validity involves the process of asking an expert or a group of experts to comment on the representativeness and suitability of the questionnaire, while reliability is concerned with the internal consistency of responses to questions (Saunders et al., 2012).

The draft questionnaire developed was pre-tested by circulating it to a set of fellow research scholars, academic experts, citizens and e-governance practitioners. Overall, a group of around eighteen members was approached for this pre-testing of the questionnaire. A sample questionnaire was then distributed to each member of the group. Also, the provision was kept to keep enough space in the sample questionnaire for the group members to write their comments on the questionnaire wherever required. Members of the pre-test group were requested to verify all the aspects of the questionnaire including a sequence of the questions, understanding of the language of each question, redundancy in the questionnaire, appropriateness of the questions, the absence of any question, etc. (Bailey, 1994). In all, a positive response was received from members of the group. Though they suggested a few minor changes related to use of simple words without making a few of them very technical and sequence of questions for easy understanding for the respondents. The suggested changes were incorporated in the questionnaire, and it was presented again to the pre-test group for their confirmation and further feedback. The research questionnaire was thus finalized through this interactive and iterative approach. The average time taken to fill-up the research questionnaire was estimated as twenty minutes on the basis of feedback of the pre-test group. The questionnaire was subjected to various validity tests before launching it for the actual respondents. Validity of the questionnaire refers as the extent to which it measures what the researcher intends to measure (Kerlinger, 1983).

4.7.3 Sampling Method and Data Collection

In the present study, 'Purposive non-probability sampling technique' has been used for collection of data. It is also known as judgmental, selective, or subjective sampling. Purposive sampling is a type of non-probability sampling where researcher makes a conscious decision on what the sample needs to include and choose participants accordingly (Polit and Hungler, 1997). As per the context of the study, five e-governance projects have been selected. Hence, any implementer who has been involved in implementation of any of these services and any beneficiary could respond to the questionnaire. Also, all five projects selected for the study: (i) Aadhaar card from UIDAI; (ii) CGHS; (iii) Passport Seva Project (PSP); (iv) Income Tax Return (ITR) filing; (v) Indian Railway Catering and Tourism Corporation (IRCTC), are National level projects.

The questionnaire consisting of thirty-seven micro variables and hundred and seventy two question items was used for survey. The questionnaire was circulated to around 600 beneficiaries and 150 implementers. However, 439 beneficiaries and 120 implementers responded. Out of 439 beneficiaries responses, 12 were incomplete and out of 120 implementers responses, 02 forms were found to be incomplete. Hence, valid responses collected for the study were 427 beneficiaries and 118 implementers. Both online and manual survey methods were used to collect the responses. The sample size of 427 beneficiaries and 118 implementers was considered suitable for the study as recommended for analysis using PLS-SEM (Hair et al., 2010).

4.7.4 Partial Least Squares-Structural Equation Modeling (PLS-SEM)

The Partial Least Squares (PLS) method was introduced by Wold (1974, 1982, 1985a, and 1989) for the analysis of high dimensional data in a low-structure environment, and has undergone different modifications and extensions thereon. It belongs to the family of alternating least squares algorithms which are used for canonical correlation and principal component analysis. PLS is used primarily in the exploratory analysis (as is the case of this study), and it does not require the normal distribution of data and is suitable for a small size sample (Hair et al., 2017). The proposed model can be tested by SEM to make better inferences by testing multiple hypotheses at the same time. Also, PLS-SEM helps to note the interaction effect in the same model and makes hypothesis testing easier.

PLS-SEM also helps to test the higher-order constructs used in the proposed model like the one taken for this study.

This research uses the PLS-SEM approach due to its applicability as recommended by (Sarstedt et al., 2017) for the research where: (i) the objective is explaining and predicting target constructs and/or detecting important driver constructs; (ii) the structural model has reflective measured constructs; (iii) the model is complex (with many constructs and indicators); (iv) the researcher is working with small sample size, and (v) the researcher intends to further use latent variable scores.

Reflective Measurement Model

A reflective model is based on confirmatory factor analysis (CFA) for PLS-SEM. This test allows testing the null hypothesis that the construct measures are reflective (Coltman et al., 2008). Reflective measures are expected to have high inter-correlations. This is what one usually tests with exploratory or confirmatory factor analysis. The reflective measurement model is tested through the very common Cronbach's alpha, composite reliability, convergent validity and discriminant validity. The measure of indicators reflects on constructs which in turn reflects the latent variable (Bagozzi, 2007).

4.8 Synthesis of Results

To synthesize the findings, this research work uses a mixed-method approach, combining qualitative and quantitative analysis. The combination of research methods is referred to as the process of triangulation, which grants the ability to verify empirical details from differing perspectives (Lee and Gough, 1993; Mingers, 2001). Triangulation provides a better, contextual basis for the interpretation of results and consequently, a more robust collection of results has been achieved through the process of cross-validation (Yin, 1994; Leech and Onwuegbuzie, 2007).

4.8.1 Research Methods Used in the Study

Various data collection methods and sampling techniques used to achieve the objectives of the study are shown in Table 4.6.

Table 4.6: Description of Data Collection and Sampling Methods Used

Study Phase	Study Objective	Data Collection Method	Sampling Method
Pilot Study	To conduct a pilot study for developing better insights about 'big data and e-governance performance'	Survey questionnaire, field visits and interview	Convenient Sampling
Empirical Survey	To undertake empirical analysis and suggest a validated framework for evaluating 'use of big data for e-governance performance'.	Questionnaire based survey (Tools used: TISM-P Analysis and PLS-SEM)	Purposive Sampling

Further, Table 4.7 describes the research analysis techniques and objective of the analysis as applied in the context of this study along with the references.

Table 4.7: Description of Research Methods Used

Objective of the Analysis	Research Analysis Techniques	Reference
To develop insights about the macro and micro constructs based on the observed sample values	Univariate Analysis	Kothari et al. (2005)
To analyze the conceptualized variables for developing the systemic hierarchical model	TISM-P Analysis	Sushil (2009; 2012); Nasim (2011); Neetu and Sushil (2014)
To analyze the internal consistency of the construct	Reliability Analysis (Cronbach Alpha and Composite Reliability)	Cronbach (1951); Nunnally (1978); Nunnally and Bernstein (1994)
To assess the validity of constructs	Validity Analysis [Convergent Validity (AVE) and Discriminant Validity (SQRT AVE)]	
For testing the fitment of hypothesized constructs to the observed data	Confirmatory Factor Analysis (CFA)	Hinkin (1998); Thompson (2004)
For testing the research hypotheses and for validating the proposed model	PLS-SEM Analysis	Wold (1974;1982; 1985a; 1985b; 1989); Hair et al. (2010)

4.8.2 Justification of the Research Methodology Used

A mixed approach of research methodology, i.e., qualitative and quantitative for the study has been chosen. It is reported that a single approach generally lacks in providing the richness required for the research (Kaplan and Duchon, 1988). The combination of two research methods strengthens the ability for empirical validation from different perspectives particularly for the research containing multi-disciplinary areas such as 'big data and e-governance performance' taken up for this study (Lee and Gough, 1993; Mingers, 2001). The dual approach of research methodology also provides a better contextual basis for the interpretation of results and such results are considered a robust outcome (Kaplan and Duchon, 1988; Yin, 1994).

4.9 Flowchart of Research Methodology

A research methodology is a mechanism to solve the research problem starting from the theoretical aspect of the research to the collection and analysis of data (Hussey and Hussey, 1997). In other words, research methodology is a system of models, procedures and techniques (Creswell and Plano Clark, 2011) used to find the results of a research problem (Panneerselvam, 2014). It consists of various research techniques that can be used during data collection and data analysis. The aim of this research is to explore the influence of big data related variables on the 'Performance of e-governance projects using big data'. An objective of this research (*Chapter 1, Section 1.4*) is to identify the influence of conceptualized big data related variables on the 'Performance of e-governance projects using big data' in India. The exploratory study aims at answering a few research questions, e.g., what is the performance of the select e-governance projects in India? To what extent the big data related variables influence the 'Performance of select e-governance projects using big data' in India? A conceptual framework is developed (*Chapter 4, Figure 4.1*) to seek answers to these research questions. This conceptual framework is required to be empirically tested and validated. The research methodology followed for conducting the study is presented in Figure 4.3.

4.10 Brief Description of Projects Selected for Study

E-governance projects that make use of big data since last two years or more have been selected in accordance with the study objectives.

4.10.1 Basis for the Selection of the Projects

The e-governance projects have been selected keeping in view the objectives of the research. Criterion for project selection is a consideration based on implementers as well as target beneficiaries. Five National e-governance projects have been selected that make use of big data for enhancing their services. E-governance projects based on the G2G and G2B are not included in the study. The e-governance model has several stages of growth. E-governance projects which are in the planning stage or under the implementation stage in India are not considered for selection. All selected projects for study have been implemented successfully and in operation for the last five years or more. The projects have started making use of big data since last two years or more. To increase the overall scope of the study all selected projects are of National level.

4.10.2 Aadhaar card services from UIDAI [https://uidai.gov.in/]

Aadhaar, a unique identification number issued to residents of India, is a part of the digital identity systems that have been gaining popularity in recent years. The detailed description is given in section 3.3 as Aadhaar is selected as a project for the pilot study.

4.10.3 Central Government Health Scheme (CGHS) [https://cghs.nic.in/]

The CGHS is a healthcare system established by the Government of India in 1954 to provide comprehensive medical care to its employees and pensioners. It is managed by the Ministry of Health and Family Welfare and is funded by the central government. The CGHS provides medical facilities through its various dispensaries, polyclinics, and hospitals, spread across the country. It offers a range of services including outpatient and inpatient care, diagnostic tests, and medicines. The system also includes a network of empanelled private hospitals and diagnostic centres where beneficiaries can avail of medical services. The CGHS is open to serving and retired employees of the central government and their dependent family members. The system also covers Members of Parliament (MP), Supreme Court and High Court judges, and freedom fighters.

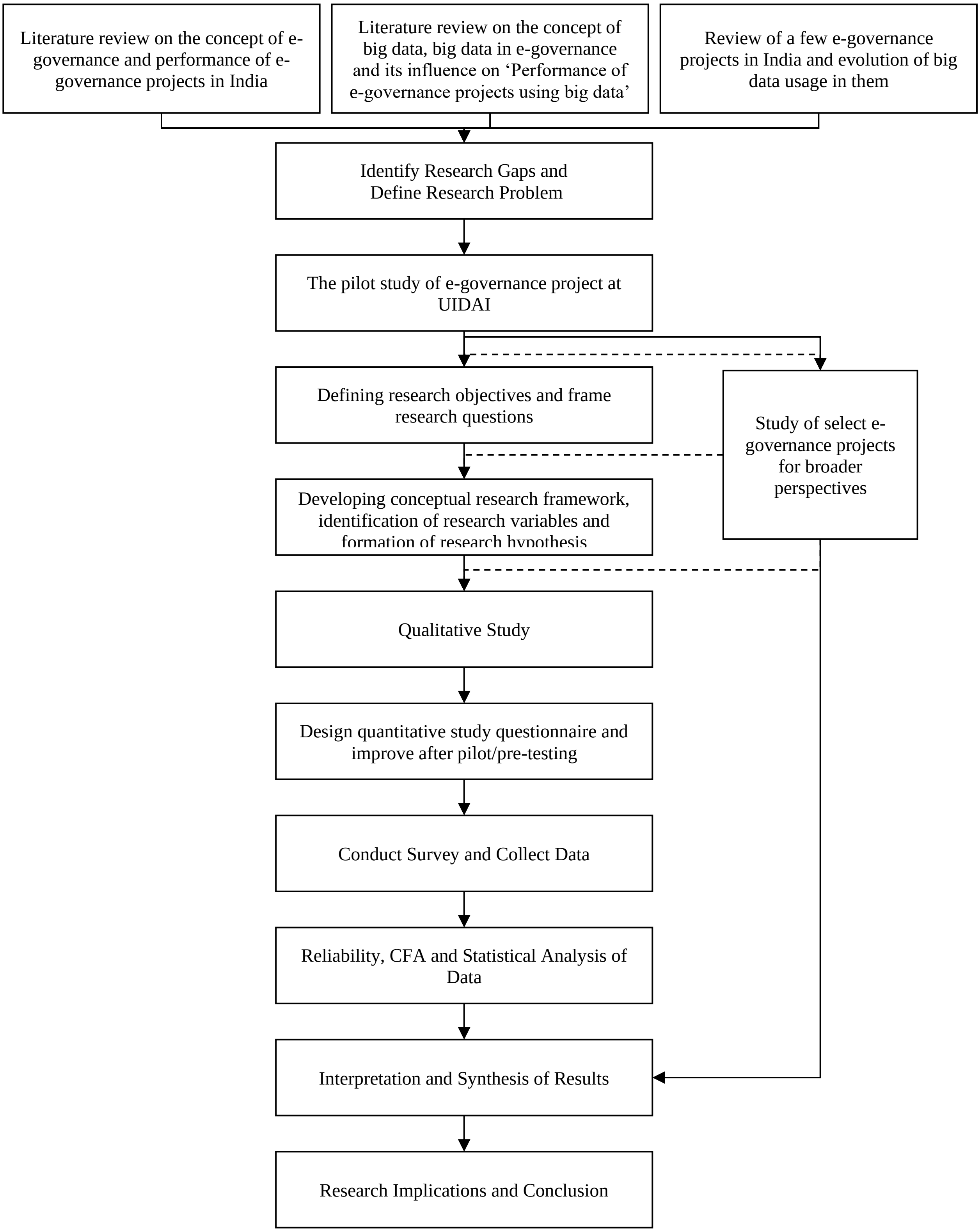

Figure 4.3: The Research Methodology

As on 24 April 2023, it has over 42 lakh active beneficiaries (i.e., card holders and their eligible dependents), out of which about 25 lakh are serving personnel, whereas the remainder (17 lakh) are pensioners. It serves these beneficiaries across 79 cities in India. It provides health care through following systems of Medicine: Allopathic, Homoeopathic, Ayurveda, Unani, Siddha and Yoga. The CGHS aims to provide affordable and accessible healthcare services to its beneficiaries. It operates on a cashless basis; the beneficiaries are not required to pay for medical services at the time of treatment. The central government covers the cost of treatment. In recent years, the CGHS has undergone several reforms to improve its services and make them more efficient. These include the introduction of online appointment booking, e-prescription services, and the digitization of medical records**.** Successful execution of these programs required structured design, planning, and implementation of several big data and analytics initiatives.

Evolution of Big Data and Analytics initiatives at CGHS

The CGHS in India has implemented several big data management and analytics initiatives to improve healthcare services' efficiency and effectiveness. Here is a detailed chronological overview of CGHS's key initiatives:

Implementation of Electronic Medical Records (EMR) in 2013: CGHS took the first step towards implementing data management and analytics by implementing the Electronic Medical Record (EMR) system at its dispensaries in Delhi. The systems (Figure 4.4) has been designed, developed, and hosted by NIC, Ministry of Electronics and Information Technology (MeitY), Government of India.

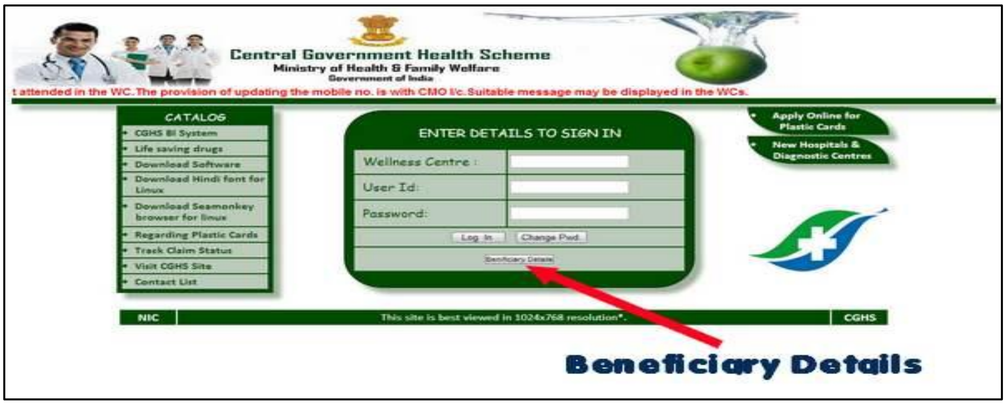

Figure 4.4: Screenshot of the EMR in 2013

[Source: https://cghs.nic.in/]

The EMR system (Figure 4.5) aimed to capture patient data electronically, including patient demographics, medical history, lab results, and prescriptions.

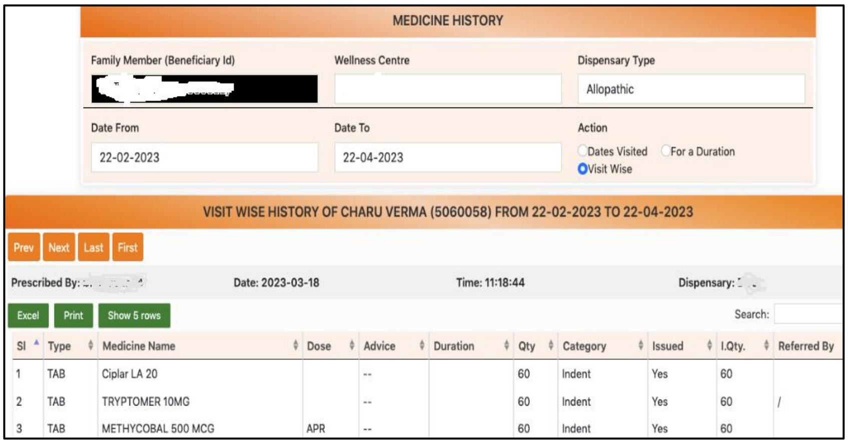

Figure 4.5: Screenshot of CGHS EMR in 2023

[Source: https://cghs.nic.in/]

The system enabled healthcare providers to access patient information quickly and easily, reducing the chances of errors in diagnosis and treatment. The EMR system was a crucial step towards CGHS's goal of improving healthcare services' quality and patient outcomes. When launched in 2013, it had basic functionality that enabled beneficiaries to access their medical consultation history (Figure 4.6).

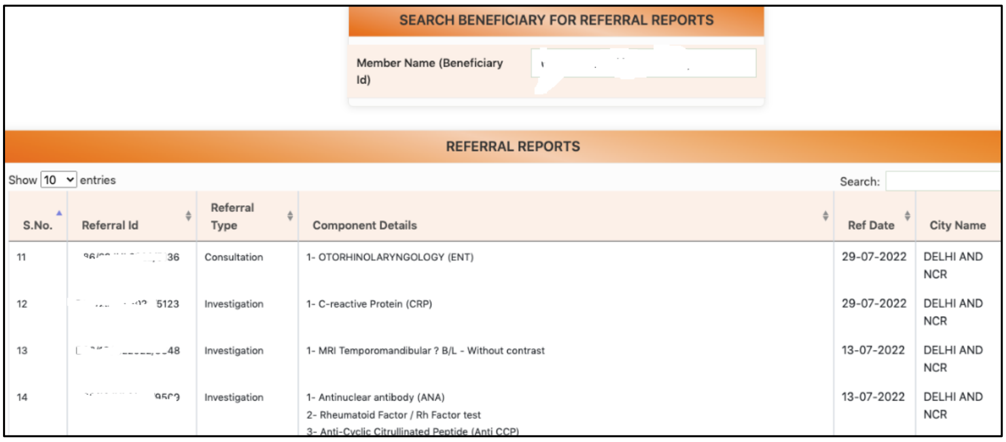

Figure 4.6: Referral Reports in CGHS EMR in 2023

[Source: https://cghs.nic.in/]

However, over the years the system has seen several upgrades. Most recent upgrades enable beneficiaries to perform detailed query and search on the EMR databases. Visit wise details of the dispensary along with the medication provided is available. Additionally, the beneficiary is able to search for referral reports too. The implementation of the EMR system allowed CGHS to store and manage patient data electronically, enabling quick access to patient information across its facilities. The EMR system also facilitated the integration of various healthcare services, such as lab tests and prescription management into a single platform, streamlining healthcare operations and improving the service quality.

Launch of the CGHS website in 2014: CGHS launched its website to provide online access to healthcare services. The website enabled patients to view their medical records, including prescriptions and lab results, and book appointments online. The website also provided healthcare providers with a platform to share patient data securely. The launch of the website was a significant step towards CGHS's efforts to improve healthcare services' accessibility and convenience. The implementation of the CGHS website allowed patients to access healthcare services from the comfort of their homes, reducing the need to visit healthcare facilities physically. The website also enabled patients to access their medical records from anywhere, improving service quality and reducing the chances of errors in diagnosis and treatment.

Implementation of Health Information Exchange (HIE) in 2016: CGHS implemented the Health Information Exchange (HIE) system to improve healthcare services' efficiency and effectiveness. The HIE system enabled the sharing of patient information across healthcare facilities, ensuring that patient data is available to healthcare providers at any facility. This improved the quality of care and reduced the risk of duplication of tests and procedures. The HIE implementation was critical to CGHS's efforts to improve healthcare services' efficiency and effectiveness. The HIE system enabled CGHS to provide seamless healthcare services to patients across its facilities. The system allowed healthcare providers to access patient information quickly and efficiently, reducing the chances of errors in diagnosis and treatment. The HIE system also enabled healthcare providers to share patient data securely, improving service quality and reducing the risk of data breaches.

Implementation of Health Information Management System (HIMS) in 2019: CGHS implemented the Health Information Management System (HIMS) to manage patient data across all its facilities. The HIMS system enabled healthcare providers to access patient data from anywhere, improving the quality of care and reducing the risk of duplication of tests and procedures. The HIMS implementation was a significant step towards CGHS's goal of providing seamless healthcare services to its patients.

Implementation of Telemedicine in 2020: In August 2020, CGHS implemented telemedicine services through the e-Sanjeevani platform of the Ministry of Health & Family Welfare (MoHFW) to improve access to healthcare services, particularly for patients in remote areas. While initially, it started with the focus on Delhi/NCR, later in December 2020, it expanded this services across India. The consultation scope included four specialties –medicine, orthopaedics, eye, ENT, and psychiatry. Telemedicine services (Figure 4.7) also generated patient data that could be analyzed to improve healthcare services. The implementation of telemedicine was a significant step towards CGHS's goal of leveraging technology to improve healthcare services' efficiency and effectiveness. Telemedicine services helped to reduce the burden on healthcare facilities, enabling healthcare providers to focus on critical cases.

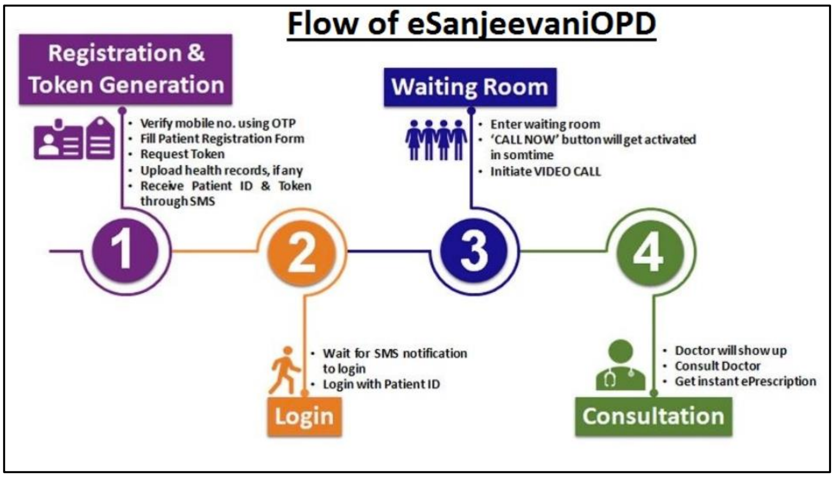

Figure 4.7: e-Sanjeevani OPD

[Source: https://cghs.nic.in/]

CGHS Future Plans: Alignment with the Vision of CGHS IT2.0 PM-JAY ABDM

The National Health Policy (NHP) was published in 2017, has the following goal: "The attainment of the highest possible level of health and wellbeing for all at all ages, through a preventive and promotive health care orientation in all developmental policies, and universal access to good quality healthcare services without anyone having to face financial hardship as a consequence." To define the rationale, scope, and implementation arrangements of the framework of digital healthcare ecosystem laid out in the NHP and its blueprint, the National Digital Health Blueprint (NDHB), the Government launched the Ayushman Bharat Digital Mission (ABDM) on August 15, 2020. In 2021, the National Health Authority (NHA), Government of India articulated the vision of convergence of

Central Government Health Schemes across various CGHSs of various ministries - labour and employment, social welfare and empowerment, and home affairs - into the ABDM. These embraced the platform developed by NHA along the lines of ABDM (Figure 4.8) and Ayushman Bharat Pradhan Mantri Jan Arogya Yojana (PM-JAY). This program, also known as CGHS IT 2.0 ensures data-driven, paperless, and cashless transactions across over 23,000 healthcare service providers that are part of PM-JAY.

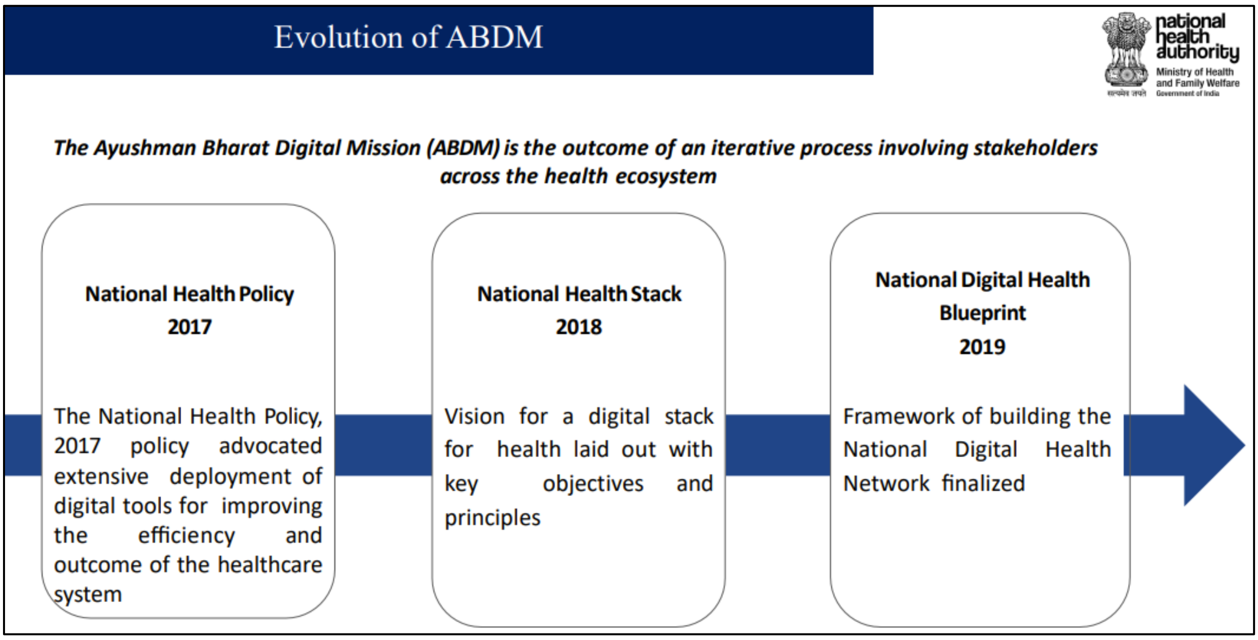

Figure 4.8: Ayushman Bharat Digital Mission (ABDM)

[Source: https://cghs.nic.in/]

The platform has three key modules - beneficiary identification (eKYC), hospital management, and transaction management (from patient admission to discharge and claims). Since the announcement of ABDM, the National Health Authority (NHA) has launched the following key building blocks - Health ID, Personal Health Records (PHR) App and Healthcare Professionals Registry (HPR) starting with doctors, Health Facility Registry (HFR) and Health Information Exchange & Consent Manager (HIE-CM).

The Four Components of PM-JAY ABDM Platform

ABDM aims to transform the way digital health services are rendered in India. The aim of this architecture is to allow for interoperability of both health data and health services. It has four core components (Figure 4.9):

- **JAM and Existing Digital Ecosystems**: ABDM has been designed to operate effectively with, and leverage India's extant digital ecosystems, such as Aadhaar, Jan Dhan Bank Accounts, and Mobile (JAM), UPI, e-Sign, Digi locker, etc. These cross-domain capabilities are leveraged in ABDM to enable certain key functionalities such as (i) creation of a Health ID for individuals; (ii) accessibility of digital health records through Digi Locker; (iii) access to doctors and health facilities.
- **Health Data Exchange Layer**: This layer encompasses the core digital infrastructure modules needed to ensure the interoperability of health data. These building blocks include core registries - the Health ID, the Healthcare Professionals Registry and the Health Facility Registry, HIE-CM, Health Data Standards (based on FHIR), coding terminology and data aggregation specifications that drive trust and shareability of health data between patients and healthcare providers.
- **Unified Health Interface- Health Services Layer**: Building blocks in this layer are envisioned to enable interoperable and seamless interactions between patients and providers of digital health services, and along with other ABDM building blocks to address challenges in delivering healthcare services digitally by creating an ecosystem that benefits both patients and providers.
- **User Applications**: This is the end-user layer of the ABDM ecosystem. It comprises the applications and platforms developed by the government or private sector through which patients, healthcare providers, insurers, researchers, policy makers, etc. access trusted health services. The application layer will interact with the health services and the health data layers thereby enabling health data exchange and a wide range of digital health services.

Next Steps: Plan to Implement and Integrate CGHS into PM-JAY ABDM

In January 2023, in a bid to provide more hospital options for patients, the government is considering allowing CGHS beneficiaries to avail treatment at hospitals empaneled with the flagship AB-PMJAY. The NHA is in the process of integrating the CGHS with ABDM. This is aimed at creating digital health identification of CGHS beneficiaries and storing their digital health records, thus ensuring quick treatment to the needy.

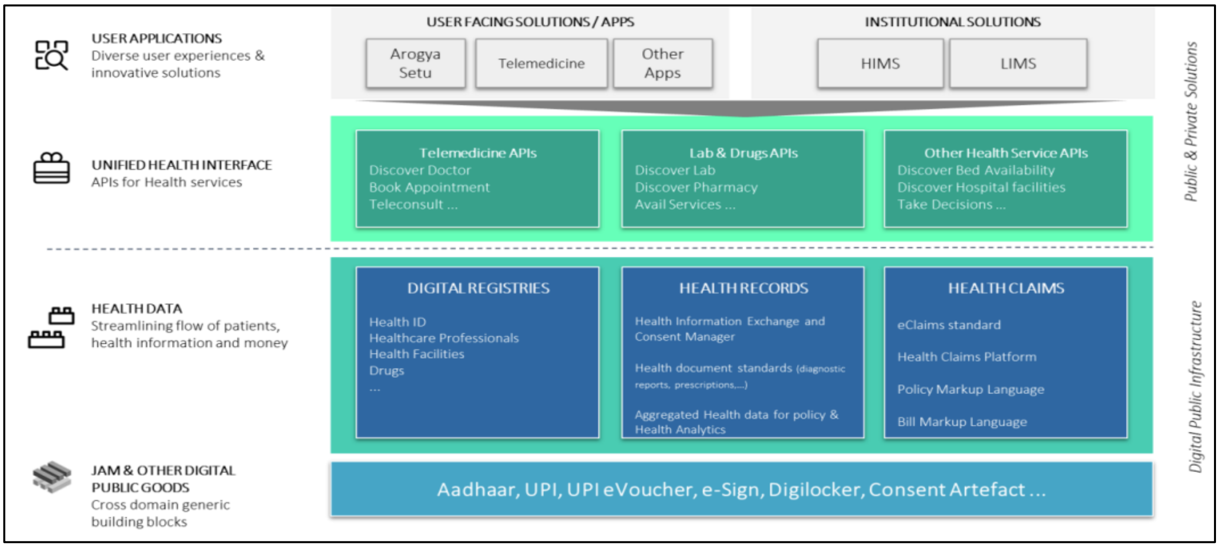

Figure 4.9: Components of Ayushman Bharat Digital Mission (ABDM)

[Source: https://cghs.nic.in/]

By January 2023, around 100 million health records had already been linked to ABDM.

Table 4.8: Summary of E-Governance Project - CGHS

Attribute	**Description**
Objective	To provide comprehensive health care facilities for the Central Government employees and pensioners and their dependents residing in CGHS covered cities in India
Scope	Processes in CGHS dispensaries only
Coverage	All 495 Wellness Centers/CGHS dispensaries across India, CGHS approved hospitals, 1681 doctors and laboratories/diagnostic centers
Department	MoHFW
Beneficiaries	Central Government employees and pensioners and their dependents
Expected Benefits	Automated medical and family welfare services
Services offered	• Dispensary services including domiciliary care • Family Welfare & Mother Child Health Services • Specialist consultation facilities both at dispensary, polyclinic and hospital level including X-Ray, ECG and laboratory examinations • Hospitalization • Organization for the purchase, storage, distribution and supply of medicines and other requirements • Health Education to beneficiaries

[Source: https://cghs.nic.in]

4.10.4 Passport Seva Project (PSP) [https://www.passportindia.gov.in/]

Passport Seva is an initiative by the Ministry of External Affairs (MEA) of the Government of India to provide passport-related services to Indian citizens in a more efficient and convenient manner. The Passport Seva project (PSP) was launched in 2010 as part of the NeGP to improve the delivery of public services using technology. The PSP aims to provide end-to-end passport services through a network of Passport Seva Kendras (PSKs) and Post Office Passport Seva Kendras (POPSKs) across the country. These centers offer various passport-related services such as new passport issuance, passport renewal, police clearance certificates, and other miscellaneous services. PSP has transformed the way passport-related services are delivered in India. Prior to the launch of this program, the process of getting a passport was cumbersome and time-consuming. Now citizens can apply for a passport online, schedule an appointment at a nearby PSK/POPSK, and track the status of their application in real-time. This has made the process of getting a passport more transparent, efficient, and user-friendly.

Big data initiatives by Passport Seva

Passport Seva has been leveraging big data and analytics to improve its services and provide a better experience to passport applicants. The implementation of big data platforms has enabled Passport Seva to gain insights into customer behaviour and preferences, as well as to identify areas where its services could be improved. A chronological sequence of big data initiatives taken by Passport Seva is presented in Table 4.9, which can be broadly categorized into three phases.

Table 4.9: Description of Key initiatives taken by Passport Seva

Year	**Initiative**	**Description**
Phase1: 2007-09 Project Initiation		Project initiation through detailed project report, floating RFP and awarding the contract, overhaul of the data center, disaster recovery site, network operations center, security operations center, call center supporting 17 Indian languages, designing of application based upon a complete process reengineering and setting up of a portal for citizen interface.
Phase 2: 2009-12 Project implementation		Implementation phase, leading to the complete transformation from old to a new services paradigm, included piloting through 4 Passport Seva Kendras (Passport Service Centers), obtaining a certificate of successful piloting from

		STQC, PAN India roll out through 37 Regional Passport Offices and 77 Passport Seva Kendras and obtaining a successful Go-live certification from STQC.
2010	PSP Launch	PSP launched to streamline the passport application and issuance process. This was the first major IT initiative by Passport Seva. The project has been implemented in a Public Private Partnership (PPP) mode with Tata Consultancy Services (TCS), selected through a public competitive procurement process. Under this program, the sovereign and fiduciary functions like verification, granting and issuing of passport have been retained by MEA. The ownership and strategic control of the core assets including data/information is with MEA.
2012	Online system Launch	The online passport application system was launched, allowing applicants to apply for passports from the comfort of their homes. This reduced the need for applicants to physically visit the passport office.
Phase 3: 2013- to date Maintenance, enhancement and integration with other e-governance services		Phase on operations and improvising the processes that were put in place. During this phase, new functionalities like online payment and access through mobile app, enhanced security, integration with District Police for expediting police verification, integration with the CSC Scheme of MeitY, Government of India to bridge the divide divided were launched. Also, included was integration with UID and process certifications. A host of APIs were also created for integration with external government entities like the Digi Locker scheme and police system integration (CCTNS).
2013	Passport Seva Mobile App	The Passport Seva Mobile App was launched, allowing applicants to access passport-related services and information on their mobile phones.
2014	PSK integration with CCTNS	PSKs were integrated with the Crime and Criminal Tracking Network & Systems (CCTNS), enabling the police to conduct online verification of passport applicants.
2014	Passport Seva integration with big data platform for analytics and insights	Passport Seva partnered with MapR Technologies, a provider of a leading big data platform, to deploy a big data infrastructure for processing and analyzing large amounts of data generated from passport applications and related services. The platform was designed to enable Passport Seva to process data in real-time and derive valuable insights from the data to improve its services.
2015	Passport Seva website revamp	The Passport Seva website was revamped to provide a better user experience and to integrate with other government services such as the Aadhaar authentication system.
2015	Passport Seva	Passport Seva launched its enhanced Passport Seva Mobile App, which

	Mobile App enhanced	allows users to apply for a passport, track their application status, and locate PSKs using their mobile devices. The app also features a feedback mechanism, enabling users to provide feedback on their experience with Passport Seva.
2016	mPassportSeva with Payment Gateway	The Ministry of External Affairs launched the mPassportSeva app, which provided additional features such as fee payment and appointment booking.
2016	Passport Seva Portal with helpdesk	Passport Seva launched its Passport Seva Portal, which offers a wide range of services, including online passport application, appointment scheduling, fee payment, and tracking of passport application status. The portal also features a helpdesk to assist users with any queries related to passport services.
2017	PSP in Embassies/Consulates abroad	The Government launched the Passport Seva Project in the Embassies/Consulates abroad, aimed at providing passport services to Indian citizens living abroad.
2018	Passport Seva integrated with UMANG	Passport Seva integrated with the Unified Mobile Application for New-age Governance (UMANG) app, providing citizens with a single platform to access a range of government services.
2019	Passport Seva online PCC	Passport Seva introduced the Police Clearance Certificate (PCC) online application system, allowing applicants to apply for PCCs online and reducing the need for physical visits to the passport office.
2020	mPassport Police App	Passport Seva launched the 'mPassport Police App' aimed at helping police personnel verify the credentials of passport applicants using their mobile phones. This helps to speed up the verification process and reduce the time taken to issue passports.
2022	PSP-V2.0 called ePassport	The PSP-V2.0 is an expansion and improvement of the PSP-V1.0. The new initiative is aimed at creating a digital platform that would be "transparent, more accessible and reliable" and that it would be backed by a trained workforce. Key features: • **Technology upgrades:** latest biometrics technology, Artificial Intelligence (AI), Advance data analytics, chat-bot, auto-response, Natural Language Processing (NLP), Cloud enablement • **ePassport:** ePassport is an upgrade to the traditional passport and is aimed at making it more secure and ensuring smooth passage through immigration posts globally. The ePassports will be embedded with a chip that will include personal details of the holder including biographical information. The software for the

		ePassport has been developed by IIT Kanpur and the NIC. The e-passports will follow the International Civil Aviation Organization (ICAO) standards, and will be tougher, as well as harder to destroy.

[Source: https://www.passportindia.gov.in/]

Roadmap

The Passport Seva has been focusing on several initiatives to enhance their big data analytics capabilities. Some of the next steps being implemented as part of PSP -V2.0 include:

- **Enhancing real-time data processing:** The PSK is working on enhancing their real-time data processing capabilities by adopting more advanced big data technologies such as Apache Kafka, Apache Spark, and Apache Flank. This will enable them to process large volumes of data in real-time, improving their decision-making capabilities.
- **Implementing predictive analytics:** The PSK is exploring the implementation of predictive analytics to improve their operational efficiencies. By leveraging machine learning algorithms and predictive models, they can predict demand patterns, identify potential bottlenecks, and optimize their processes accordingly.
- **Expanding data sources:** The PSK is looking to expand their data sources beyond their existing databases to include external sources such as social media, government portals, and other public sources. By doing so, they can gain a more comprehensive understanding of their customers and their needs.
- **Strengthening data security:** As the PSK collects and processes large volumes of sensitive data, ensuring data security is a top priority. They are investing in advanced data security technologies such as encryption, access control, and threat detection to safeguard their data.
- **Leveraging big data for customer experience:** The PSK is exploring ways to leverage big data analytics to improve the overall customer experience. By analyzing customer data, they can identify pain points in the passport application process and take steps to address them, such as streamlining the application process or improving customer service.

Overall, these initiatives reflect the PSK's commitment to leveraging big data analytics to enhance their operations, improve customer experience, and stay ahead of the curve in a rapidly evolving technological landscape.

4.10.5 Income Tax Return (ITR) Filing [https://www.incometax.gov.in]

The Income Tax Department, Government of India, is responsible for collecting income tax from individuals and businesses in the country. It operates under the supervision of the Central Board of Direct Taxes (CBDT), which is a part of the Department of Revenue in the Ministry of Finance. The Income Tax Department is responsible for enforcing various tax laws and regulations, including the Income Tax Act, the Wealth Tax Act, and the Black Money (Undisclosed Foreign Income and Assets) and Imposition of Tax Act. It also works to combat tax evasion and money laundering by conducting investigations, raids, and seizures of assets.

Individuals and businesses are required to file their income tax returns with the Income Tax Department on an annual basis. The department uses this information to assess their tax liability and issue refunds as necessary. The department also conducts audits and assessments to ensure that taxpayers are compliant with tax laws and regulations. The Income Tax Department has an online portal where taxpayers can file their returns, make payments, and access various other services related to their taxes. The department also provides customer support and assistance to taxpayers through its call center and various other channels.

Big Data Initiatives at Income Tax Department, India

Here is a chronological sequence of major big data initiatives taken by the Income Tax Department, Government of India (Table 4.10):

Table 4.10: Description of Key initiatives taken by Income Tax

Year	**Initiative**	**Description**
2004	Tax Information Network (TIN)	TIN is a nationwide online system for the collection, processing, and monitoring of direct taxes. The TIN system has greatly improved the efficiency and accuracy of tax processing and has enabled taxpayers to access their tax-related information online.
2009	Centralized Processing Center (CPC)	CPC established in Bangalore, is a state-of-the-art processing facility for the electronic processing of income tax returns. The CPC has significantly reduced the processing time for tax returns and has enabled faster refunds for taxpayers.
2010	e-Filing Portal	E-Filing portal is an online platform for taxpayers to file their income tax returns and make online payments. The e-Filing portal has simplified the

		tax filing process for taxpayers and has enabled faster processing of tax returns.
2011	Digital Signature Certificate (DSC)	The Income Tax Department introduced the use of DSC for online tax filing in 2011. The use of DSCs has improved the security and authenticity of online tax filing and has reduced the need for physical documentation.
2015	Electronic Verification Code (EVC)	EVC is an alternative to the physical signature for verifying tax returns filed online. The EVC has made the tax filing process simpler and more convenient for taxpayers.
2017	Project Insight	Project Insight is a big data analytics platform designed to improve tax compliance and identify tax evaders. It uses advanced analytics tools to analyze data from various sources, including bank transactions, property records, and social media, to detect discrepancies and anomalies in tax returns. Income-tax Department initiated Project Insight to focus on three goals: • to promote voluntary compliance and deter noncompliance • to impart confidence that all eligible persons pay appropriate tax • to promote fair and judicious tax administration Under this project an integrated data warehousing and business intelligence platform is being rolled out in a phased manner.
	Income Tax Transaction Analysis Centre (INTRAC)	New centre of Insight called INTRAC that leverages data analytics in tax administration and performs tasks related to data integration, data processing, data quality monitoring, data warehousing, master data management, data analytics, web/text mining, alert generation, compliance management, enterprise reporting and research support.
	Compliance Management Centralized Processing Centre (CMCPC)	CMCPC uses campaign management approach (consisting of emails, SMS, reminders, outbound calls, letters) to support voluntary compliance and resolution of compliance issues. A dedicated compliance portal would be used to capture response on compliance issues in a structured manner for effective compliance monitoring and evaluation.
	Reporting Portal	Reporting Portal is one of the critical components of Insight Platform to collect information from Reporting Entity. The portal can be accessed at https://report.insight.gov.in. The reporting portal has been designed as an integrated portal for all third party reporting activities. The reporting portal provides enhancements (over present upload on e-filing portal) in following aspects: • Seamless data processing & quality monitoring

		• Data encryption for enhanced security • Seamless information exchange with reporting entities • Comprehensive resources module for capacity building • Seamless reporting entity compliance management • Dedicated helpdesk support
2019	Integrated Taxpayer Data Management System (ITDMS)	ITDMS is a big data analytics platform that consolidates data from various sources, including tax returns, PAN cards, TDS statements, and foreign remittances. The platform uses machine learning algorithms to analyze this data and identify potential tax evaders.
2020	Faceless Assessment	Faceless Assessment is a completely online, anonymous, and location-agnostic assessment process for tax returns. This initiative has improved transparency, reduced the scope for corruption and harassment, and has made the assessment process faster and more efficient.
2020	Compliance Management Centralized Processing Center 2.0 (CMCPC 2.0)	CMCPC 2.0 is a big data analytics platform that analyzes data from various sources to identify potential non-compliant taxpayers. The platform uses advanced analytics tools to detect discrepancies and anomalies in tax returns and sends out automated notices to non-compliant taxpayers.
2021	Project Insight Phase II	Project Insight Phase II is an upgraded version of the original Project Insight platform. The platform uses advanced data analytics tools to identify high-risk taxpayers and analyze their financial transactions to detect potential tax evasion.

[Source: https://www.incometax.gov.in]

Roadmap

The Income Tax Department has made significant progress in implementing Big Data analytics initiatives. By continuing to explore innovative technologies and collaborate with other government agencies, the department can further improve its tax compliance efforts and better serve the needs of taxpayers. Some of the areas that could be further explored, include:

- **Collaborate with other government agencies:** The Income Tax Department can collaborate with other government agencies, such as the GST Council and the Ministry of Corporate Affairs, to share data and information on taxpayers. This can help to create a more comprehensive picture of taxpayers' financial activities and improve the accuracy and effectiveness of tax compliance efforts.

- **Improved Data Security and Privacy:** The Income Tax Department must ensure that its Big Data analytics initiatives comply with data security and privacy regulations. The department must implement robust security measures to protect sensitive taxpayer data and ensure that all data analytics processes are carried out in compliance with applicable laws and regulations.
- **Focus on Taxpayer Education:** The Income Tax Department can focus even more on educating taxpayers about the benefits of tax compliance and the consequences of non-compliance. By increasing awareness of tax compliance requirements and making it easier for taxpayers to file their tax returns, the department can improve overall tax compliance and reduce the burden on tax administration.

4.10.6 Indian Railway Catering and Tourism Corporation (IRCTC) [https://www.irctc.co.in/]

Indian Railway Catering and Tourism Corporation (IRCTC) is a subsidiary of the Indian Railways that manages the catering, tourism, and online ticketing operations of the Indian Railways. It was incorporated in 1999 as a public sector undertaking (PSU) under the Ministry of Railways. IRCTC's main objective is to enhance passenger convenience and satisfaction by providing a range of services through its website, mobile app, and other channels. Some of the services offered by IRCTC include online ticket booking, catering and hospitality services, tour packages, hotel bookings, and e-catering services. IRCTC's online ticketing platform, known as the IRCTC website, is one of the most visited websites in India, with millions of users every day. The website allows users to book train tickets, check train availability, cancel tickets, and check PNR status, among other things. IRCTC has also launched several initiatives to enhance passenger comfort and convenience. For example, it has introduced e-catering services that allow passengers to order food from a range of restaurants and food chains while travelling on a train. It has also launched a mobile app that offers a range of services, including train ticket booking, hotel booking, and tour packages.

In recent years, IRCTC has been focusing on leveraging new technologies such as big data analytics, AI and machine learning (ML) to enhance its services and improve the overall passenger experience. It has also partnered with several technology companies and startups to develop innovative solutions and services for its customers. IRCTC plays a critical role in the Indian Railways ecosystem by providing a range of services to passengers and contributing to the growth of the Indian tourism industry.

Big Data Initiatives at IRCTC

IRCTC has undertaken several big data initiatives in recent years as shown in Table 4.11 below.

Table 4.11: Description of Key initiatives by IRCTC

Year	Initiative	Description
2002	Online Ticket Booking	Online ticket booking system launched, which allowed passengers to book train tickets through the Internet.
2005	E-ticketing	E-ticketing introduced, which enabled passengers to book and cancel tickets through the IRCTC website.
2014	Next Generation e-Ticketing System (NGET)	NGET launched, which improved the website's capacity to book and handle a large number of transactions at once.
2014	Mobile Application	Official mobile application launched, which allowed users to book train tickets, check their PNR status, and get updates on train schedules and routes.
2015	Business Intelligence and Analytics (BI&A) system	New analytics platform BI&A system launched. The platform was developed to analyze passenger data and generate insights that could be used to improve the overall passenger experience. The BI&A system was based on the SAP HANA platform and was designed to process large volumes of data in real-time.
2016	AskDISHA	Service "AskDISHA" launched that leveraged AI and NLP technologies to answer customer queries. The service was designed to improve customer satisfaction by providing quick and accurate responses to customer queries. AskDISHA was built using IBM Watson's AI platform and was integrated with IRCTC's ticketing system.
2016	Food On Track app	Food On Track app launched, which allowed passengers to order food from their preferred restaurants and have it delivered to their seats on the train.
2017	Business Intelligence Portal (BIP)	New data analytics tool called BIP launched to provide real-time analytics and insights into various aspects of IRCTC's operations, such as ticket bookings, cancellations, and refunds. The tool was based on the Hadoop big data platform and was developed in-house by IRCTC's IT

		team.
2017	Rail Connect app	Rail Connect app launched, which was a revamped version of its earlier mobile application. The app included additional features such as seat availability and fare enquiry.
2018	AskDISHA AI-powered chatbot	IRCTC partnered with the Centre for Railway Information Systems (CRIS) to develop a new AI-powered chatbot called AskDISHA to provide customers with quick and accurate responses to their queries related to train timings, ticket bookings, and other aspects of railway travel. The chatbot was built using Microsoft's Bot Framework and was integrated with IRCTC's ticketing system.
2018	Predictive tool	IRCTC introduced a new feature that predicted the probability of a waitlisted ticket getting confirmed.
2019	Project Swarna	New initiative called Operation Gold Standard or "Project Swarna" launched to improve the overall passenger experience. As part of this initiative, IRCTC used big data analytics to identify areas for improvement, such as cleanliness, punctuality, and catering. The initiative also involved the use of AI-powered surveillance cameras to monitor the cleanliness of trains and railway stations.
2020	Partnered with Google to integrate its ticket booking platform with Google Pay	IRCTC partnered with Google to integrate its ticket booking platform with Google Pay. The integration was designed to simplify the ticket booking process for customers and provide them with a seamless payment experience. The partnership also involved the use of big data analytics to analyze customer behavior and preferences, which could be used to improve the overall customer experience.
2021	QR code-based ticket checking system	QR code-based ticket checking system introduced, which enabled ticket examiners to scan the QR code on a passenger's ticket to verify its authenticity.
2021	Presence on two new social media platforms such as Koo and Telegram	IRCTC connected with its users on two new social media platforms such as Koo and Telegram.

[Source: https://www.irctc.co.in/]

Roadmap

The catering division is gradually pivoting from a product business to a service business further strengthening IRCTC's position as a tech player. Previously, only IRCTC food was served on trains. Now, the e-catering feature allows customers to order from partner restaurants charging a fee for the transaction. This provides the customers with menu diversity and greater choices. The Railneer segment is expected to perform better in the quarters ahead with higher utilization and increased consumption of packaged drinking water. In addition to the 15 plants for drinking water bottles at present, four more production facilities are under construction. Recently, the management notified that the company is planning to build and operate budget hotels across the country. For this first-of-a-kind initiative, it has estimated an investment of INR 5000 million for the first phase.

4.11 Concluding Remarks

This chapter presented the research variables identified based on the insights and learning through literature review, functional experience and a pilot study. The conceptual research framework has been developed on the basis of the theoretical background. Further, a description of macro as well as micro research variables and research hypotheses related to variables for statistical testing has been formulated. Brief descriptions of research methods in terms of qualitative and quantitative techniques to validate the proposed framework are also covered in this chapter. Project decriptions, big data initiatives and roadmaps of the selected e-governance projects are also covered in this chapter. The implementation of the research methodology based on a qualitative approach using, TISM-P to study and verify the interrelationships of the constituents of ‘use of big data for e-governance performance’ is presented in the next chapter.

Chapter 5

Qualitative Validation of ‘Performance of E-Governance using Big Data’ Framework[2]

5.1 Introduction

‘Performance of e-governance projects using big data’ is measured in terms of four macro variables or factors, viz., ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS). The big data related macro variables are ‘Information and data’ (ID), ‘Information technology’ (IT), ‘Organization and management’ (OM), ‘Law and regulation’ (LR) and ‘Institution and environment’ (IE). It is assumed that e-governance performance is influenced by each one of these macro variables. There are hardly any empirically validated framework in the literature for assessing or measuring the ‘Performance of e-governance projects using big data’. Therefore, this study is an effort towards this direction of conceptualizing a framework and validating that empirically. To do so, in the previous chapter, a research framework has been conceptualized along with the constituting macro and micro variables. A qualitative research methodology, i.e., Total Interpretive Structural Modeling with Polarity (TISM-P) has been applied to find out and analyze the interrelationship among the variables of the proposed framework. The verification of the proposed frameworks has been taken up further by assessing it through the feedback received from the domain experts who were given the questionnaire having five options of agreement. The following sections describe the TISM-P approach for questionnaire development and survey methodology.

5.2 Methodology

Macro variables (factors) and micro variables (indicators) constituting the ‘e-governance performance’ and big data related factors and indicators influencing ‘e-governance performance’ were identified through review of literature as listed in Table 4.1 and Table 4.2 in the last chapter. This study for qualitative validation selected a panel of 32 experts that included e-governance practitioners, consultants, and academicians with at least 5 years of working experience in e-governance. Analysis of experts' inputs after

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[2]Part of this chapter has been published as

Verma, C. & Suri, P. K. (2022, December) Hierarchical Model for Big Data in E-Governance: Using Delphi and Total Interpretive Structural Modeling with Polarity (TISM-P) during GLOGIFT 2022 @LM Thapar School of Management, Punjab

two rounds of Delphi led to a list of 9 factors and 40 indicators (initially 46 indicators were identified from the literature review). Out of these 9 factors, 4 were constituent factors of ‘e-governance performance’ vis-a-vis ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS). The other 5 were big data related factors, vis-à-vis ‘Information and data’ (ID), ‘Information technology’ (IT), ‘Organization and management’ (OM), ‘Law and regulation’ (LR), and ‘Institution and environment’ (IE). The study uses Delphi followed by TISM-P. TISM-P is an enhancement of Interpretive Structural Modeling (ISM) to explore the hierarchical models that aid in theory building in information and organization management. The polarity of relationship between elements makes the model more explanatory. This study explores the key elements of a hierarchical model for big data in e-governance. The model also depicts the polarity of relationships between the elements. Out of these 32 experts, responses from 10 experts were used to develop the hierarchical model and later assess the validity of the hierarchical model. The resulting hierarchical model for big data in e-governance depicted the polarity of relationship between elements apart from the different set of levels.

5.2.1 Identify a Panel of Experts

Delphi requires inputs from a panel of experts. Judgments are more effective when inputs are obtained from different experts. Therefore, the panel of 32 experts for this study included practitioners (17), consultants (10), and academicians (05). Academicians included those who have research or teaching experience of more than 5 years in e-governance. Practitioners and consultants included government officers working on e-governance projects for more than 5 years. It was, therefore, ensured that all these experts have at least 5 years of work experience in e-governance. These experts in e-governance were shortlisted through purposive sampling. Purposive sampling was used because it assumes that a researcher's knowledge about the subject and related population can be used to select the experts (Polit and Hungler, 1997).

5.2.2 Conduct Modified Delphi Survey (Round1)

The initial questionnaire, attached in Appendix III (a), was designed that included a set of open-ended questions based on an extensive review of the literature. The pilot version of the questionnaire included 9 factors and 46 indicators. This pilot version was reviewed and corrected by an assessment group. Three options for each item are presumed to include essential, useful but not essential, and not necessary. Content Validity Ratio

(CVR), is calculated as CVR = (Ne – N/2)/(N/2), where, Ne is the number of experts who indicated that an item is "essential" and N is the total number of experts. If a panel has 32 experts, then the CVR threshold is 0.375 (Lawshe, 1975). CVR was calculated and CVR< 0.375, hence was rejected. The factor and the indicator with the highest level of consensus (> 70%) goes to the next round (Gordijn et al., 2016; Napitupulu et al., 2018) for effective results.

5.2.3 Conduct Delphi Survey (Round2)

The questionnaires were sent to 32 experts who were involved in the Round1 as shown in Table 5.1. Out of 32, only 28 experts responded. CVR for this round was calculated; CVR< 0.357 are rejected because, with 28 expert panelists, the least accepted score of CVR is 0.357 (Lawshe, 1975).

5.2.4 TISM-P Models for the Research (Round3)

Theory building in information management requires mapping of the mental models and hypothesized relationships (Sushil, 2018). This mapping may be done using multiple methods. One such method is ISM or TISM. ISM (Warfield, 1974) and TISM (Sushil 2012, 2018) are interpretive methods to convert ill-structured mental models into well-structured and articulated hierarchical conceptual models. TISM-P is an enhanced methodology with polarity of relationships (Sushil, 2018). The broad steps for TISM-P are shown in Table 5.1 below.

Table 5.1: TISM-P Process and Broad Steps

Step No.	Step Name	Description
1.	Define Elements, Contextual Relationships, and Interpretation	Through literature review and discussion with experts
2.	Develop questionnaire with successive comparisons along with Transitivity checks and polarity of relationships	Elements are pair-compaired in a successive manner. With every pair comparison, the direction of the relationship is assessed as forward (i-j), backward (j-i), both ways (i=j), and no relationship (0). Polarity (+ve/-ve) is also specified if there is relationship.

<table>
<tr><td>3.</td><td>Get pair-comparisons with simultaneous Transitivity checks</td><td>Pair-comparisons are made by experts and transitivity checks are done by researcher and if no transitivity then it is done by expert along with the polarity.</td></tr>
<tr><td>4.</td><td>Develop successive comparison digraph and then transitive reachability matrix along with polarity. Convert this into reachability matrix without polarity</td><td>Pair-comparisons converted using the following:

<table>
<tr><th rowspan="2">Pair</th><th colspan="2">Polarity</th><th colspan="2">Cell</th></tr>
<tr><td>+ve</td><td>-ve</td><td>ij</td><td>ji</td></tr>
<tr><td>i-j</td><td>+ve</td><td></td><td>+1</td><td>0</td></tr>
<tr><td>i-j</td><td></td><td>-ve</td><td>-1</td><td>0</td></tr>
<tr><td>j-i</td><td>+ve</td><td></td><td>0</td><td>+1</td></tr>
<tr><td>j-i</td><td></td><td>-ve</td><td>0</td><td>-1</td></tr>
<tr><td>i=j</td><td>+ve</td><td></td><td>+1</td><td>+1</td></tr>
<tr><td>i=j</td><td></td><td>-ve</td><td>-1</td><td>-1</td></tr>
<tr><td>0*</td><td></td><td></td><td>0</td><td>0</td></tr>
</table>
* no relationship
Reachability Matrix with +1, -1 and 0 converted into binary reachability matrix with 1 (for +1/-1) and 0 entries with marked transitive relationships.</td></tr>
<tr><td>5.</td><td>Carry out hierarchical partitioning of the reachability matrix</td><td>Find reachability, antecedent and intersection set for all elements. Elements having same reachability and intersection sets are taken at highest level, and the process is repeated after iteratively removing these elements till all the elements are classified into different levels of hierarchy.</td></tr>
<tr><td>6.</td><td>Prepare hierarchical digraph and direct interaction matrix with polarity of relationships</td><td>Arrange elements in hierarchical levels and link them with direct as well as select transitive links as per the reachability matrix with polarity.</td></tr>
<tr><td>7.</td><td>Prepare Interpretive Matrix with Polarity</td><td>Experts consulted back to interpret the links.</td></tr>
<tr><td>8.</td><td>Prepare TISM-P</td><td>Both Nodes and links are interpreted</td></tr>
<tr><td>9.</td><td>Classification of elements</td><td>Sum of row(s) in reachability matrix (step 4) gives the driving power and the sum of column(s) gives the dependence of respective elements. Further classified as driver, linkage, autonomous and dependent elements.</td></tr>
<tr><td>10.</td><td>Grouping of elements on TISM for better comprehension</td><td>The elements (driver, linkage, autonomous and dependent) with +ve or –ve orientation are grouped and placed on the TISM model.</td></tr>
</table>

11.	Identify Paths with polarity	The paths from driver (elements) to dependent (elements) through linkages are identified and their polarities are examined.

[Source: Sushil (2018)]

5.3 Results

5.3.1 Delphi (Round1)

In this round, one item 'open data' (having CVR < 0.375) in the original questionnaire was rejected. Others like 'techniques' was merged with 'Algorithms & scalability', 'Resistance to change' was merged with 'internal conflicts', 'talent' was merged with 'qualified personnel', 'Lack of alignment of organizational goals and project' was merged with 'Multiple or conflicting goals' and 'Awareness' was merged with 'Organizational change' (Table 5.2). The new questionnaire that includes 9 factors and 40 indicators was used for the survey in Round2.

5.3.2 Delphi (Round2)

Since the Round2 results show that CVR > 0.357 for all indicators, therefore, this confirms that the variables have already reached high concentration. The final big data model for e-governance performance consisted of 9 factors and 40 indicators (Table 5.2).

Table 5.2: The Results of the two Delphi Rounds

Factor/Indicator	**Round1 (Accepted/ Rejected)**	**Round2 (Accepted/ Rejected)**
'Efficiency' (EF)		
(EF1:FEP) 'Fast execution of core process'	Accepted	Accepted
(EF2:SOP) 'Simplification of processes'	Accepted	Accepted
(EF3:REP) 'Reduced paperwork'	Accepted	Accepted
(EF4:REC) 'Reduced cost'	Accepted	Accepted
'Transparency' (TR)		
(TR1:REI) 'Reliable information'	Accepted	Accepted
(TR2:COI) 'Comprehensive information'	Accepted	Accepted
(TR3:EAI) 'Easy access to information'	Accepted	Accepted
(TR4:FAR) 'Fairness'	Accepted	Accepted
'Interactivity' (IN)		

(IN1:IMI) ‘Improved interaction’	Accepted	Accepted
(IN2:PAR) ‘Participative’	Accepted	Accepted
(IN3:COO) ‘Consensus-oriented’	Accepted	Accepted
‘Decision support’ (DS)		
(DS1:IMP, IDM) ‘Improved planning and decision-making’	Accepted	Accepted
(DS2:BMC) ‘Better monitoring and control’	Accepted	Accepted
(DS3:ACC) ‘Accountability’	Accepted	Accepted
‘Information and data‘ (ID)		
(ID1:IDQ) ‘Information and data quality’	Accepted	Accepted
(ID2:DYI) ‘Dynamic information’	Accepted	Accepted
(ID3:PAS) ‘Privacy and security’	Accepted	Accepted
(ID4) ‘Preservation and curation’ **(merged with ID3)**	Accepted	Accepted
(ID5) ‘Data ownership’ **(merged with ID3)**	Accepted	Accepted
(ID6) ‘Open data’	**Rejected**	
‘Information technology’ (IT)		
(IT1:USE) ‘Usability’	Accepted	Accepted
(IT2:SEI) ‘Security issues’	Accepted	Accepted
(IT3:TEC) ‘Technological incompatibility’	Accepted	Accepted
(IT4) ‘Technology complexity’ **(merged with IT5)**	Accepted	Accepted
(IT5:TEN) ‘Technology newness’	Accepted	Accepted
(IT6:TSE) ‘Technical skills and experience’	Accepted	Accepted
(IT7) ‘Techniques’ (IT8:TAS) ‘Algorithms and scalability’ **(merged with IT7)**	Accepted Accepted	Accepted
‘Organization and management’ (OM)		
(OM1:PRS) ‘Project size’	Accepted	Accepted
(OM2:MAB) ‘Manager’s attitudes and behaviour’	Accepted	Accepted
(OM3:UOD) ‘Users or organizational diversity’	Accepted	Accepted
(OM4:AOG) ‘Lack of alignment of organizational goals and project’ (OM5) ‘Multiple or conflicting goals’ **(merged with OM4))**	Accepted Accepted	Accepted
(OM6:RTC) ‘Resistance to change’ (OM7) ‘Turf and internal conflicts’ **(merged with OM6)**	Accepted Accepted	Accepted
(OM8:QUP) ‘Qualified personnel’	Accepted	Accepted
(OM9) ‘Awareness’ (OM10) ‘Organizational change’ **(merged with OM9)**	Accepted Accepted	Accepted
(OM11) ‘Talent’ **(merged with OM8)**	Accepted	Accepted
‘Law and regulation’ (LR)		

(LR1:CLR) ‘Restrictive laws and regulations’	Accepted	Accepted
(LR2:CSB) ‘Budgeting, budget allocation and disbursement’	Accepted	Accepted
(LR3:IGR) ‘Intergovernmental relationships’	Accepted	Accepted
‘Institution and environment’ (IE)		
(IE1:PSC) ‘Privacy and related security concerns’	Accepted	Accepted
(IE2”AOA) ‘Autonomy of agencies’	Accepted	Accepted
(IE3:PPP) ‘Policy and political considerations’	Accepted	Accepted
(IE4:ENV) ‘Environmental (social, economic, demographic) context’	Accepted	Accepted

5.3.3 Total Interpretive Structural Model with Polarity of Relationships: TISM-P (Round3)

TISM-P was developed as follows by using the broad steps as described in Table 5.1 above. TISM-P analysis is a stepwise process involving eleven steps. These steps are illustrated systematically along with the matrices and corresponding figures using the factors affecting ‘e-governance performance’ by using big data.

Step 1: Identification and Definition of Elements, Contextual Relationships, and Interpretation

The factors accepted after two rounds of Delphi were taken as the elements (Table 5.3) for developing the hierarchical big data model for e-governance. The initial set of factors were conceptualized through literature review and discussion with experts. Major nine factors were identified after a thorough review of literature. These were improvement in ‘Efficiency’ (EF) due to e-governance project, ‘Transparency’ (TR) through the use of the e-governance project, improved ‘Interactivity’ (IN) through the e-governance project, ‘Decision support’ (DS)as a result of the use of the e-governance project. These were the factors that are basically constituents of the ‘e-governance performance’. The other factors were basically big data related factors that influence the ‘Performance of the e-governance projects using big data’. These factors included ‘Information and data’ (ID) in the e-governance project using big data, ‘Information technology’ (IT) specially to cater to the big data in e-governance project, ‘Organization and management’ (OM) perspective for the organization involved in implementation, ‘Law and regulation’ (LR) framework of the government and finally the ‘Institution and environment’ (IE) factors that may influence the ‘Performance of e-governance projects using big data’. These factors are summarised in Table 5.3. The contextual relationship is regarding the influence (+ve/-ve) and the interpretation is all about how or in what way one factor influences the other as given in Table 5.3.

Table 5.3: Elements, Contextual Relationship and Interpretation

Element No.	Elements	Contextual Relationship	Interpretation
1.	'Efficiency' (EF)	Element A of the 'big data model for e-governance' will influence element B (positively or negatively) of 'big data model for e-governance'	How or in what way element A of 'big data model for e-governance' will influence element B of 'big data model for e-governance'.
2.	'Transparency' (TR)		
3.	'Interactivity' (IN)		
4.	'Decision support' (DS)		
5.	'Information and data' (ID)		
6.	'Information technology' (IT)		
7.	'Organization and management' (OM)		
8.	'Law and regulation' (LR)		
9.	'Institution and environment' (IE)		

Step 2: Develop questionnaire with successive comparisons along with Transitivity checks and Polarity of relationships

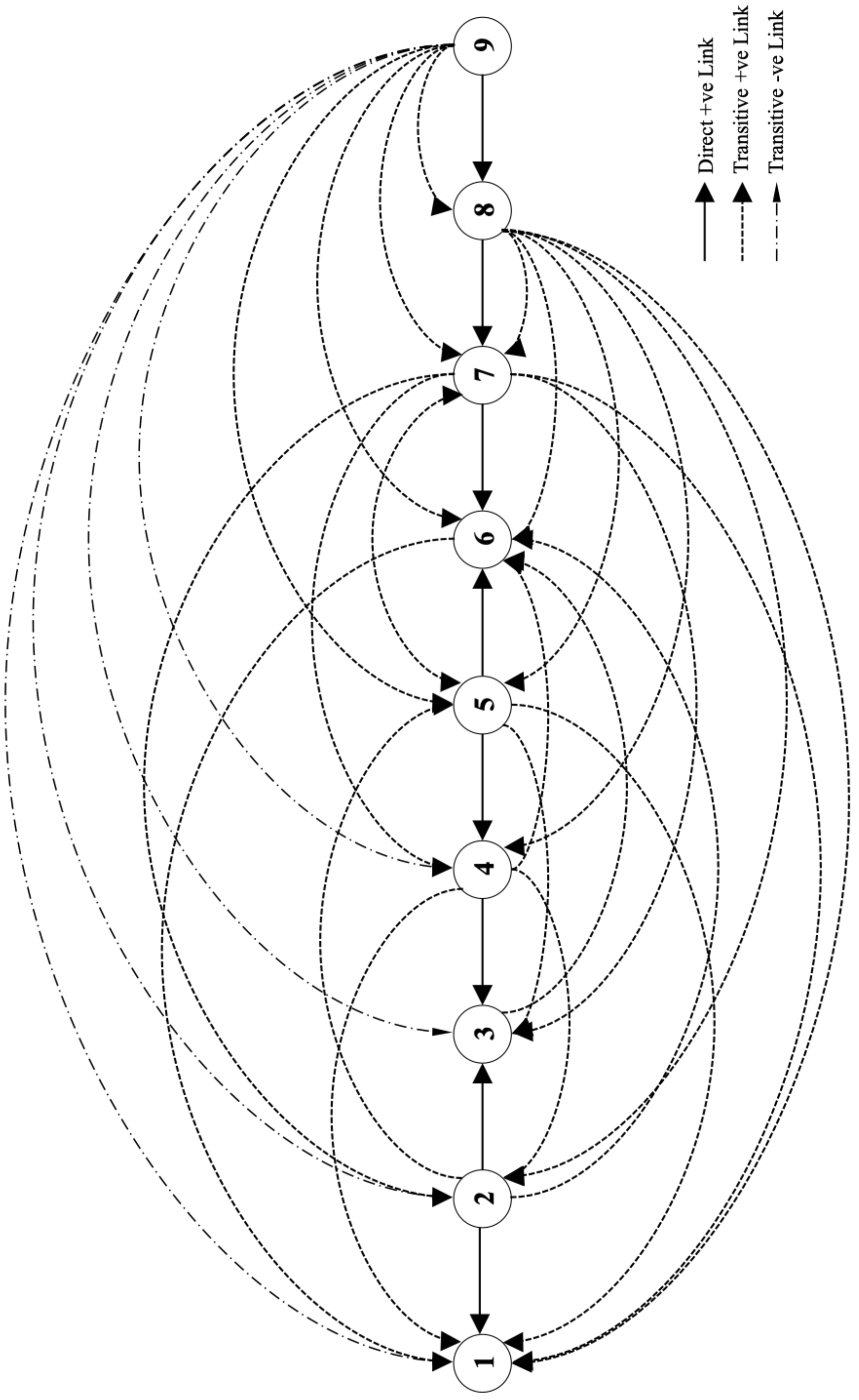
A questionnaire was developed for successive pair-comparisons along with the polarity of their relationships [Appendix III (a)]. Elements are pair-compaired in a successive manner. With every pair comparison, the direction of the relationship is assessed as forward (i-j), backward (j-i), both ways (i=j), and no relationship (0). Polarity (+ve/-ve) is also specified if there is relationship, e.g., 'Transparency' affects 'Efficiency' with positive impact means high level of 'Transparenc***y***' will result in increased 'Efficiency' in e-governance projects [Appendix III (a)]. The direct successive comparisons (1,2; 2,3; 3,4; 4,5; 5,6; 6,7; 7,8; 8,9) in the questionnaire were obtained from the experts in e-governance using big data. The transitive comparisons in between have been carried out. In case of the transitivity, the polarity has also been derived logically using the polarity of previous relationships. If any transitivity check depicts 'No', then the concerned pair was subjected to expert opinion for final confirmation.

Step 3: Get pair-comparisons with simultaneous Transitivity checks

Pair-comparisons are made by experts and transitivity checks are done by researcher and if no transitivity then it is done by expert along with the polarity. The response for pair-wise comparisons and inputs for transitive checks with no transitivity was taken from 4 experts as described in the research methodology above. Appendix III (a) shows transitivity between element 1 [‘Efficiency’ (EF)] and element 4 [‘Decision support’ (DS)].

Step 4: Development of successive comparison Digraph, Transitive Reachability Matrix along with Polarity and conversion into Reachability Matrix without Polarity

A comparison digraph was prepared to have a visualization of the relationships with polarity from the answering of the questionnaire and the calculated transitivity as given in Figure 5.1 below. It shows the direct +ve/-ve links between the elements and also the transitive +ve/-ve links if there exist one. We can see that ‘Transparency’ (TR) has a direct positive impact on ‘Efficiency’ (EF) that means the ‘Performance of the e-governance projects using big data’ in terms of the efficiency may improve by increasing ‘Transparency’ (TR). ‘Transparency’ (TR) also has a direct positive impact on the ‘Interactivity’ (IN) of the e-governance projects. So beneficiaries and implementers would prefer to interact more with the online system if they feel that it is transparent. ‘Information and data’ used in e-governance may increase the decision-making capability that may enhance the decision support for the beneficiaries and it may further directly impact the ‘Interactivity’. It is quite evident from Figure 5.1 that ‘Information and data’ and ‘Organization and management’ (OM) factors directly impact the kind of ‘Information technology’ (IT) that will be used for the e-governance projects. ‘Institution and environment’ (IE) directly impact the ‘Law and regulation’ (LR) framework that in turn impacts the ‘Organization and management’ (OM) capabilities for the ‘e-governance projects using big data’. Apart from these direct links there are many transitive and positive links like ‘Decision support’ (DS) will enhance the ‘Efficiency’ (EF) of the ‘e-governance projects using big data’. There are transitive links that impact negatively like extensive set of ‘Institution and environment’ issues may hamper the ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS) for the beneficiaries. Side-by-side the relationships are entered as ‘+1’, ‘-1’ or 0 in the Reachability Matrix with polarity as shown in Table 5.4. Colour coding may be done both in the digraph and the Reachability Matrix to visualize direct and transitive relationships with +ve or –ve polarity. The reachability matrix with polarity is shown in Table 5.4.



1 = 'Efficiency' (EF); 2 = 'Transparency' (TR); 3 = 'Interactivity' (IN); 4 = 'Decision support' (DS); 5 = 'Information and data' (ID); 6 = 'Information technology' (IT); 7 = 'Organization and management' (OM); 8 = 'Law and regulation' (LR); 9 = 'Institution and environment' (IE)

Figure 5.1: Successive Comparison Digraph with Direct and Transitive Links with Polarity of Links (Relationships)

Table 5.4: Reachability Matrix with Polarity of Relationships

Criteria	1	2	3	4	5	6	7	8	9	Driving Power	
1	1	0	0	0	0	0	0	0	0	+ve 1	-ve
1/2	1/1	1	0/1	0*/1	0*/1	0*/1	0/0	0/0	0/0	0 6	0
2/3	+1/0	1/0	1	+1*/0	+1*/0	+1*/1*	0/0	0/0	0/0	5 2	0
3/4	0*/1	0/0	1/1	1	0/0	+1*/1*	0/0	0/0	0/0	1 3	0
4/5	+1*/1*	0/0	+1/1*	1/1	1	+1*/1	0*/1	0/0	0/0	2 6	0
5/6	+1*/1*	0/0	+1*/0	+1/0	1/0	1	+1*/0	0/0	0/0	5 2	0
6/7	+1*/0	0*/1	0*/1	0*/1	0*/1	1/1	1	0/0	0/0	1 6	0
7/8	0*/1	+1*/1*	+1*/1*	+1*/1*	+1*/1*	+1/1*	1/1	1	0/0	5 8	0
8/9	+1*/1*	+1*/1*	+1*/1*	+1*/1*	+1*/1*	+1*/1*	+1/1*	1/1	1	7 9	0
9/Dependence	-1*/7	-1*/4	-1*/7	-1*/7	-1*/5	-1*/8	+1*/4	+1/2	1/1	2	6
Dependence	6	2	6	5	4	6	3	1	1		
+ve and -ve	1	1	1	1	1	1	0	0	0		

* Transitive Relationship

The reachability matrix along with the polarity is converted into a reachability matrix without polarity by replacing entries with '+1' and '-1' by '1' entry as shown in Table 5.5.

Table 5.5: Transitive Reachability Matrix

* Transitive Relationship

Step 5: Carry out Hierarchical partitioning of the Reachability Matrix

The reachability matrix in Table 5.5 is the fully transitive reachability matrix. It is used as the foundation for hierarchical partitioning, different iterations of this are illustrated in Appendix III (b) and the level-wise placement of all the nine factors is summarised in Table 5.6 below.

Table 5.6: List of Elements and their corresponding Levels in TISM

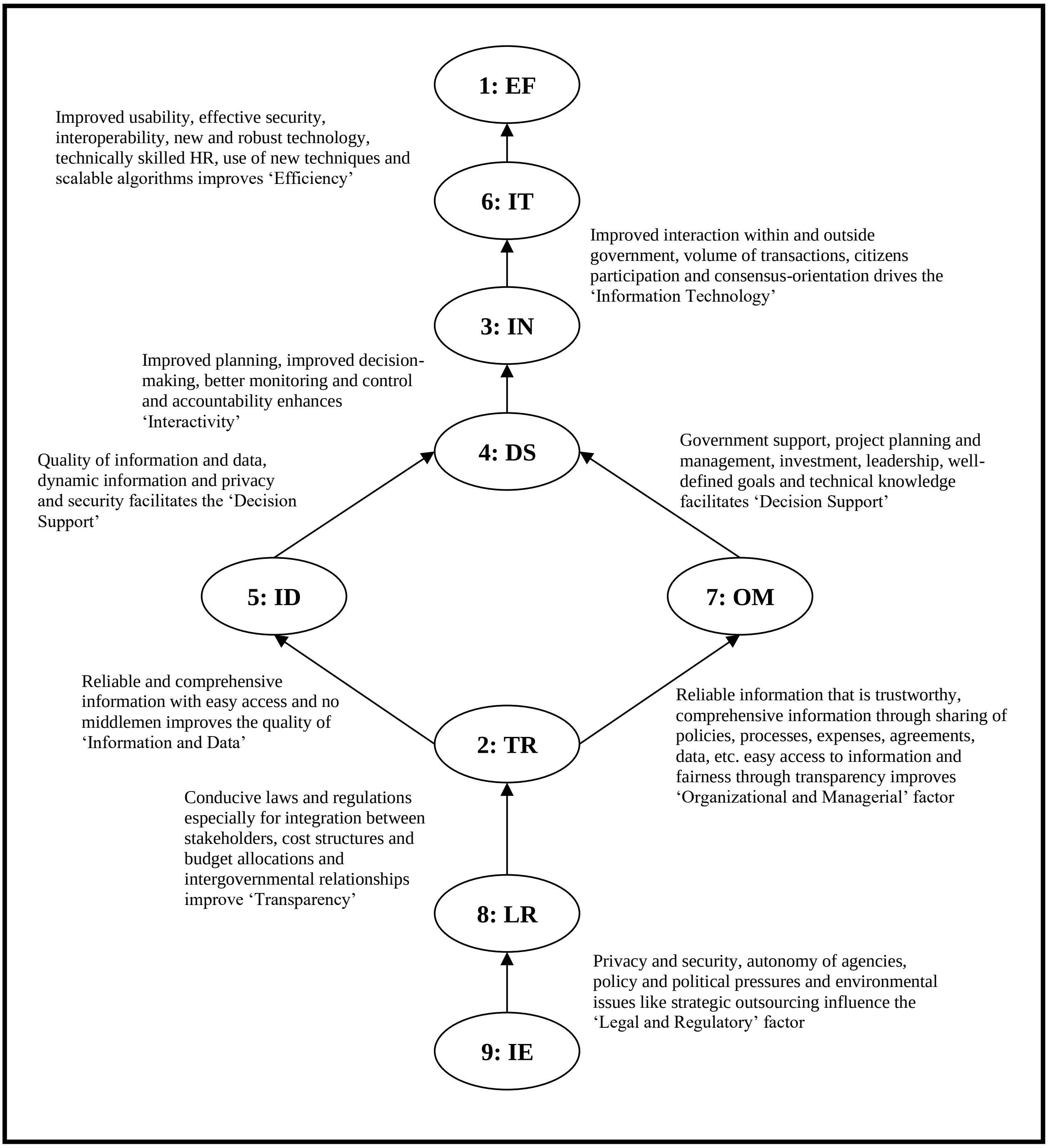
Element No.	Elements	Level in TISM
1.	'Efficiency' (EF)	I
2.	'Transparency' (TR)	VI
3.	'Interactivity' (IN)	III

4.	‘Decision support’ (DS)	IV
5.	‘Information and data’ (ID)	V
6.	‘Information technology’ (IT)	II
7.	‘Organization and management’ (OM)	V
8.	‘Law and regulation’ (LR)	VII
9.	‘Institution and environment’ (IE)	VIII

It may be observed from Table 5.6 that the ‘Efficiency’ (EF) is at highest level, level I and ‘Institution and environment’ (IE) factor is at the lowest level, level VIII. It is followed by ‘Information technology’ (IT) at level II, ‘Interactivity’ (IN) at level III and ‘Decision support’ (DS) at level IV. ‘Information and data’ (ID) and ‘Organization and management’ (OM) are both at the same level V. ‘Transparency’ (TR) is at level VI and finally ‘Law and regulation’ (LR) are at last but one level that is level VII.

Step 6: Prepare Hierarchical digraph and Direct Interaction Matrix with Polarity of Relationships

The elements are arranged as per the level from the hierarchical partitioning. Elements are connected to each other with links that depict the polarity (+ve/-ve) between them (Figure 5.2). The diagraph in Figure 5.2 shows that issues related to ‘Institution and environment’ (IE) influence the ‘Law and regulation’ (LR) mechanism that in turn influence the ‘Transparency’ (TR) of e-governance projects.



1 = 'Efficiency' (EF); 2 = 'Transparency' (TR); 3 = 'Interactivity' (IN); 4 = 'Decision support' (DS); 5 = 'Information and data' (ID); 6 = 'Information technology' (IT); 7 = 'Organization and management' (OM); 8 = 'Law and regulation' (LR); 9 = 'Institution and environment' (IE)

Figure 5.2: Digraph after Hierarchical Partitioning

TR impacts the 'Information and data' (ID) and 'Organization and management' (OM) variables. ID and OM then influence the 'Decision support' (DS) that influences the interactivity for the users and this along with 'Information technology' (IT) results in efficient e-governance projects. Select transitive links (having distinct influence) are retained and rest other transitive links are dropped while preparing the hierarchical

Criteria	1	2	3	4	5	6	7	8	9
1	-	0	0	0	0	0	0	0	0
2	+1	-	+1	+1*	+1*	+1*	0	0	0
3	0	0	-	0	0	+1*	0	0	0
4	+1*	0	+1	-	0	+1*	0	0	0
5	+1*	0	+1*	+1	-	+1	+1*	0	0
6	+1*	0	0	0	0	-	0	0	0
7	0	+1*	+1*	+1*	+1*	+1	-	0	0
8	+1*	+1*	+1*	+1*	+1*	+1*	+1	-	0
9	-1*	-1*	-1*	-1*	-1*	-1*	+1*	+1	-

digraph. The final digraph is translated first into binary interaction matrix with polarity (Table 5.7).

Step 7: Prepare Interpretive Matrix with Polarity

The experts' knowledge is used to convert all +1/-1 into binary interaction matrix (Table 5.7).

Step 8: Prepare TISM-P

The nodes in the hierarchical digraph (Figure 5.2) are interpreted as elements and links are interpreted from the interpretation matrix (Table 5.7). Binary interaction matrix (Table 5.7) is used for the interpretive matrix (Table 5.8) that gives interpretation to each link.

Table 5.7: Interaction Matrix (Binary Matrix with Polarity)

* Transitive Relationship

The interpretation of the nodes and links gives the final total interpretive structural big data model in e-governance with polarity of relationships is shown in Figure 5.3. In this case, 'Institution and environment' positively influences 'Law and regulation' that further influences 'Transparency' (TR) and in turn finally the 'Efficiency' (EF) of e-governance is improved. The TISM model with polarity (TISM-P) is more explanatory both regarding the interpretation of relationships and their polarity than ISM.

Table 5.8: Interpretive Matrix

S. No.	1: EF	2: TR	3: IN	4: DS	5: ID	6: IT	7: OM	8: LR	9: IE
1	-	0	0	0	0	0	0	0	0
2	Reliable, comprehensive, easy to access information reduces corruption to increase efficiency	-	Transparent system result in interactive and participative systems	Transparent systems facilitate improved decision-making and better monitoring and control	Transparent system will dictate the data, privacy and security	Transparent systems will drive the IT	0	0	0
3	0	0	-	0	0	Interactivity drives the IT	0	0	0
4	Improved decision-making, monitoring increases efficiency	0	Better decision-making and monitoring will result in better interactivity	-	0	Decision-making and monitoring requirements will drive IT	0	0	0
5	Information/Data quality and ownership	0	Information and data quality, security will	Information and data quality enhances the	-	Information and data requirements will drive the	Information and data quality strengthen the	0	0

	increases efficiency		make systems more interactive	decision-making and data control		IT algorithms and techniques	OM skills and users		
6	Usability, techniques, algorithms and stability increase efficiency	0	0	0	0	-	0	0	0
7	0	OM will facilitate the transparency	OM will facilitate the interactivity	OM will facilitate the decision-making and data control	OM will facilitate the ID quality	OM will facilitate the IT techniques, compatibilities, etc.	-	0	0
8	Legal and regulatory frameworks have provisions for enhanced efficiency	LR does affect the transparency requirements	LR also guides on access controls for interactivity	Provisions for decision-making and data monitoring, etc.	Provisions and rules for ID privacy, security, ownership, etc.	IT requirements acts and laws, etc.	LR affects the OM diversity, structure and culture	-	0
9	Environmental issues may hamper the efficiency	IE may hamper the transparency	IE may hamper the interactivity	IE may hamper the decision-making and data control, etc.	IE may hamper ID attributes	IE may hamper IT attributes	IE may facilitate OM	IE may enhance LR	-

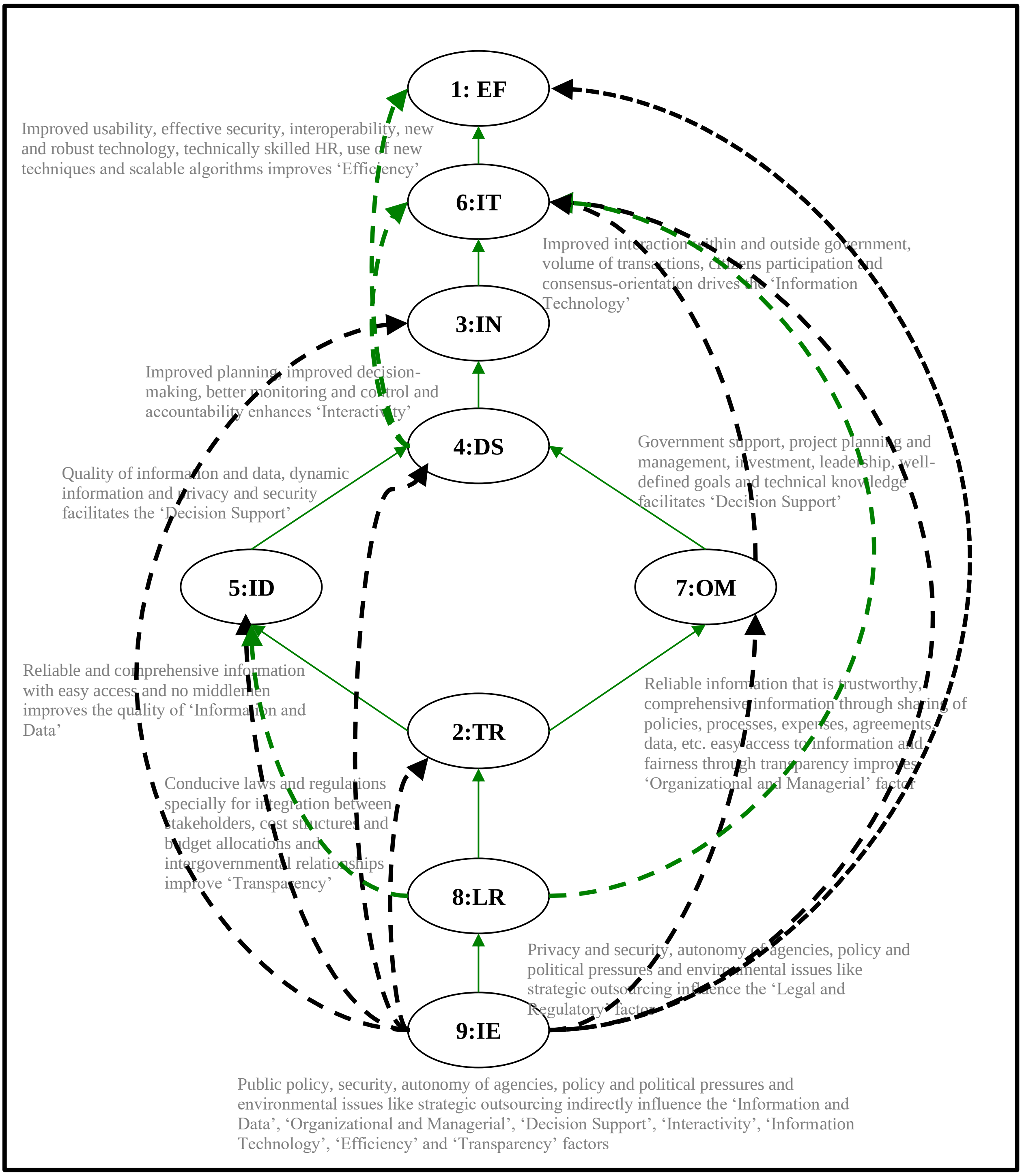


Figure 5.3: TISM-P for 'Performance of E-Governance Projects using Big Data'

[Green colour: +ve relationship ; Black colour: The relationship can be +ve/-ve]

Step 9: Classification of Elements

Classification of the elements done by placing them on the driving power-dependence graph. The reachability matrix (Table 5.5) is used to calculate the driving power and dependence. An element is classified as driver if it has high driving power (low dependence), as linkage if it has medium driving power (medium dependence) and as dependent or outcomes if it has low driving power (high dependence).

Step 10: Grouping of Elements on TISM for Better Comprehension

Classification of variables is superimposed on the TISM as in Figure 5.4 and that shows the classification of variables with their +ve/-ve orientations and interrelationships with polarity in one diagram. This kind of representation gives insight into theory building. The TISM-P will thus help in the formulation of both the positive and negative hypotheses, with mediation effect through linkages. Figure 5.4 shows that there are no autonomous criteria or factors that have low dependence and low driving power. ‘Institution and environment’ (IE), ‘Law and regulation’ (LR) and ‘Transparency’ (TR) factors are the drivers for the overall model. Only one factor ‘Efficiency’ (EF) is there that has high dependence and low driving power.

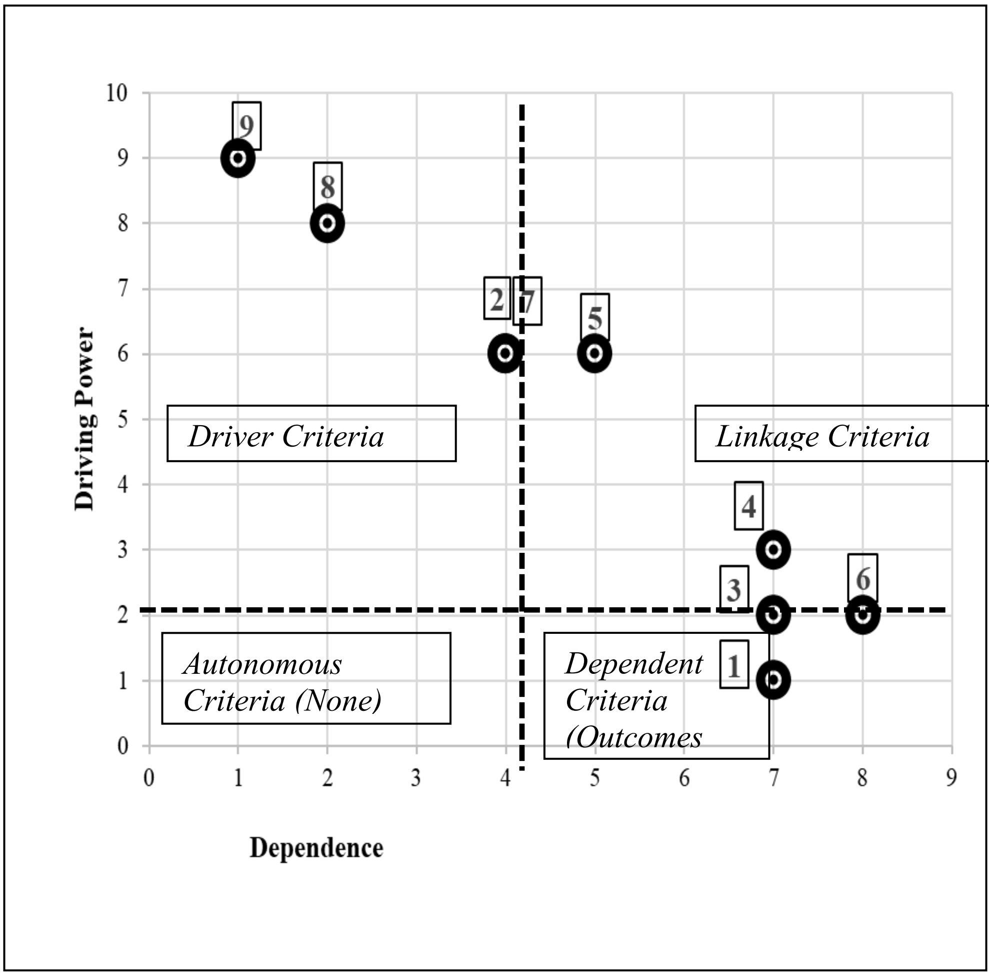


Figure 5.4: TISM-P and Classification of Variables for ‘Performance of E-Governance Projects using Big Data’

There are multiple linkage criteria or factors like ‘Interactivity’ (IN), ‘Decision support’ (DS), ‘Information and data’ (ID) and ‘Information technology’ (IT) that have high dependence as well as high driving power in the overall model.

Step 11: Identify Paths with Polarity

As a start point, the four (check) driver criteria are taken to trace their influence paths on the outcomes going through the intermediate variables that are directly influenced by them (Table 5.9).

Table 5.9: Nature of Paths

Driver Variables	Path through the Variables	Polarity of Path
‘Transparency’ (TR) (2)	‘Information and data’ (ID) (5)	+ve
	‘Organization and management’ (OM) (7)	+ve
‘Information and data’ (ID) (5)	‘Decision support’ (DS) (4)	+ve
‘Organization and management’ (OM) (7)	‘Decision support’ (DS) (4)	+ve
‘Law and regulation’ (LR) (8)	‘Transparency’ (TR) (2) ‘Information and data’ (ID) (5)	+ve +ve
‘Institution and environment’ (IE) (9)	All	+ve/-ve

5.4 Discussion

This study contributes to the e-governance literature in the use of big data in e-governance research. It is an endeavour to conceptualize the e-governance model for projects using big data through the set of indicators and factors whose importance was assessed through two rounds of the Delphi and TISM-P analysis. Nine main factors with 40 indicators were identified, concluding with four output factors constituting the ‘Performance of the e-governance projects using big data’ and five input factors related to big data that influence the ‘Performance of e-governance projects using big data’. TISM-P analysis depicted the driver-dependence relationship with polarity.

Surprisingly, the more important elements of the overall big data model for e-governance are technical indicators from the ‘Information technology’ factor including ‘Technology newness’ that means technology being current and latest to handle huge amount of data and related privacy and security issues. ‘Technology compatibility’ with the existing infrastructure is also very pivotal. Apart from the technical issues, the ‘inter-governmental’ indicators were perceived as the most important indicator in influencing the ‘Performance of e-governance projects using big data’ as e-governance services are delivered with the interplay of multiple departments and divisions of the government.

Moreover, there are a few factors even though they are less important but are indispensable for the big data model for an e-governance system. There is a validation of the factors that were used in a few previous studies. This study has added value by assessing the relative importance of each indicator as well as each factor. Important factors for e-governance performance are ‘Efficiency’ (EF) and ‘Decision support’ (DS), in which the two most strongly weighted indicators are ‘Improved planning and decision-making’ and ‘Fast execution of core process’. The most important big data related factors impacting e-governance performance are ‘Information technology’ (IT) and ‘Information and data’ (ID), in which the most strongly weighted indicators are ‘Technological incompatibility’, ‘Technology newness’, ‘Security issues', and 'Privacy and security’.

Building upon the e-governance literature, this analysis explores the usage of big data to enhance the ‘Performance of e-governance projects using big data’. This analysis helps overcome the disadvantages of traditional e-governance systems by using big data for added value. This research may have a huge significance in establishing the relevance of the role of big data for effective e-governance and may be useful for designing a conceptual framework for ‘Performance of e-governance projects using big data’.

5.5 Concluding Remarks

The chapter started with the main indicators and factors of the big data model for assessing the ‘Performance of e-governance projects using big data’. There were 9 factors and 40 indicators of the e-governance model using big data that were further used for developing the TISM-P. Total interpretive structural big data model with polarity was developed using the TISM-P methodology. It is an attempt to utilize TISM-P to develop driver-dependence relationship between big data-related indicators for e-governance including the polarity of relationships. Macro and micro variables identified for study through literature review, practical experience and content experts helped in developing the conceptual framework. Response to TISM-P questionnaire from ten subject experts facilitated this TISM-P model. The reasoning of the agreement has been captured through an interpretive logic knowledge base. The logic knowledge base enabled the creation of a hierarchical level of the variables represented through the digraph for validating the conceptual framework. The variable placed at the top of the model has higher precedence and those at the bottom have a high driving capability. The logic knowledge base obtained from the analysis is further synthesised in the form of an interpretive matrix for deriving the relationship amongst the variables. This results in a valuable knowledge base that can be further used by the practitioners for a better understanding of the domain. This study uses the dual approach of validation of conceptualised framework. Validation of the framework through a qualitative approach is presented in this chapter. Statistical validation of the research framework through a quantitative approach by applying the PLS-SEM tool is presented in the next chapter.

Chapter 6
Empirical Validation of ‘Performance of E-Governance using Big Data’ Framework

6.1 Introduction

This chapter presents empirical validation of the proposed research framework for ‘Performance of e-governance using big data’. PLS-SEM has been used for analysing the collected survey data. The conceptual research model has been tested and examined in the light of statistical support for related hypotheses.

The chapter has been structured as follows: First, a description of survey questionnaire development and sampling method is presented that is followed by a discussion of how the data set is prepared for the analysis. Further, the reliability and validity test has been conducted to establish the reliability for internal consistency and validity of the constructs through the appropriate measurement models. Finally, the hypotheses formulated based on conceptual research framework (*Chapter 4, Figure 4.1*) have been examined.

6.2 Survey Questionnaire and Pre-Testing

This section presents details of the development of survey questionnaires, sampling method, and data collection used for the research.

6.2.1 Questionnaire Development

A close-ended questionnaire based on five point Likert scale has been used to collect the data during the period from January 2023 to May 2023. The initial version of the questionnaire is pre-tested with the help of captive audiences (Bailey, 1994) such as fellow research scholars, academic experts, citizens and practitioners in domain of e-governance and big data. A group of 18 members was included in the pre-testing group. Each member was given a draft questionnaire typed with triple line space which allowed them to write comments on each questionnaire item. Members checked all the aspects of the questionnaire such as question-wording, question order, missing questions, inappropriate, inadequate, or confusing response categories, and so forth (Baily, 1994). Members were asked to re-state questions that are difficult to understand or to answer by the respondents. Positive feedback was received from the pre-testing of the questionnaire.

The research questionnaire (Appendix I and Appendix II), is divided into three parts: (i) A non-disclosure undertaking and instructions for respondents who are filling up the questionnaire; (ii) Demographic information (gender, age group, educational qualification, profession, etc.) of the respondents; (iii) Questions to capture the data required to test and validate the conceptual research framework. The response to questions presented in part three of the questionnaire, is captured through a five point Likert scale. It is a commonly used summated scale which makes it easy for respondents to provide their feedback on each item depending on its intensity (Millar, 1970). In the survey questionnaire used in present study, '1' represents 'Strongly Disagree', '2' represents 'Disagree', '3' represents Can't Say', '4' represents 'Agree' and '5' represents 'Strongly Agree'. Feedback received helped in refining and finalizing the questionnaire. While developing the questionnaire, the issue of non-response bias and Common Method Bias (CMB) was also addressed. To avoid the non-response bias, a close-ended questionnaire was developed. A neutral questionnaire was prepared and due care was taken to avoid the personal opinions of the researcher. Double-barreled questions, i.e., questions that touch on more than one issue but allow for only one answer have also been avoided. With two questions in one, it's impossible to know which question the respondent's answer applies to. Further, it has been ensured that options for the questions cover the required possible answers and provide an "interest hypothesis" (Benson, 1946; Donald, 1960). The "interest hypothesis" assumes that respondents who are more interested in the subject matter of the questionnaire respond more promptly (Reuss, 1943; Baur, 1947; Larson and Catton, 1959).

6.2.2 Sampling Method

In this study, the referral sampling approach has been used for data collection due to the non-availability of the sampling frame and challenges in identifying the beneficiaries as well as implementers of the services. The questionnaire for conducting the survey was first served to the identified beneficiaries and implementers in person and they were requested to further refer to those whom they know and have availed/implemented the services of select projects taken for the study. The prospective respondents were contacted through email and WhatsApp. The survey questionnaires were served to them through these platforms.

6.2.3 Target Respondents and Sample Size

The sample should be an effective representation of the population and the sample size should be sufficient enough to address the research questions (Collis and Hussey, 2013). At times a small sample size may hamper some important statistical tests among the proposed relationships of the hypotheses (Collis and Hussey, 2013). The target respondents of the study are beneficiaries (who availed the e-governance services) as well as implementers of any of the five e-governance projects selected for the study: (i) Aadhaar card from UIDAI; (ii) CGHS; (iii) Passport Seva Project (PSP); (iv) Income Tax Return (ITR) filing; (v) Indian Railway Catering and Tourism Corporation (IRCTC).

Both online and offline survey methods have been used to collect the responses. In offline data collection, the questionnaire was served to the identified respondent physically. For online data collection, Google form was used. The link to the Google form-based questionnaire was forwarded to prospective respondents by email and WhatsApp. The questionnaire was circulated to around 600 respondents (beneficiaries). However, 439 of them responded. Out of 439 responses, 12 forms were found to be incomplete. Hence, valid responses collected for the study were 427. The sample size of 427 was considered suitable for the study as recommended for analysis using Structural Equation Modeling (Hair et al., 2010). As this study uses PLS-SEM to analyze the proposed conceptual model, a sample size of 427 was considered to be adequate for that as well (Sarstedt et al., 2017). Regarding the data collection form the implementers of e-governance services of the selected e-governance projects, the questionnaire was circulated to around 150 implementers. However, 120 of the implementers responded. Out of 120 responses, 02 forms were found to be incomplete. Hence, valid responses were 118. The sample size of 118 (implementers) was considered suitable for the study as recommended for analysis using Structural Equation Modeling (Hair et al., 2010). As this study uses PLS-SEM to analyze the proposed conceptual model, a sample size of 118 (implementers) was considered to be adequate for that as well (Sarstedt et al., 2017).

6.2.4 Pilot Testing

A pilot study is conducted as a small-scaled version or trial run before conducting a full-fledged study (Polit et al., 2002). Pilot testing of questionnaires helps in removing the redundancy and ambiguity that may exist in them. It also helps the researchers in obtaining the assessment of the validity and reliability of the questionnaires (Saunders et al., 2012). Validity is the process of seeking feedback from an expert or group of experts that helps in freezing the representativeness and suitability of the questionnaire. Reliability is concerned with the consistency of responses to questions (Saunders et al., 2012).

There are several rules for determining the sample size for a pilot study. Cooper and Schindler (2011) suggested a sample between 25 and 100 individuals. It is also said that a range from 10 to 30 individuals is enough for a pilot test (Isaac and Michael, 1995). Moreover, several scholars suggested that the sample size should be 10 per cent of the sample project for the main study (Connelly, 2008). Furthermore, the sample size could also be decided based on the type of analysis at the preliminary stage (Cooper and Schindler, 2011). A sample of 30 respondents is usually considered as adequate for conducting a pilot study (Memon et al., 2017). A total of 51 responses for the pilot survey were collected to check the validity and reliability of the questionnaire. Common method bias (Podsakoff et al., 2003; Ketokivi and Schroeder, 2004; MacKenzie and Podsakoff, 2012) has been reduced by taking care of the following:

- Respondents were provided with the information on purpose of research. They were also provided with the set of instructions as to how to submit their response and how their information will be used and how their correct response shall help facilitate the government in providing better and effective e-governance services to the citizens (Podsakoff et al., 2003; 2012). Redundant and overlap information were minimized.
- Ambiguous scale items are difficult to understand and interpret, therefore, ambiguous terms such as *‘occasionally’ and ‘somewhat’, and* words with multiple meanings and multiple ideas in an item were removed. Scale item clarity was improved through these measures.
- Positive and negative items were balanced. The questionnaire was presented to the respondents in a manner to break the patterns that may cause CMB.

6.2.5 Respondents' Profile

A survey was conducted on two basic aspects namely demographic data and subject related data through questionnaire. Demographic statistics contain the respondent's gender, age group, qualification level, profession, etc. Table 6.1 shows frequency analysis of the demographic profile of respondents (beneficiaries) to understand the usage pattern of select 'e-governance projects using big data' by different demographic groups.

Table 6.1: Sample Profile of Respondents (Beneficiaries) of E-Governance Projects using Big Data'

Variables	**Groups**	**Frequency**	**Percentage**
Gender	Male	247	58
	Female	179	42
Age	18-30 years	222	52.1
	31-45 years	82	19.2
	46-60 years	87	20.4
	More than 60 years	35	8.2
Education Level	No schooling	0	0
	Till Class X	2	0.5
	Till Class XII	20	4.7
	Undergraduate	181	42.4
	Postgraduate	128	30
	Professional	48	11.2
	Doctoral	47	11
Employment Status	Employed	191	45
	Unemployed	22	5.2
	Retired	34	8
	Business	5	1.2
	Student	161	38
	Not Applicable	10	2.4
	Self employed	3	0.7
Area of occupation	Student	153	35.8
	Government	137	32.1
	Information Technology	70	16.4
	Education	31	7.3

	Medical/Health	9	2.1
	Others (Financial Institution, Aviation, FMCG, Business, Manufacturing, Mechanical Engineer, NGO, Biotechnology, R&D, Legal, Architecture, etc.)	27	7
Annual approximate earning (INR)	Less than 2 lacs	26	6.1
	2 lacs - 5 lacs	27	6.3
	5 lacs - 10 lacs	68	15.9
	10 lacs - 20 lacs	66	15.5
	More than 20 lacs	73	17.1
	Not Applicable	167	39.1
Organization	Central Government	98	23
	State Government	38	8.9
	Autonomous	47	11
	Private Industry	82	19.2
	Business	6	1.4
	Not Applicable	156	36.5
Work experience (years)	Less than 5	62	14.5
	5 - 10	35	8.2
	11 - 15	42	9.8
	16 - 20	14	3.3
	More than 21	114	26.7
	Not Applicable	160	37.5
E-governance services availed	Aadhaar card from UIDAI	213	48.5
	CGHS	53	12.1
	PSP	53	12.1
	ITR filing	54	12.3
	IRCTC	54	12.3

As seen in Table 6.1, male (58%) representation was more than the females (42%). Though the difference in male and female representation was not much. The respondents mostly belonged to the age group of 18 to 60 years. Very few were above 60 years (8.2%). The education level of the respondent has been reflected in seven different categories as

‘No schooling’, ‘Till Class X’, ‘Till Class XII’, ‘Undergraduate’, ‘Postgraduate’, ‘Professional’ and ‘Doctoral’. However, the qualification of most of the respondents was undergraduation (42.4%), followed by postgraduation (30%), professional (11.2%) and doctoral (11%). Employment status of most of the respondents was either employed (45%) or not employed for student (38%). Area of occupation of respondents was students (35.8%), followed by government job (32.1%) and then IT job (16.4%). Annual approximate earning (INR) is mostly more than 5 lacs. Respondents work for different set of organizations like in Central government (23%), private industry (19.2%) and State government (8.9%). There are respondents who may not be working and mentioned not applicable (36.5) in response to organization. As far as work experience (years) is concerned, many of the respondents mentioned as not applicable (37.5%). Out of those who had experience, many respondents have more than 21 years of professional experience (26.7%), followed by less than 5 years (14.5%), 11-15 years (9.8), 5-10 years (8.2%) and 16-20 years (3.3%). As far as the e-governance services usage pattern is concerned, the majority of the respondents (48.5%) have used e-governance services for ‘Aadhaar card from UIDAI’ followed by approximately 12% of usage for other e-governance services like CGHS, PSP, ITR filing and IRCTC.

Table 6.2 shows frequency analysis of the demographic profile of respondents (implementers) to understand the usage pattern of select ‘e-governance projects using big data’ by different demographic groups.

Table 6.2: Sample Profile of Respondents (Implementers) of ‘E-Governance Projects using Big Data’

Variables	**Groups**	**Frequency**	**Percentage**
Gender	Male	73	61.86
	Female	45	38.14
Age	31-45 years	55	46.60
	46-60 years	63	53.40
Education Level	Undergraduate degree	51	43.22
	Postgraduate degree	31	26.27
	Professional degree	20	16.95
	Doctoral degree	11	9.32
	Other	5	4.23

Employment Status	Employed	118	100
Area of occupation	Government	67	56.78
	Information Technology (IT)	51	43.22
Annual approximate earning (INR)	Less than 2 lacs	6	5.09
	2 lacs - 5 lacs	5	4.24
	5 lacs - 10 lacs	18	15.25
	10 lacs - 20 lacs	40	33.90
	More than 20 lacs	49	41.52
Organization	Central Government	68	57.63
	State Government	3	2.54
	Autonomous	3	2.54
	Private Industry	44	37.29
Work experience (years)	Less than 5	11	9.32
	5 - 10	16	13.56
	11 - 15	11	9.32
	16 - 20	47	39.83
	More than 21	33	27.97
E-governance services implemented	Aadhaar card from UIDAI	30	25.42
	CGHS	21	17.80
	PSP	20	16.95
	ITR filing	22	18.64
	IRCTC	25	21.19

As seen in Table 6.1, male (61.86%) representation was more than the females (38.14%). The respondents mostly belonged to the age group of 31 to 60 years with 46-60 years being 53.4% and 31-45 years being 46.60%. The qualification of most of the respondents was undergraduation (43.22%), followed by postgraduation (26.27%), professional (16.95%) and doctoral (9.32%). Employment status of all the respondents was employed. Area of occupation of respondents was government job (56.78%) and IT job (43.22%). Annual approximate earning (INR) is mostly more than 20 lacs. Respondents work for different set of organizations like in Central government (57.63%), private industry (37.29%) and State government (2.54%). As far as work experience (years) is concerned, many respondents have 16–20 years (39.83%), followed by more than 21 years of professional experience (27.97%), followed by 5-10 years (13.56%), then 11-15 years

(9.32%) and less than 5 years (9.32%). Regarding the e-governance implementation pattern, more than 15% have implemented e-governance services for Aadhaar card from UIDAI, CGHS, PSP, ITR filing and IRCTC each.

The collected sample data was edited through coding, tabulation, grouping, and organised according to the requirement of the study. SmartPLS version 4.0 has been used to load the data and run the model for multiple set of analyses.

6.3 Validity and Reliability Test

A validity test through factor analysis is required for assessing the relevance and appropriateness of the constructs in the conceptual research framework. But choosing between exploratory factor analysis (EFA) or CFA gets confusing for the researchers. EFA is primarily used for theory generation, whereas CFA is used for a theory-testing method (Henson and Roberts, 2006). EFA can be employed when little is known regarding the factor structure and number of factors (Green et al., 2016). This method is mainly adopted during the scale development process and used to specify construct dimensions (Reise et al., 2000; Thompson, 2004; Pallant, 2007). However, CFA is more appropriate with a well-established scale and a priori knowledge of the factor structure (Green et al., 2016). Unlike EFA, CFA is driven by theoretical expectations regarding the structure of the data (Henson and Roberts, 2006). Therefore, CFA should be conducted if the scale is well established and adopted from past literature with explicit theoretical grounding.

Moreover, using both EFA and CFA on the same data set seems to be a common practice among the researchers. Henson and Roberts (2006) prohibit using EFA with CFA by stating, “It is not informative, and can be potentially misleading, to follow an EFA with a CFA on the same data set”. According to Green et al. (2016) “conducting both EFA and CFA on the same dataset confirms nothing else except demonstrating that the two modeling approaches on the same data converge”. Therefore, it is recommended by Green et al., (2016) that the “factor structure from an EFA should be confirmed with CFA on a different data set”. The researchers should just apply CFA as long as the questionnaire is well designed (adopted or adapted) with the support from theory and literature review. In this study, the proposed conceptual framework based on the literature review has been first validated using the TISM-P approach (Chapter 5). The questionnaire designed for the empirical analysis is well supported by theory. CFA has, therefore, been followed to validate the constructs (Green et al., 2016). Cronbach's alpha and composite reliability has been computed to ascertain internal consistencies and the reliability of the questionnaire. The correlation analysis has been undertaken to ascertain the relationship between variables. The subsequent sections describe these in detail.

6.4 Correlation Analysis

The correlation matrix for all micro variables shows that all the variables have a high positive correlation with each other. A positive correlation is considered as good to interpret that the statement was simple, understandable and relevant to the respondents. Due to positive correlations among the variables, these are retained in the conceptual model.

6.5 Data Analysis

The primary focus of the research is to identify and explain the key target constructs and/or identify the key driver constructs (Rigdon, 2014; Hair et al., 2017) of 'big data in e-governance performance'. The conceptual framework proposed for validation in this study is a reflective-formative-formative model. Approach of PLS-SEM has been adopted using the software SmartPLS version 4.0. This tool also facilitates both modes (regression and correlation weights) in the measurement model more efficiently (Hair et al., 2017).

6.5.1 Partial Least Squares-Structural Equation Modeling (PLS-SEM)

PLS-SEM is capable of handling complex cause-effect structural models (Gudergan et al., 2008; Rigdon, 2014; Richter et al., 2016; Hair et al., 2019) and is a suitable analytical tool for models with many constructs and indicators, (Hair et al., 2017). PLS-SEM is used when the structural model is complex and is based on extension of established theories, path model includes one or more formatively measured constructs, sample size is small, distribution issues are a concern such as lack of normality and when research requires latent variable scores for follow-up analyses for higher order constructs (Hair et al., 2019). Hair et al. (2017) suggested that the complexity of structural model does not require a large sample size because the "PLS algorithm does not compute all the relationships at the same time". As far as the data distribution is concerned, PLS-SEM is labelled as soft-

Modeling because of its greater flexibility to accommodate distributional assumptions (Wold, 1984; Hair et al., 2017). Hence, when the multivariate normality assumption is a concern, PLS-SEM would be a better option for analysis (Hair et al., 2017). For this research, the Cramer-von Mises p-value < 0.05 that shows that the data is not normal (Leong et al., 2020). Because of the non-normality of the distribution, the variance-based SEM of PLS was adopted (Hair et al., 2019; Leong et al., 2020). PLS-SEM is robust against non-normal distribution compared to the covariance-based SEM (Leong et al., 2020).

6.5.2 Evaluation of Measurement Models of Lower Order Components (LOCs) of 'E-Governance Performance using Big Data'

SEM is divided into two models, i.e., the measurement model and the structural model (Figure 6.1).

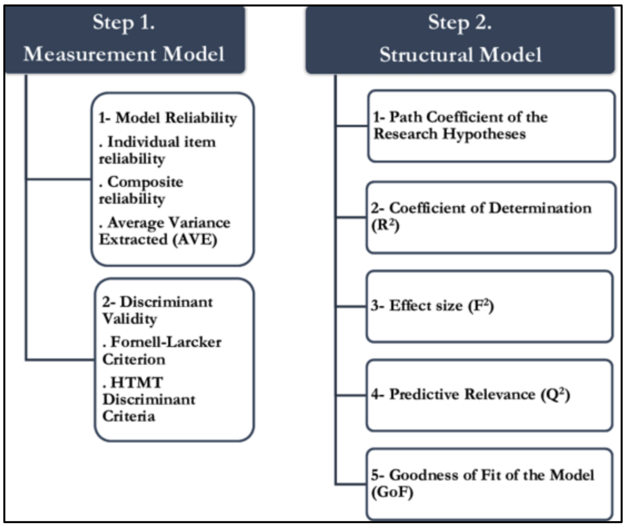


Figure 6.1: Steps of SmartPLS Data Analysis

[Source: Fehan and Aigbogun (2021)]

The measurement model helps in assessing the reliability and validity of the construct. The reliability of the construct shows its consistency whereas the validity of the construct shows its accuracy. In this section evaluation of measurement models of lower order constructs of 'e-governance performance using big data' are presented. In this study the conceptual framework is a third order SEM model. The third order construct is 'E-Governance Performance' (EGP). The second/higher order components (HOCs) are 'Efficiency' (EF), 'Transparency' (TR), 'Interactivity' (IN) and 'Decision support' (DS) for the endogenous variable. The HOCs for big data related variables are ‘Information and data’ (ID) and ‘Information technology’ (IT), ‘Organization and management’ (OM), ‘Law and regulation’ (LR) and ‘Institution and environment’ (IE). The LOCs for ‘E-Governance Performance’ are: ‘Fast execution of core process’ (FEP), ‘Simplification of processes’ (SOP), ‘Reduced paperwork’ (REP), ‘Reduced cost’ (REC), ‘Reliable information’ (REI), ‘Comprehensive information’ (COI), ‘Easy access to information’ (EAI), ‘Fairness’ (FAR), ‘Improved interaction’ (IMI), ‘Participative’ (PAR), ‘Consensus-oriented’ (COO), ‘Improved planning’ (IMP), ‘Improved decision-making’ (IDM), ‘Better monitoring and control’ (BMC), ‘Accountability’ (ACC). The LOCs for big data related macro variable ‘Information and data’ (ID) are: ‘Information and data quality’ (IDQ), ‘Dynamic information’ (DYI) and ‘Privacy and security’ (PAS). For macro variable ‘Information technology’ (IT), LOCs are: ‘Usability’ (USE) ‘Security issues’ (SEI), ‘Technological compatibility/interoperability’ (TEC), ‘Technology complexity/newness’ (TEN), ‘Technical skills and experience’ (TSE) and ‘Techniques, algorithms and scalability’ (TAS). For macro variable ‘Organization and management’ (OM), LOCs are: ‘Project size’ (PRS), ‘Manager’s attitudes and behavior’ (MAB), ‘Users or organizational diversity’ (UOD), ‘Alignment and awareness of organizational goals’ (AOG), ‘Resistance to change/internal conflicts’ (RTC) and ‘Qualified personnel/talent’ (QUP). For macro variable ‘Law and regulation’ (LR), LOCs are: ‘Conducive laws and regulations’ (CLR), ‘Cost structures’, ‘Budgeting, Budget allocation and disbursement’ (CSB) and ‘Intergovernmental relationships’ (IGR). For macro variable ‘Institution and environment’ (IE), LOCs are: ‘Privacy and related security concerns’ (PSC), ‘Autonomy of agencies’ (AOA), ‘Policy and political pressures’ (PPP) and ‘Environmental’ (ENV). In this section the evaluation of measurement models for LOCs is done.

Construct Reliability and Validity

Primarily, construct reliability is analyzed in terms of alpha value referred to as Cronbach’s alpha. Cronbach's alpha value should be greater than 0.70 for it to be considered adequate (Fornell and Larcker, 1981). Bagozzi (1991) advises that Cronbach’s alpha with a value greater than 0.60 is desirable. An alpha value below 0.60 indicates a lack of reliability (Hair et al., 2011) but in some cases, 0.60 may also be acceptable (Hair et al., 1998). In this study, Cronbach's alpha value of 0.70 has been taken as the threshold. Table 6.3 presents the Cronbach's alpha value for the survey questionnaire items associated with each micro variable. An analysis of Cronbach’s alpha value reveals that all the alpha values are greater than the recommended threshold of 0.70. The value of Composite Reliability (CR) is also taken into consideration along with the alpha value. CR value should also be >=0.70. In this case, CR values as shown in Table 6.3 are also as per the recommended threshold. This too, reflects that our constructs are reliable. Rho is also considered one of the measures of reliability for the construct. The Rho value should be in between the value of Cronbach's alpha and CR values. It can be seen in Table 6.3 that all Rho values are in between Cronbach's alpha and CR values.

Table 6.3: Internal Consistency for Constructs of 'Performance of E-Governance Projects using Big Data'

	Cronbach's alpha	**Composite reliability (rho_a)**	**Composite reliability (CR)**	**Average variance extracted (AVE)**
'Efficiency' (EF)	**0.966**	**0.967**	**0.969**	**0.609**
'Fast execution of core process' (FEP)	0.916	0.922	0.937	0.750
'Simplification of processes' (SOP)	0.927	0.928	0.945	0.774
'Reduced paperwork' (REP)	0.895	0.897	0.923	0.704
'Reduced cost' (REC)	0.924	0.929	0.943	0.769
'Transparency' (TR)	**0.974**	**0.976**	**0.976**	**0.676**
'Reliable information' (REI)	0.919	0.922	0.940	0.757
'Comprehensive information' (COI)	0.940	0.941	0.954	0.806
'Easy access to information' (EAI)	0.931	0.932	0.948	0.784
'Fairness' (FAR)	0.922	0.933	0.942	0.765
'Interactivity' (IN)	**0.962**	**0.965**	**0.966**	**0.641**
'Improved interaction' (IMI)	0.931	0.932	0.946	0.743
'Participative' (PAR)	0.897	0.905	0.924	0.708
'Consensus-oriented' (COO)	0.930	0.931	0.947	0.782
'Decision support' (DS)	**0.979**	**0.980**	**0.981**	**0.719**
'Improved planning' (IMP)	0.948	0.948	0.960	0.827
'Improved decision-making' (IDM)	0.947	0.947	0.959	0.825
'Better monitoring and control' (BMC)	0.931	0.934	0.949	0.787
'Accountability' (ACC)	0.950	0.951	0.962	0.834
'Information and data' (ID)	**0.975**	**0.975**	**0.977**	**0.727**
'Information and data quality' (IDQ)	0.954	0.955	0.963	0.815
'Dynamic information' (DYI)	0.938	0.941	0.953	0.803

'Privacy and security' (PAS)	0.930	0.931	0.947	0.782
'Information technology' (IT)	**0.969**	**0.979**	**0.972**	**0.555**
'Usability' (USE)	0.943	0.945	0.954	0.778
'Security issues' (SEI)	0.943	0.944	0.954	0.778
'Technological compatibility' (TEC)	0.822	0.902	0.864	0.575
'Technology complexity/newness' (TEN)	0.745	1.120	0.725	0.413
'Technical skills and experience' (TSE)	0.948	0.949	0.960	0.828
'Techniques, algorithms and scalability' (TAS)	0.945	0.945	0.958	0.820
'Organization and management' (OM)	**0.973**	**0.978**	**0.975**	**0.611**
'Project size' (PRS)	0.931	0.932	0.951	0.828
'Manager's attitudes and behavior' (MAB)	0.928	0.929	0.949	0.823
'Users or organizational diversity' (UOD)	0.925	0.925	0.947	0.817
'Alignment and awareness of organizational goals' (AOG)	0.937	0.937	0.955	0.841
'Resistance to change/internal conflicts' (RTC)	0.925	0.934	0.947	0.816
'Qualified personnel/talent' (QUP)	0.962	0.962	0.970	0.841
'Law and regulation' (LR)	**0.969**	**0.973**	**0.973**	**0.707**
'Conducive laws and regulations' (CLR)	0.934	0.958	0.951	0.767
'Cost structures, budgeting, budget allocation and disbursement' (CSB)	0.931	0.932	0.948	0.785
'Intergovernmental relationships' (IGR)	0.926	0.927	0.948	0.819
'Institution and environment' (IE)	**0.978**	**0.978**	**0.980**	**0.738**
'Privacy and related security concerns' (PSC)	0.949	0.950	0.963	0.868
'Autonomy of agencies' (AOA)	0.933	0.934	0.952	0.833
'Policy and political pressures' (PPP)	0.934	0.938	0.951	0.795
'Environmental' (ENV)	0.924	0.928	0.946	0.815
Performance	**0.991**	**0.992**	**0.992**	**0.611**

The validity of the construct shows that the construct taken for the study is acceptable and can measure the outcome of the construct through its indicators. To analyze the validity of the constructs two types of validity are generally analyzed in terms of convergent validity and discriminate validity.

Convergent Validity

It shows that all the data items converge into a construct to which they belong. To measure convergent validity, the value of Average Variance Extracted (AVE) is computed. The value of AVE should be greater than 0.50. It can be seen from Table 6.3 that the value of AVE of all the constructs is >0.50 which confirms the convergent validity of the constructs. The convergent validity of a construct is also assessed through factor loadings. Factor loadings in PLS are termed as outer loadings and the value of 0.708 or more is considered appropriate. Convergent validity for 'Efficiency' (EF), 'Transparency' (TR), 'Interactivity' (IN) and 'Decision support' (DS) are shown in Table 6.4 below. Factor loadings meet the criteria >0.708. Few indicators (TEC4, TEC5, TEN2, TEN3, TEN4 and CLR1) do not fulfill the criteria as factor loadings <0.708. AVE is also greater than 0.5. But AVE for micro variable 'TEN' <0.5 and does not fulfill the criteria. Hence these were dropped for the final model.

Table 6.4: Convergent Validity for Constructs of 'Performance of E-Governance Projects using Big Data'

Constructs and Items	**Factor loading**	**Result (Criteria>0.708)**	**AVE**	**Result (AVE>0.5)**
'Efficiency' (EF)				
'Fast execution of core process' (FEP)			0.750	Fulfilled
FEP1	0.899	Fulfilled		
FEP2	0.827	Fulfilled		
FEP3	0.890	Fulfilled		
FEP4	0.910	Fulfilled		
FEP5	0.799	Fulfilled		
'Reduced cost' (REC)			0.769	Fulfilled
REC1	0.861	Fulfilled		
REC2	0.893	Fulfilled		
REC3	0.870	Fulfilled		
REC4	0.821	Fulfilled		
REC5	0.935	Fulfilled		
'Reduced paperwork' (REP)			0.704	Fulfilled
REP1	0.857	Fulfilled		
REP2	0.843	Fulfilled		
REP3	0.831	Fulfilled		
REP4	0.813	Fulfilled		

REP5	0.851	Fulfilled		
‘Simplification of processes’ (SOP)			0.774	Fulfilled
SOP1	0.895	Fulfilled		
SOP2	0.908	Fulfilled		
SOP3	0.875	Fulfilled		
SOP4	0.860	Fulfilled		
SOP5	0.861	Fulfilled		
‘Transparency’ (TR)				
‘Comprehensive information’ (COI)			0.757	Fulfilled
COI1	0.915	Fulfilled		
COI2	0.866	Fulfilled		
COI3	0.897	Fulfilled		
COI4	0.903	Fulfilled		
COI5	0.908	Fulfilled		
Easy access to information (EAI)			0.806	Fulfilled
EAI1	0.893	Fulfilled		
EAI2	0.879	Fulfilled		
EAI3	0.902	Fulfilled		
EAI4	0.877	Fulfilled		
EAI5	0.875	Fulfilled		
‘Fairness’ (FAR)			0.784	Fulfilled
FAR1	0.902	Fulfilled		
FAR2	0.765	Fulfilled		
FAR3	0.907	Fulfilled		
FAR4	0.898	Fulfilled		
FAR5	0.893	Fulfilled		
‘Reliable information’ (REI)			0.765	Fulfilled
REI1	0.894	Fulfilled		
REI2	0.825	Fulfilled		
REI3	0.803	Fulfilled		
REI4	0.909	Fulfilled		
REI5	0.915	Fulfilled		
‘Interactivity’ (IN)				
‘Consensus-oriented’ (COO)			0.743	Fulfilled
COO1	0.847	Fulfilled		
COO2	0.912	Fulfilled		

COO3	0.893	Fulfilled		
COO4	0.925	Fulfilled		
COO5	0.841	Fulfilled		
‘Improved interaction’ (IMI)			0.708	Fulfilled
IMI1	0.843	Fulfilled		
IMI2	0.832	Fulfilled		
IMI3	0.885	Fulfilled		
IMI4	0.863	Fulfilled		
IMI5	0.886	Fulfilled		
IMI6	0.862	Fulfilled		
‘Participative’ (PAR)			0.782	Fulfilled
PAR1	0.829	Fulfilled		
PAR2	0.911	Fulfilled		
PAR3	0.816	Fulfilled		
PAR4	0.786	Fulfilled		
PAR5	0.859	Fulfilled		
‘Decision support’ (DS)				
‘Better monitoring and control’ (BMC)			0.827	Fulfilled
BMC1	0.909	Fulfilled		
BMC2	0.790	Fulfilled		
BMC3	0.902	Fulfilled		
BMC4	0.905	Fulfilled		
BMC5	0.924	Fulfilled		
‘Improved decision-making’ (IDM)			0.825	Fulfilled
IDM1	0.883	Fulfilled		
IDM2	0.921	Fulfilled		
IDM3	0.894	Fulfilled		
IDM4	0.935	Fulfilled		
IDM5	0.908	Fulfilled		
‘Improved planning’ (IMP)			0.787	Fulfilled
IMP1	0.872	Fulfilled		
IMP2	0.924	Fulfilled		
IMP3	0.903	Fulfilled		
IMP4	0.937	Fulfilled		
IMP5	0.911	Fulfilled		
‘Acountability’ (ACC)			0.834	Fulfilled

ACC1	0.914	Fulfilled		
ACC2	0.900	Fulfilled		
ACC3	0.928	Fulfilled		
ACC4	0.929	Fulfilled		
ACC5	0.895	Fulfilled		
‘Information and data’ (ID)				
‘Information and data quality’ (IDQ)			0.815	Fulfilled
IDQ1	0.888	Fulfilled		
IDQ2	0.909	Fulfilled		
IDQ3	0.914	Fulfilled		
IDQ4	0.915	Fulfilled		
IDQ5	0.913	Fulfilled		
IDQ6	0.876	Fulfilled		
‘Dynamic information’ (DYI)			0.803	Fulfilled
DYI1	0.916	Fulfilled		
DYI2	0.865	Fulfilled		
DYI3	0.930	Fulfilled		
DYI4	0.906	Fulfilled		
DYI5	0.861	Fulfilled		
‘Privacy and security’ (PAS)			0.782	Fulfilled
PAS1	0.879	Fulfilled		
PAS2	0.879	Fulfilled		
PAS3	0.897	Fulfilled		
PAS4	0.871	Fulfilled		
PAS5	0.896	Fulfilled		
‘Information technology’ (IT)				
‘Usability’ (USE)			0.778	Fulfilled
USE1	0.887	Fulfilled		
USE2	0.871	Fulfilled		
USE3	0.894	Fulfilled		
USE4	0.937	Fulfilled		
USE5	0.864	Fulfilled		
USE6	0.836	Fulfilled		
‘Security issues’ (SEI)			0.778	Fulfilled
SEI1	0.905	Fulfilled		

SEI2	0.870	Fulfilled		
SEI3	0.906	Fulfilled		
SEI4	0.858	Fulfilled		
SEI5	0.887	Fulfilled		
SEI6	0.863	Fulfilled		
‘Technological compatibility’ (TEC)			0.575	Fulfilled
TEC1	0.884	Fulfilled		
TEC2	0.904	Fulfilled		
TEC3	0.875	Fulfilled		
TEC4	**0.504**	**Not Fulfilled**		
TEC5	**0.509**	**Not Fulfilled**		
‘Technology complexity/newness (TEN)’			**0.413**	**Not Fulfilled**
TEN1	0.888	Fulfilled		
TEN2	**0.603**	**Not Fulfilled**		
TEN3	**0.444**	**Not Fulfilled**		
TEN4	**0.551**	**Not Fulfilled**		
‘Technical skills and experience’ (TSE)			0.828	Fulfilled
TSE1	0.897	Fulfilled		
TSE2	0.913	Fulfilled		
TSE3	0.901	Fulfilled		
TSE4	0.932	Fulfilled		
TSE5	0.908	Fulfilled		
‘Techniques, algorithms and scalability’ (TAS)			0.820	Fulfilled
TAS1	0.888	Fulfilled		
TAS2	0.908	Fulfilled		
TAS3	0.922	Fulfilled		
TAS4	0.919	Fulfilled		
TAS5	0.891	Fulfilled		
‘Organization and management’ (OM)			0.828	Fulfilled
‘Project size’ (PRS)				
PRS1	0.903	Fulfilled		
PRS2	0.912	Fulfilled		
PRS3	0.919	Fulfilled		
PRS4	0.905	Fulfilled		
‘Manager’s attitudes and behavior’ (MAB)			0.823	Fulfilled

MAB1	0.905	Fulfilled		
MAB2	0.890	Fulfilled		
MAB3	0.907	Fulfilled		
MAB4	0.926	Fulfilled		
‘Users or organizational diversity’ (UOD)			0.817	Fulfilled
UOD1	0.884	Fulfilled		
UOD2	0.915	Fulfilled		
UOD3	0.909	Fulfilled		
UOD4	0.907	Fulfilled		
‘Alignment and awareness of organizational goals’ (AOG)			0.841	Fulfilled
AOG1	0.908	Fulfilled		
AOG2	0.905	Fulfilled		
AOG3	0.930	Fulfilled		
AOG4	0.925	Fulfilled		
‘Resistance to change/internal conflicts’ (RTC)			0.816	Fulfilled
RTC1	0.894	Fulfilled		
RTC2	0.912	Fulfilled		
RTC3	0.930	Fulfilled		
RTC4	0.877	Fulfilled		
‘Qualified personnel/talent’ (QUP)			0.841	Fulfilled
QUP1	0.915	Fulfilled		
QUP2	0.910	Fulfilled		
QUP3	0.920	Fulfilled		
QUP4	0.921	Fulfilled		
QUP5	0.918	Fulfilled		
QUP6	0.920	Fulfilled		
‘Law and regulation’ (LR)				
‘Conducive laws and regulations’ (CLR)			0.767	Fulfilled
CLR1	**0.538**	**Not Fulfilled**		
CLR2	0.939	Fulfilled		
CLR3	0.931	Fulfilled		
CLR4	0.923	Fulfilled		
CLR5	0.931	Fulfilled		
CLR6	0.920	Fulfilled		
‘Cost structures, budgeting, budget allocation & disbursement’ (CSB)			0.785	Fulfilled

CSB1	0.861	Fulfilled		
CSB2	0.887	Fulfilled		
CSB3	0.899	Fulfilled		
CSB4	0.928	Fulfilled		
CSB5	0.853	Fulfilled		
‘Intergovernmental relationships’ (IGR)			0.819	Fulfilled
IGR1	0.902	Fulfilled		
IGR2	0.891	Fulfilled		
IGR3	0.935	Fulfilled		
IGR4	0.891	Fulfilled		
‘Institution and environment’ (IE)				
‘Privacy and related security concerns’ (PSC)			0.868	Fulfilled
PSC1	0.913	Fulfilled		
PSC2	0.929	Fulfilled		
PSC3	0.943	Fulfilled		
PSC4	0.941	Fulfilled		
‘Autonomy of agencies’ (AOA)			0.833	Fulfilled
AOA1	0.893	Fulfilled		
AOA2	0.904	Fulfilled		
AOA3	0.945	Fulfilled		
AOA4	0.908	Fulfilled		
‘Policy and political pressures’ (PPP)			0.795	Fulfilled
PPP1	0.793	Fulfilled		
PPP2	0.895	Fulfilled		
PPP3	0.934	Fulfilled		
PPP4	0.930	Fulfilled		
PPP5	0.897	Fulfilled		
‘Environmental’ (ENV)			0.815	Fulfilled
ENV1	0.889	Fulfilled		
ENV2	0.934	Fulfilled		
ENV3	0.925	Fulfilled		
ENV4	0.860	Fulfilled		

Discriminant Validity

Discriminant validity is about the differentiation of the construct. It is a measure of the similarity of constructs. All constructs should, therefore, have a different identity and should be different from others. Thus, established discriminant validity implies that a construct is unique and captures phenomena not represented by other constructs in the model. To establish discriminant validity, the criterion of Fornell-Larcker, cross-loadings and Heterotrait-Monotrait (HTMT) are required to be met. As per the Fornell-Larcker criterion, the AVE of a latent variable should be higher than the squared correlations between the latent variable of other variables (Fornell and Larker, 1981; Chin, 1998; Chin, 2010). The discriminant validity (DV) should be the square root of the AVE value of the construct and it should be greater than 0.50. Table 6.5 shows the discriminant validity of all LOCs of 'e-governance performance' and it can be seen that the value of DV of all the constructs is the square root of its AVE and is also greater than 0.50. This way discriminant validity criteria are established.

Table 6.5: Measurement Models Evaluation (Convergent and Discriminant Validity: Fornell and Larcker)

	AVE	**Convergent Validity Result (Criteria AVE>0.5)**	**SQRT (AVE)**	**Fornell-Larcker Criterion (SQRT AVE)**	**Discriminant Validity Result (Fornell-Larcker Criterion = SQRT AVE)**
'Efficiency' (EF)					
FEP	0.750	Fulfilled	0.866	0.866	Fulfilled
REC	0.769	Fulfilled	0.877	0.877	Fulfilled
REP	0.704	Fulfilled	0.839	0.839	Fulfilled
SOP	0.774	Fulfilled	0.880	0.880	Fulfilled
'Transparency' (TR)					
REI	0.757	Fulfilled	0.870	0.870	Fulfilled
COI	0.806	Fulfilled	0.898	0.898	Fulfilled
EAI	0.784	Fulfilled	0.885	0.885	Fulfilled
FAR	0.765	Fulfilled	0.875	0.875	Fulfilled
'Interactivity' (IN)					
IMI	0.743	Fulfilled	0.862	0.862	Fulfilled
PAR	0.708	Fulfilled	0.841	0.841	Fulfilled
COO	0.782	Fulfilled	0.884	0.884	Fulfilled

'Decision support' (DS)					
IMP	0.827	Fulfilled	0.909	0.909	Fulfilled
IDM	0.825	Fulfilled	0.908	0.908	Fulfilled
BMC	0.787	Fulfilled	0.887	0.887	Fulfilled
ACC	0.834	Fulfilled	0.913	0.913	Fulfilled
'Information and data' (ID)					
IDQ	0.815	Fulfilled	0.903	0.903	Fulfilled
DYI	0.803	Fulfilled	0.896	0.896	Fulfilled
PAS	0.782	Fulfilled	0.884	0.884	Fulfilled
'Information technology' (IT)					
USE	0.778	Fulfilled	0.882	0.882	Fulfilled
SEI	0.778	Fulfilled	0.882	0.882	Fulfilled
TEC	0.575	Fulfilled	0.758	0.759	Fulfilled
TEN	0.413	**Not Fulfilled**	0.643	0.643	Fulfilled
TSE	0.828	Fulfilled	0.910	0.910	Fulfilled
TAS	0.820	Fulfilled	0.906	0.906	Fulfilled
'Organization and management' (OM)					
PRS	0.828	Fulfilled	0.910	0.910	Fulfilled
MAB	0.823	Fulfilled	0.907	0.907	Fulfilled
UOD	0.817	Fulfilled	0.904	0.904	Fulfilled
AOG	0.841	Fulfilled	0.917	0.917	Fulfilled
RTC	0.816	Fulfilled	0.903	0.904	Fulfilled
QUP	0.841	Fulfilled	0.917	0.917	Fulfilled
'Law & regulation' (LR)					
CLR	0.767	Fulfilled	0.876	0.876	Fulfilled
CSB	0.785	Fulfilled	0.886	0.886	Fulfilled
IGR	0.819	Fulfilled	0.905	0.905	Fulfilled
'Institution and environment' (IE)					
PSC	0.868	Fulfilled	0.932	0.932	Fulfilled
AOA	0.833	Fulfilled	0.913	0.913	Fulfilled

PPP	0.795	Fulfilled	0.892	0.891	Fulfilled
ENV	0.815	Fulfilled	0.903	0.903	Fulfilled

Cross Loadings

To establish the discriminant validity cross-loadings criteria is also required to be met. All the items in a construct should load better in themselves compared to other construct items. Cross-loadings value of the indicator's outer loadings on the associated construct should be greater than all of its loadings on other constructs. Cross loadings criteria for LOCs for 'e-governance performance' are as per the prescribed values. All the items in FEP, REC, REP, SOP, COI, EAI, FAR, REI, COO, IMI, PAR, BMC, IDM, IMP and ACC are better in themselves compared to other construct items. Similarly the items in constructs for ID, IT, OM, LR and IE. Cross loadings value of the indicator's outer loadings on the associated construct should be greater than all of its loadings on other constructs.

Heterotrait-Monotrait Ratio (HTMT)

The similarity between latent variables is measured by the HTMT. An estimate of the correlation between the construct is represented by HTMT. It is one of the criteria to establish the discriminant validity of the constructs and is based on the average of Heterotrait-Monotrait correlations. The ratio of HTMT is expected to be lower than 1. However, the threshold is set as 0.90 at a 95% confident interval (Henseler et al., 2015). To examine the HTMT ratio, it is tested whether the HTMT values are significantly different from 1. The value of HTMT higher than 0.9 indicates there is a lack of discriminant validity. Most of the constructs had HTMT<0.9.

6.5.3 Evaluation of Structural Models of Lower Order Components (LOCs) of 'E-Governance Performance using Big Data'

After the evaluation of measurement models, the next step is to validate and establish a structural model, i.e., to validate how the variables are related to each other. Assessment of the structural model helps in determining the model's capability to predict one or more target constructs. Assessment of structural model is accomplished through (Figure 6.1): (i) Collinearity assessment; (ii) Path coefficients; (iii) Coefficients of determination (R^2

value); (iv) Effect size (f^2 value); (v) Blindfolding and Predictive relevance (Q^2 value); (vi) Effect size (q^2 value).

Path Coefficients

Path-coefficient is the coefficient linking construct in structural modeling. It represents the hypothesized relationship or the strength of the relationship. Path coefficient close to +1 indicates a strong positive relationship. The closer the estimated coefficients are to 0, the weaker the relationships. Very low values (close to 0) generally are not statistically validated. The value of path coefficients for different LOCs that are constituents of e-governance performance, are shown as in Table 6.6 below.

Table 6.6: Path Coefficients for Constituents of 'Performance of E-Governance Projects using Big Data'

Efficiency (EF)	**Path coefficients**	**Transparency (TR)**	**Path coefficients**	**Interactivity (IN)**	**Path coefficients**	**Decision Support (DS)**	**Path coefficients**
FEP	0.266	**COI**	0.271	**COO**	0.355	**BMC**	0.258
REC	0.289	**FAR**	0.259	**PAR**	0.312	**IDM**	0.259
REP	0.267	**EAI**	0.278	**IMI**	0.409	**IMP**	0.273
SOP	0.287	**REI**	0.264			**ACC**	0.277

The value of path coefficients for different LOCs that are influencers of e-governance performance are shown as in Table 6.7 below.

Table 6.7: Path Coefficients for Influencers of 'Performance of E-Governance Projects using Big Data'

ID	**Path coefficients**	**IT**	**Path coefficients**	**OM**	**Path coefficients**	**LR**	**Path coefficients**	**IE**	**Path coefficients**
IDQ	0.407	**USE**	0.251	**PRS**	0.193	**CLR**	0.408	**PSC**	0.263
DYI	0.329	**SEI**	0.245	**MAB**	0.186	**CSB**	0.351	**AOA**	0.250
PAS	0.314	**TEC**	0.142	**UOD**	0.194	**IGR**	0.296	**PPP**	0.306
		TEN	0.055	**AOG**	0.194			**ENV**	0.238
		TSE	0.206	**RTC**	0.109				
		TAS	0.222	**QUP**	0.273				

It can be seen in Figure 6.2, Tables 6.6 and Table 6.7 that all values are greater than 0. It means that the relationship of all the constructs of ‘e-governance performance’ is moderate. The values of path coefficients in Figure 6.2 depict the strength of relationships of the LOCs within the structural model.

t- Statistic

When an empirical t-value is larger than the critical value, we conclude that the path coefficient is statistically significant at a certain error probability. Commonly used critical values for the two-tailed test are 1.65 (at a 10% significant level) and 1.96 (at a 5% significant level). It has been seen that all the values for the path coefficients are higher than the critical value of 1.96 taken at a significant level of 95%.

6.5.4 Evaluation of Second Order Model: Effect of Big Data related factors on components of ‘E-Governance Performance using Big Data’

The SEM model for this research is a third order model. This was converted to a structural model for second order constructs to evaluate the effect of big data related factors: ‘Information and data’ (ID), ‘Information technology’ (IT), ‘Organization and management’ (OM), ‘Law and regulation’ (LR) and ‘Institutional and environment’ (IE) on the components of ‘e-governance performance using big data’ that are: ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS). This was required to validate the formulated hypotheses HA6-HA25 as in Table 4.3 in chapter 4. All constructs are formative, hence no construct reliability and validity is evaluated.

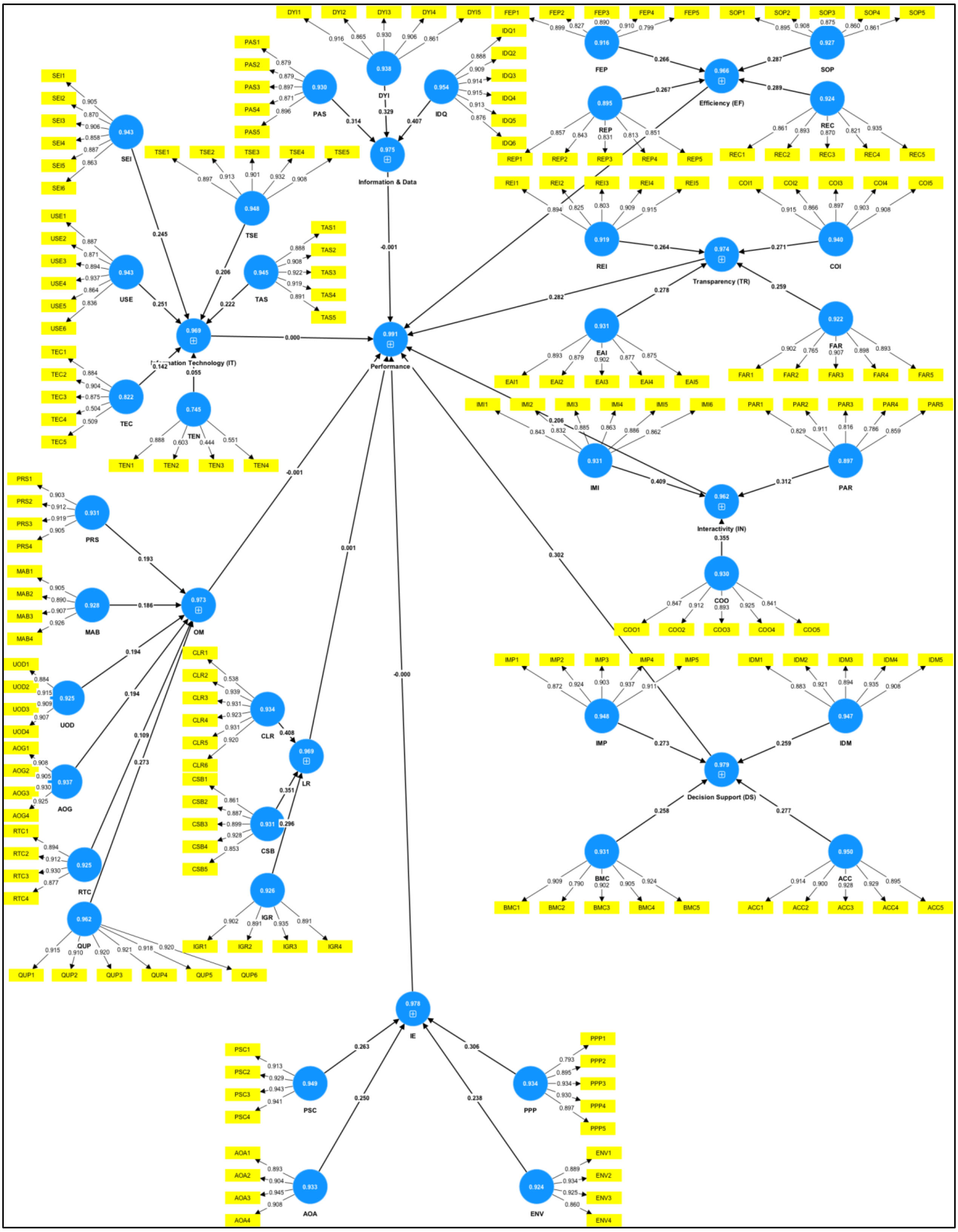


Figure 6.2: Structural Model of Lower Order Components (LOCs) of 'Performance of E-Governance Projects using Big Data'

The updated strcutural model of LOCs after dropping TEC4, TEC5, TEN all, CLR1 (as not meeing the criteria of factor loadings>0.708 and AVE>0.5) is as shown in Figure 6.3 below.

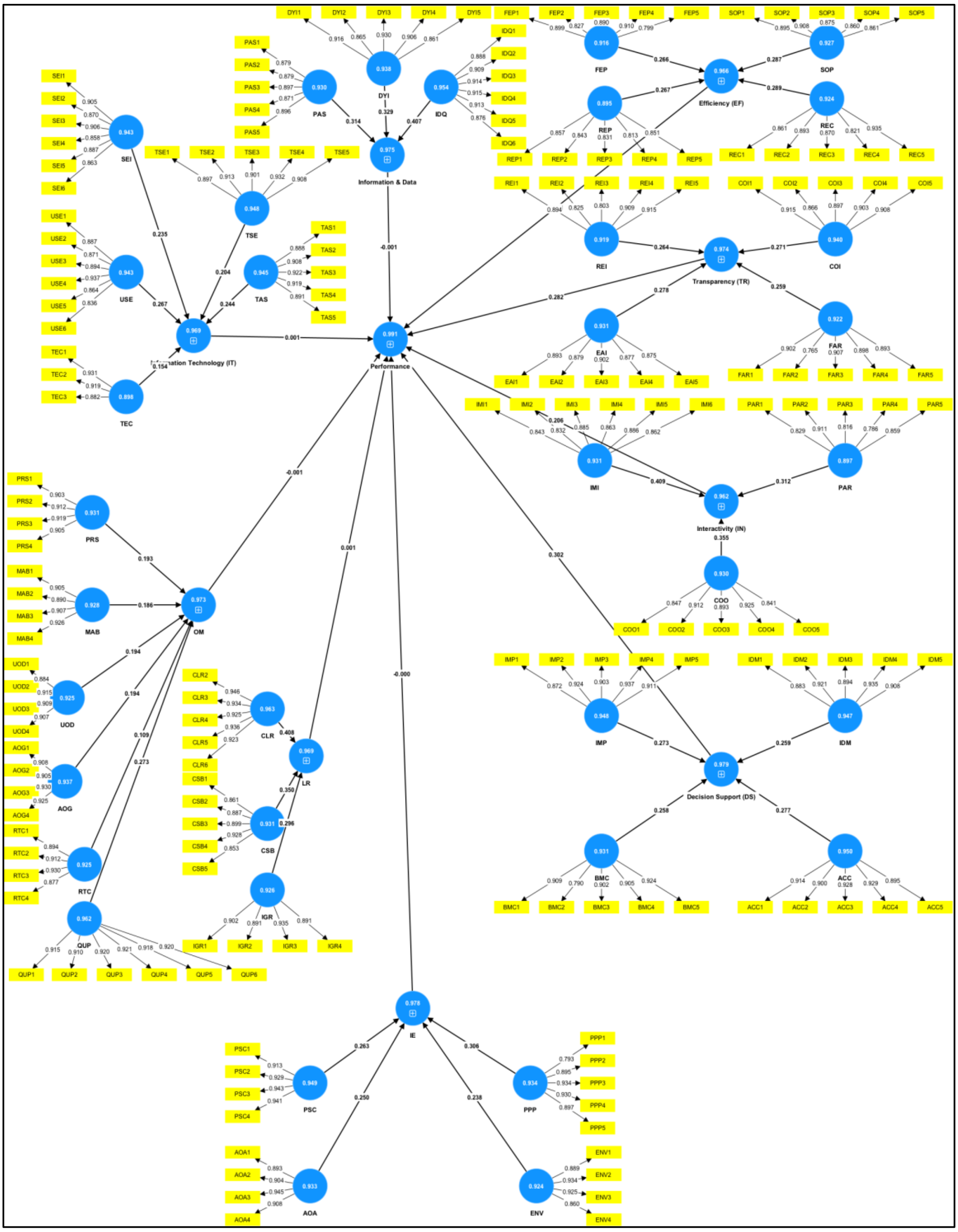


Figure 6.3: Updated Structural Model of Lower Order Components (LOCs) of 'Performance of E-Governance Projects using Big Data'

Path Coefficients

Path-coefficient is the coefficient linking construct in structural modeling. It represents the hypothesized relationship or the strength of the relationship. Path coefficient close to +1 indicates a strong positive relationship. The closer the estimated coefficients are to 0, the weaker the relationships. Very low values (close to 0) generally are not statistically validated. The values are there in Figure 6.4.

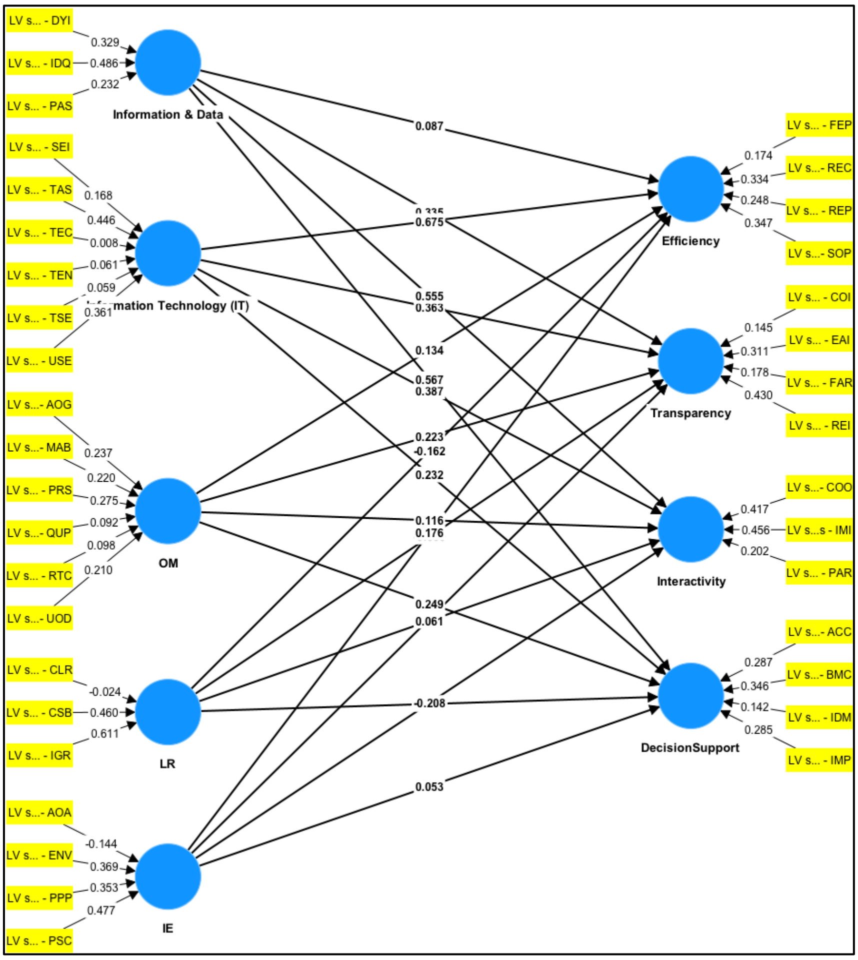


Figure 6.4: Effect of Big Data related factors on components of 'Performance of E-Governance Projects using Big Data'

The values of path coefficients are there in Table 6.8 for different macro constructs.

Table 6.8: Path Coefficients for Effect of Big Data related factors on components of 'Performance of E-Governance Projects using Big Data'

	DecisionSupport	Efficiency	Interactivity	Transparency
'Institution and environment' (IE)	0.053	0.176	-0.208	0.066
'Information and data' (ID)	0.567	0.087	0.555	0.335

‘Information technology’ (IT)	0.232	0.675	0.387	0.363
‘Law and regulation’ (LR)	-0.147	-0.162	0.061	-0.05
‘Organization and management’ (OM)	0.249	0.134	0.116	0.223

Whether a coefficient is significant or not depends on the standard error that is obtained by the bootstrapping process in PLS-SEM. A table with mean value, standard errors, etc. obtained from the bootstrapping process is shown in Table 6.9. Bootstrapping process also enables computing the empirical t-values, p-values for structural path coefficients.

t- Statistic

When an empirical t-value is larger than the critical value, we conclude that the coefficient is statistically significant at a certain error probability. Commonly used critical values for the two-tailed test are 1.65 (at a 10% significant level) and 1.96 (at a 5% significant level). Table 6.9 shows the t-values for the structural model shown in Figure 6.5.

Table 6.9: t-Statistic for Effect of Big Data related factors on components of ‘Performance of E-Governance Projects using Big Data’

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
IE -> DS	0.053	0.061	0.113	0.466	0.641
IE -> EF	0.176	0.164	0.141	1.253	0.210
IE -> IN	-0.208	-0.189	0.116	1.789	0.074
IE -> TR	0.066	0.078	0.122	0.536	0.592
ID -> DS	0.567	0.520	0.137	4.125	0
ID -> EF	0.087	0.037	0.181	0.483	0.629
ID -> IN	0.555	0.498	0.156	3.554	0
ID -> TR	0.335	0.285	0.155	2.156	0.031
IT -> DS	0.232	0.255	0.143	1.622	0.105
IT -> EF	0.675	0.695	0.196	3.441	0.001
IT-> IN	0.387	0.416	0.182	2.128	0.033
IT -> TR	0.363	0.393	0.173	2.097	0.036
LR -> DS	-0.147	-0.116	0.105	1.396	0.163
LR -> EF	-0.162	-0.117	0.161	1.002	0.316
LR -> IN	0.061	0.052	0.126	0.481	0.630
LR -> TR	-0.050	-0.024	0.118	0.426	0.670
OM -> DS	0.249	0.241	0.113	2.195	0.028
OM -> EF	0.134	0.136	0.154	0.868	0.385
OM -> IN	0.116	0.138	0.155	0.748	0.454
OM -> TR	0.223	0.211	0.148	1.509	0.131

It can be seen that all the values for the path coefficients are higher than the critical value of 1.96 taken at a significant level of 95%. HTMT and Fornell Larcker values are not assessed for formative constructs.

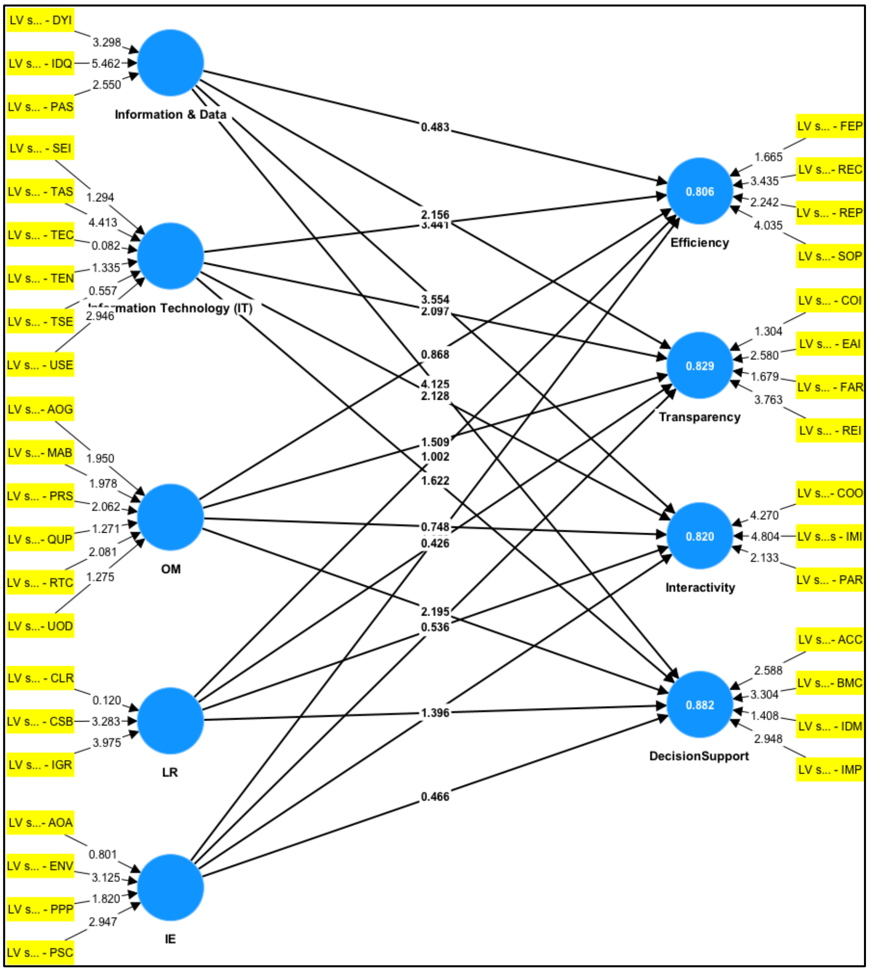


Figure 6.5: Bootstrapping (t-Statistics) of Effect of Big Data related factors on components of 'Performance of E-Governance Projects using Big Data'

Model Fit: Standardized Root Mean Square Residual (SRMR), Chi² and Normed Fit Index (NFI)

The SRMR is defined as the difference between the observed correlation and the model implied correlation matrix. Thus, it allows assessing the average magnitude of the discrepancies between observed and expected correlations as an absolute measure of (model) fit criterion. A value less than 0.10 or of 0.08 (in a more conservative version (Hu and Bentler, 1999) are considered a good fit. Henseler et al. (2014) introduce the SRMR as a goodness of fit measure for PLS-SEM that can be used to avoid model misspecification. Table 6.10 shows that SRMR <0.10 that means the model is a good fit.

Table 6.10: Mode Fit for Effect of Big Data related factors on components of 'Performance of E-Governance Projects using Big Data'

	Saturated model	Estimated model
SRMR	0.034	0.041
Chi-square	1057.381	1171.957
NFI	0.849	0.833

One of the first fit measures proposed in the SEM literature is the NFI by Bentler and Bonett (1980). It computes the Chi^2 value of the proposed model and compares it against a meaningful benchmark. The NFI is then defined as 1 minus the Chi^2 value of the proposed model divided by the Chi^2 values of the null model. Consequently, the NFI results in values between 0 and 1. The closer the NFI to 1, the better the fit. NFI values above 0.9 usually represent acceptable fit. Lohmöller (1989) provides detailed information on the NFI computation of PLS path models. Table 6.10 shows NFI as 0.833 that indicates an acceptable fit.

Coefficient of Determination (R^2 Value)

The R^2 value indicates the variance in the endogenous variable explained by the exogenous variable. The R^2 value range from 0 to 1. In the range, a higher level indicates higher levels of predicting accuracy. According to Chin (1998), the value of R^2 as 0.67, 0.33 and 0.19 is considered substantial, moderate and weak. Table 6.11 shows the R^2 and R^2 adjusted values for second order structural model. The R^2 value is above 0.67 which shows that predicting accuracy is substantial.

Table 6.11: R^2 Value for Second Order Structural Model of 'Performance of E-Governance Projects using Big Data'

	R-square	R-square adjusted
'Decision support' (DS)	0.882	0.877
'Efficiency' (EF)	0.806	0.798
'Interactivity' (IN)	0.820	0.812
'Transparency' (TR)	0.829	0.821

Effect Size (f^2 Value)

Assessment of effect size allows us to observe the effect of each exogenous construct on the endogenous construct. According to Cohen and Levinthal (1990) for assessing f2, the value of 0.02 should be interpreted as a ‘small’ representation, 0.15 as a ‘medium’ and 0.35 as a ‘large’ effect of the exogenous latent variable. Effect size values of less than 0.02 indicate that there is no effect. Table 6.12 shows the value of effect size (f2). It can be seen that all values of the constructs represent varied (medium, small and no) effect size on endogenous constructs: ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS).

Table 6.12: Effect size (f^2) for components of ‘Performance of E-Governance Projects using Big Data’

Criteria 0.35 Large 0.15 Medium 0.02 Small <0.02 No effect	**DS**	**Impact on DS**	**EF**	**Impact on EF**	**IN**	**Impact on IN**	**TR**	**Impact on TR**
IE	0.003	No effect	0.021	Small	0.032	Small	0.003	Small
ID	0.302	Medium	0.004	No effect	0.190	Medium	0.072	Small
IT	0.040	Small	0.206	Medium	0.073	Small	0.068	Small
LR	0.025	Small	0.018	Small	0.003	No effect	0.002	Small
OM	0.057	Small	0.010	No effect	0.008	No effect	0.032	Small

Blindfolding and Predictive Relevance (Q^2 Value)

In addition to evaluating the magnitude of R^2 values as a criterion of predictive accuracy, Stone-Geisser’s, Q^2 value is also to be examined (Geisser, 1974; Stone 1974). Table 6.13 shows the Q^2 values of all the endogenous constructs, which are greater than 0 indicating that the model has predictive relevance.

Table 6.13: Predictive Relevance (Q^2) for Second Order Structural Model of ‘Performance of E-Governance Projects using Big Data’

	Q^2 predict
‘Decision support’ (DS)	0.837
‘Efficiency’ (EF)	0.736
‘Interactivity’ (IN)	0.784
‘Transparency’ (TR)	0.772

This measure is an indicator of the model's predictive power or predictive relevance. The Q^2 value is obtained by using blindfolding procedures for a specified omission distance D with a value between 5 and 10. Omission distance has to be an integer and cannot be divisor for the sample size. Therefore, omission distance of 8 has been chosen. Q^2 value of larger than 0 suggests that the model has predictive relevance for a certain endogenous construct. In contrast, values of 0 and below indicates a lack of predictive relevance.

Cross-Validated Predictive Ability Test (CVPAT)

The CVPAT] represents an alternative to PLSpredict for prediction-oriented assessment of PLS-SEM results. CVPAT applies an out-of-sample prediction approach to calculate the model's prediction error, which determines the average loss value. CVPAT tests whether PLS-SEM's average loss is significantly lower than the average loss of the benchmarks. The difference of the average loss values should be significantly below zero to substantiate better predictive capabilities of the model compared to the prediction benchmarks as shown in Table 6.14 below. All the required values for the evaluation of the structural model have been computed and found to be within the recommended threshold. Hypotheses (*Chapter 4*) for testing have been framed. The result of tested hypotheses for second order structural model is presented below.

Table 6.14: Cross-Validated Predictive Ability Test (CVPAT) for Second Order Structural Model of 'Performance of E-Governance Projects using Big Data'

	Average loss difference	**t value**	**p value**
'Decision support' (DS)	-0.756	5.248	0
'Efficiency' (EF)	-0.611	4.328	0
'Interactivity' (IN)	-0.685	4.906	0
'Transparency' (TR)	-0.686	4.782	0
Overall	-0.685	4.979	0

6.5.5 Result of Hypotheses for Structural Model: Effect of Big Data related factors on components of 'E-Governance Performance using Big Data'

Table 6.15 summarizes the hypotheses test results which were framed for big data related factors effect on components of 'e-governance performance' in (*Chapter 4, Table 4.3*). Twenty alternate hypotheses, HA6-HA25 were formulated. To test the result of hypotheses, the value of the key statistics in terms of assessment of path coefficients, t-value, determination of coefficients (R^2), effect size (f^2) and predictive relevance (Q^2) as recommended by the experts are considered.

Table 6.15: Result of Hypotheses for Effect of Big Data related factors on components of 'Performance of E-Governance Projects using Big Data'

Alternate Hypothesis	**Structural Relationship**	**t-value**	**Path coefficients**	**R^2**	**f^2**	**Q^2**	**Result of Hypotheses Test**
		Criteria > 1.96	**Criteria (0-1)**	**Criteria (0.67=substantial, 0.33= moderate, 0.19= weak)**	**Criteria (0.35: large, 0.15: medium, 0.02: small)**	**Criteria Q^2> 0**	
HA6	ID->EF	0.483	0.087	0.806	0.004	0.729	Not Supported
HA7	IT->EF	3.441	0.675	0.806	0.206	0.729	**Supported**
HA8	OM->EF	0.868	0.134	0.806	0.010	0.729	Not Supported
HA9	LR->EF	1.002	-0.162	0.806	0.018	0.729	Not Supported
HA10	IE->EF	1.253	0.176	0.806	0.021	0.729	Not Supported
HA11	ID->TR	2.156	0.335	0.829	0.072	0.798	**Supported**
HA12	IT->TR	2.097	0.363	0.829	0.068	0.798	**Supported**
HA13	OM->TR	1.509	0.223	0.829	0.032	0.798	Not Supported
HA14	LR->TR	0.426	-0.05	0.829	0.002	0.798	Not Supported
HA15	IE->TR	0.536	0.066	0.829	0.003	0.798	Not Supported
HA16	ID->IN	3.554	0.555	0.820	0.190	0.784	**Supported**
HA17	IT->IN	2.128	0.387	0.820	0.073	0.784	**Supported**
HA18	OM->IN	0.748	0.116	0.820	0.008	0.784	Not Supported
HA19	LR->IN	0.481	0.061	0.820	0.003	0.784	Not Supported
HA20	IE->IN	1.789	-0.208	0.820	0.032	0.784	Not Supported
HA21	ID->DS	4.125	0.567	0.882	0.302	0.835	**Supported**
HA22	IT->DS	1.622	0.232	0.882	0.040	0.835	Not Supported
HA23	OM->DS	2.195	0.249	0.882	0.057	0.835	**Supported**
HA24	LR->DS	1.396	-0.147	0.882	0.025	0.835	Not Supported
HA25	IE->DS	0.466	0.053	0.882	0.003	0.835	Not Supported

All the laid down criteria of statistical assessment of structural modelling for hypotheses testing are found to be within the recommended threshold. Hypothesized paths from big data related factors to factors of 'e-governance performance' are found to be significant in many cases. It is, therefore, statistically tested that the twenty hypotheses may be accepted/non accepted as summarized in Table 6.15.

‘Efficiency’ (EF) is influenced by ‘Information technology’ (IT) only. This also shows that ‘Efficiency’ (EF) is not influenced by other big data related variables ,i.e., ‘Information and data’ (ID), ‘Organization and management’ (OM), ‘Law and regulation’ (LR) and ‘Institution and environment’ (IE). The constituents of ‘Efficiency’ are such that they all are directly influenced by the constituents of the ‘Information technology’ (IT). ‘Fast execution of core process’, ‘Simplification of processes’, ‘Reduced paperwork’ and ‘Reduced cost’, are influenced by the changes in work processes, business process re-engineering (BPR), simple and fast algorithms, interoperability and integration betweeen different systems and departments and use of latest and current technology that handle big data in fast and effiecient manner. ‘Transparency’ (TR) is influenced by ‘Information and data’ (ID) and ‘Information technology’ (IT) only. The constituents of ‘Transparency’ (TR), ‘Reliable information’, ‘Comprehensive information’, ‘Easy access to information’ and ‘Fairness’ are only posible with easy, fast and efficient access to thee-governance system along with the consistent, accurate, reliable and relevant data. ‘Interactivity’ (TR) is also influenced by ‘Information and data’ (ID) and ‘Information technology’ (IT) only.

The improved interaction involves direct interaction with the online system and related data. Participation with the e-governance system is enhanced if the system is usable, fast, simpler and offers consistent, accurate, reliable and relevant data. ‘Decision support’ (DS) is influened by ‘Information and data’ (ID) and ‘Organization and management’ (OM). The constituents of ‘Decision support’ (DS), ‘Improved planning’, ‘Improved decision-making’, ‘Better monitoring and control’ and ‘Accountability’ are dependent on multiple factors. They are directly influenced by constituents of ‘Information and data’ (ID), viz., ‘Information and data quality’, ‘Dynamic information’ and ‘Privacy and security’. They are also directly influened by ‘Organization and management’ (OM) factors like project management and planning, coordination, control, leadership, defined objectives and goals, measurable deliverables and qualified personnel. Constituents of ‘Information technology’ (IT), ‘Law and regulation’ (LR) and ‘Institution and environment’ (IE) are unable to influence the ‘Decision support’ (DS).

6.6 Validation of Final Model

In previous sections validation of LOCs of four macro constructs, i.e., 'Efficiency' (EF), 'Transparency' (TR), 'Interactivity' (IN) and 'Decision support' (DS) of 'e-governance performance' have been presented through the measurement and structural model. Now, HOCs are required to be validated for the outcome variable, i.e., 'e-governance performance' (EGP). In the reflective-formative model first, LOCs and then HOCs are required to be validated (Sarstedt et al., 2019). To validate the outcome variable, i.e., EGP. Macro variables taken for the study under it, i.e., 'Efficiency' (EF), 'Transparency' (TR), 'Interactivity' (IN) and 'Decision support' (DS) were treated as HOCs. These variables shall now be treated as LOCs. Statistical validation of EGP through measurement and structural model is presented below. The SEM model for this research is a third order model. This was converted to a structural model (Figure 6.6) to evaluate the effect of big data related factors: 'Information and data' (ID), 'Information technology' (IT), 'Organization and management' (OM), 'Law and regulation' (LR) and 'Institution and environment' (IE) on 'e-governance performance' (EGP). This was required to validate the formulated hypotheses HA1-HA5 (*Chapter 4, Table 4.3*). In the previous sections, an evaluation of the LOCs measurement model of 'e-governance performance using big data' is presented. The next step is to validate and establish the structural model, i.e., to validate how the variables are related to each other. Assessment of the structural model helps in determining the model's capability to predict one or more target constructs and has been done through: (i) Path coefficients; (ii) Coefficients of determination (R^2 value); (iii) Effect size (f^2 value); (iv) Blindfolding and Predictive relevant (Q^2 value).

Path Coefficients

Path-coefficient represents the hypothesized relationship or the strength of the relationship. Path-coefficient close to +1 indicates a strong positive relationship. The closer the estimated coefficients are to 0, the weaker the relationships. The value of path coefficients for the 'e-governance performance using big data' is shown in Table 6.17. Links to path coefficients are shown in Figure 6.5. It can be seen that all values are between 0 and 1. It means that the relationship of all the constructs with 'e-governance performance' is there.

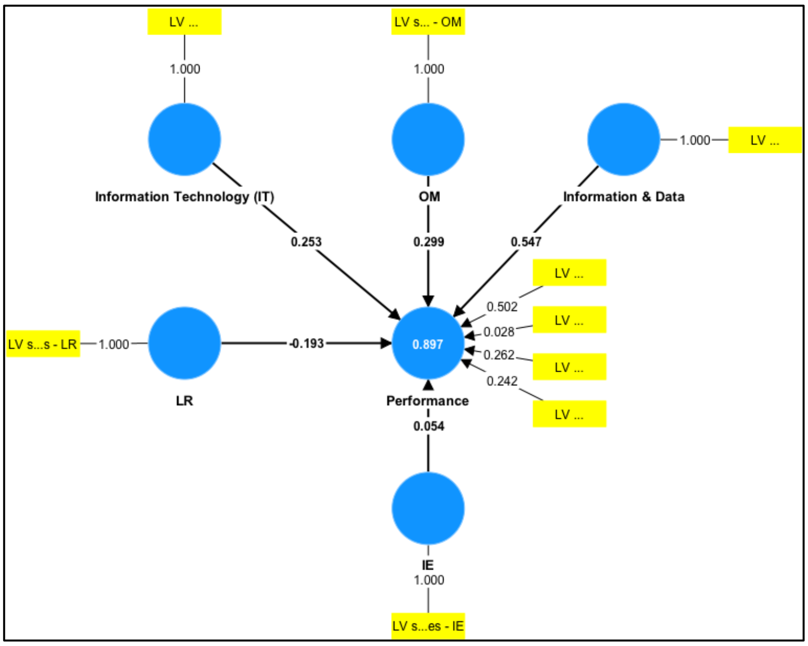


Figure 6.6: Effect of Big Data related factors on ‘Performance of E-Governance Projects using Big Data’

t- Statistic

Commonly used critical values for the two-tailed test are 1.65 (significant level 10%) and 1.96 (significant level 5%). Table 6.16 checks the threshold values for t-statistic as well as the path coeffiecients.

Table 6.16: t-Statistic and Path-coefficients of ‘Performance of E-Governance Projects using Big Data’

	t-Value Criteria (>1.96)	**Result**	**Path coefficients Criteria (0-1)**	**Result**
IE -> EGP	**0.484**	**Not Fulfilled**	0.054	Fulfilled
ID -> EGP	3.876	Fulfilled	0.547	Fulfilled
IT -> EGP	**1.652**	**Not Fulfilled**	0.253	Fulfilled
LR -> EGP	**1.610**	**Not Fulfilled**	-0.193	Fulfilled
OM -> EGP	2.749	Fulfilled	0.299	Fulfilled

It can be seen in Table 6.16 that the t-values for the ‘Information and data’ (ID) and ‘Organization and management’ (OM) constructs of ‘e-governance performance using big data’ are within the recommended threshold (>1.96) (Figure 6.7). The t-values for rest of the big data related variables, ‘Information technology’ (IT), ‘Law and regulation’ (LR) and ‘Institution and environment’ (IE) are not within the recommended threshold. This shows that the ‘E-governance performance’ is influenced by ‘Information and data’ (ID) and

‘Organization and management’ (OM) only even though the path coefficients for all big data related variables are meeting the threshold constraints.

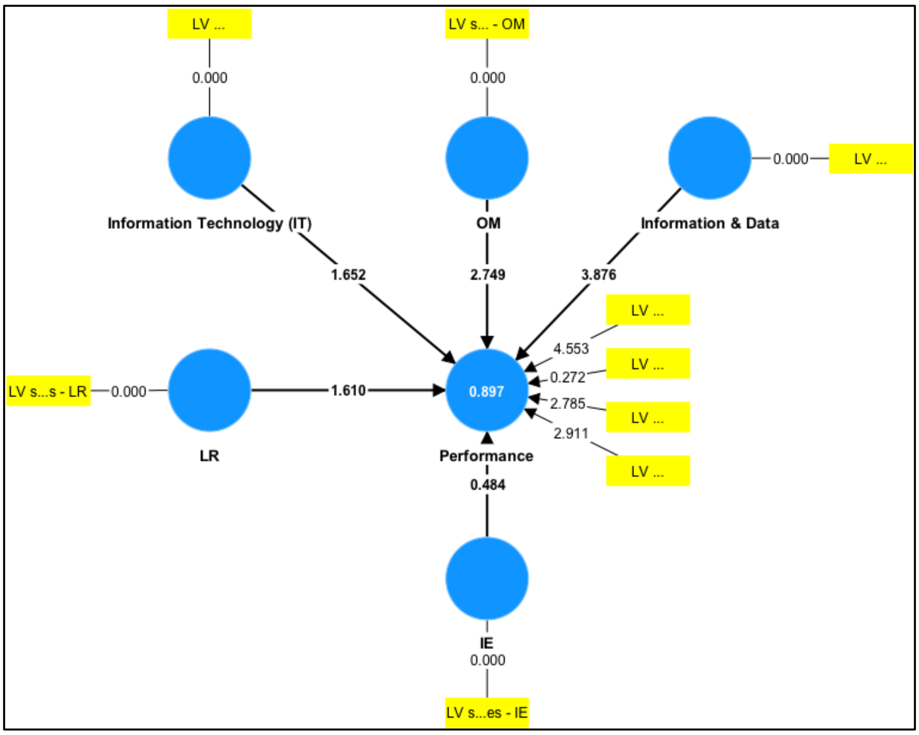


Figure 6.7: Bootstrapping (t-Statistics) for Effect of Big Data related factors on ‘Performance of E-Governance Projects using Big Data’

Coefficient of Determination (R^2 Value)

According to Chin (1998), the value of R^2 as 0.67, 0.33 and 0.19 is considered substantial, moderate and weak. The R^2 value (0.897) and R2 adjusted value is 0.892, within the range of 0-1, which shows that predicting accuracy is substantial.

Effect Size (f^2 Value)

The value of f^2 of the latent variable is interpreted as ‘small’, ‘medium’ and ‘large’ if it is 0.02, 0.15 and 0.35. Table 6.17 shows the value of effect size (f^2). It can be seen that all values of the constructs except ‘Institution and environment’ (IE) represent some effect size on ‘e-governance performance using big data’. ‘Information technology’ (IT), ‘Law and regulation’ (LR) and ‘Organization and management’ (OM) have small effect on ‘e-governance performance using big data’ while ‘Information and data’ (ID) has the medium and highest effect on ‘e-governance performance using big data’.

Table 6.17: Effect Size (f^2) of ‘Performance of E-Governance Projects using Big Data’

	Effect Size (f 2) **(0.35: large, 0.15: medium, 0.02: small)**	**Result**
IE	0.004	No Effect
ID	0.312	Medium
IT	0.044	Small
LR	0.042	Small
OM	0.083	Small

Blindfolding and Predictive Relevance (Q^2 Value)

Stone-Geisser’s, Q^2 value is to be examined for the model's predictive power or predictive relevance. Table 6.18 shows the Q^2 values of all the constructs of ‘e-governance performance using big data’ which are greater than 0 indicating that the model has predictive relevance.

Table 6.18: Predictive Relevance (Q^2) for ‘Performance of E-Governance Projects using Big Data’

	Q^2 predict
LV scores – ‘Decision support’ (DS)	0.846
LV scores – ‘Efficiency’ (EF)	0.743
LV scores – ‘Interactivity’ (IN)	0.801
LV scores – ‘Transparency’ (TR)	0.794

Model Fit: Standardized Root Mean Square Residual (SRMR), Chi² and Normed Fit Index (NFI)

The SRMR is defined as the difference between the observed correlation and the model implied correlation matrix. Thus, it allows assessing the average magnitude of the discrepancies between observed and expected correlations as an absolute measure of (model) fit criterion. A value less than 0.10 or of 0.08 (in a more conservative version (Hu and Bentler, 1999) are considered a good fit. Henseler et al. (2014) introduce the SRMR as a goodness of fit measure for PLS-SEM that can be used to avoid model misspecification. Table 6.19 shows that SRMR <0.10 that means the model is a good fit.

Table 6.19: Model Fit for ‘Performance of E-Governance Projects using Big Data’

	Saturated model	**Estimated model**
SRMR	0.01	0.01
Chi-square	26.626	26.626
NFI	0.986	0.986

One of the first fit measures proposed in the SEM literature is the NFI by Bentler and Bonett (1980). It computes the Chi² value of the proposed model and compares it against a meaningful benchmark. The NFI is then defined as 1 minus the Chi² value of the proposed model divided by the Chi² values of the null model. Consequently, the NFI results in values between 0 and 1. The closer the NFI to 1, the better the fit. NFI values above 0.9 usually represent acceptable fit. Lohmöller (1989) provides detailed information on the NFI computation of PLS path models. Table 6.20 shows NFI as 0.986 that indicates an acceptable fit.

6.6.1 Result of Hypotheses for 'Performance of E-Governance using Big Data' (EGP)

Table 6.20 summarizes the hypotheses test results which were framed for big data related factors effect on 'e-governance performance' (*Chapter 4, Table 4.3*). Five alternate hypotheses, HA1-HA5 were formulated. To test the result of hypotheses, the value of the key statistics in terms of assessment of path coefficients, t-value, determination of coefficients (R^2), effect size (f^2) and predictive relevance (Q^2) as recommended by the experts are considered. All the laid down criteria of statistical assessment of structural modelling for hypotheses testing are found to be within the recommended threshold. Hypothesized paths from big data related factors to 'e-governance performance' are found to be significant in few cases. Table 6.20 below shows the results of hypotheses test.

Table 6.20: Hypotheses Test for 'Performance of E-Governance Projects using Big Data'

Alternate Hypothesis	**Structural Relationship**	**t-value**	**Path coefficients**	**R^2**	**f^2**	**Q^2**	**Result of Hypotheses Test**
		Criteria > 1.96	**Criteria (0-1)**	**Criteria (0.67=substantial, 0.33= moderate, 0.19= weak)**	**Criteria (0.35: large, 0.15: medium, 0.02: small)**	**Criteria $Q^2 > 0$**	
HA1	ID->EGP	3.876	0.547	0.897	0.312	Fulfilled	Supported
HA2	IT->EGP	**1.652**	0.253	0.897	0.044	Fulfilled	Not Supported
HA3	OM->EGP	2.749	0.299	0.897	0.083	Fulfilled	Supported
HA4	LR->EGP	**1.61**	-0.193	0.897	0.042	Fulfilled	Not Supported

HA5	IE->EGP	**0.484**	0.054	0.897	0.004	Fulfilled	Not Supported

EGP = 'Performance of E-Governance using Big Data'

It is very clear from Table 6.21 that even though the path coefficients, coefficient of determination, effect size and predictive relevance, are meeting the thresholds for all big data related variables but t-value is not meeting the threshold for all except 'Organization and management' (OM) and 'Information and data' (ID). This shows that only 'Organization and management' (OM) and 'Information and data' (ID) significantly influence the 'Performance of e-governance projects using big data'. The other variables, 'Information technology' (IT), 'Law and regulation' (LR) and 'Institution and environment' (IE) are generally considered as the logical constructs to be there.

6.7 E-Governance Performance as Perceived by Implementers and Beneficiaries

The 'Performance of e-governance projects using big data' is conceived to be constituted of four components or constructs, viz., 'Efficiency' (EF), 'Transparency' (TR), 'Interactivity' (IN) and 'Decision support' (DS). These constructs are further constitued of micro constructs that are measured in terms of respective items under them. The difference in perception of implementers (I) of the e-governance services and the beneficiaries (B) of e-governance services of the select projects is assessed through independent samples t-test.

'*Performance* **of E-Governance Projects using Big Data'**

Table 6.21 shows the results for the group statistics for the independent samples t-test for 'Performance of e-governance projects using big data'. Table 6.22 shows the results for independent samples test for 'Performance of e-governance projects using big data'.

Table 6.21: Group Statistics for Independent Samples T-Test for 'Performance of E-Governance Projects using Big Data'

	Role	N	Mean	Std. Deviation	Std. Error Mean
Performance	B	427	3.858	1.041	0.050
	I	118	3.657	0.839	0.077

Since $p<0.05$ in Levene's Test for 'equality of variance' that means equality of variance is not assumed. All relevant values for row for 'equality of variance not assumed' are used for further analysis. There were significant differences ($t(226.404) = 2.175$, $p = 0.031$) in the scores with mean score for beneficiaries ($M = 3.858$, $SD = 1.041$) being higher than the mean score of implementers ($M = 3.657$, $SD = 0.839$) as shown in Table 6.22. The magnitude of the differences in the means (mean difference = 0.201, 95% CI: 0.019 to 0.382) is significant. It shows that there is significant difference in perceptions of implementers and beneficiaries. E-governance performance as perceived by beneficiaries is found to be higher than that perceived by implementers in 'e-governance projects using big data'.

'*Efficiency'* of **E-Governance Projects using Big Data**

Table 6.23 shows the results for independent samples test for 'Efficiency' of 'e-governance projects using big data'. Since $p<0.05$ in Levene's Test for 'equality of variance' that means equality of variance is not assumed. All relevant values for row for 'equality of variance not assumed' are used for further analysis. There were no significant differences ($t(216.499) = 1.834$, $p = 0.068$) in the scores with mean score for beneficiaries ($M = 3.872$, $SD = 1.042$) and the mean score of implementers ($M = 3.697$, $SD = 0.839$). The magnitude of the differences in the means (mean difference = 0.175, 95% CI: -0.013 to 0.363) was very small. It shows that there is no significant difference in perceptions of implementers and beneficiaries and '*Efficiency*' improvement perception by using big data in e-governance projects is same for beneficiaries as well as implementers.

Table 6.22: Independent Samples Test for ‘Performance’ of ‘E-Governance Projects using Big Data’

Performance	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					One-Sided p	Two-Sided p			Lower	Upper
Equal variances assumed	9.762	0.002	1.927	543	0.027	0.055	0.201	0.104	-0.004	0.405
Equal variances not assumed			2.175	226.404	0.015	0.031	0.201	0.092	0.019	0.382

Table 6.23: Independent Samples Test for ‘Efficiency’ of ‘E-Governance Projects using Big Data’

Efficiency	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					One-Sided p	Two-Sided p			Lower	Upper
Equal variances assumed	7.963	0.005	1.667	543	0.048	0.096	0.175	0.105	-0.031	0.381
Equal variances not assumed			1.834	216.499	0.034	0.068	0.175	0.095	-0.013	0.363

Table 6.24 shows the results for the group statistics for independent samples test for ‘Efficiency’ of ‘e-governance projects using big data’.

Table 6.24: Group Statistics for Independent Samples T-Test for ‘Efficiency’ of ‘E-Governance Projects using Big Data’

	Role	N	Mean	Std. Deviation	Std. Error Mean
Efficiency	B	427	3.872	1.042	0.050
	I	118	3.697	0.879	0.080

‘*Transparency’* of **E-Governance Projects using Big Data**

Table 6.25 shows the results for the group statistics for the independent samples t-test for ‘Transparency’ of ‘e-governance projects using big data’. Table 6.26 shows the results for independent samples test for ‘Transparency’ of ‘e-Governance projects using big data’.

Table 6.25: Group Statistics for Independent Samples T-Test for ‘Transparency’ of ‘E-Governance Projects using Big Data’

	Role	N	Mean	Std. Deviation	Std. Error Mean
Transparency	B	427	3.852	1.078	0.052
	I	118	3.653	0.890	0.082

Since $p<0.05$ in Levene’s Test for ‘equality of variance’ that means equality of variance is not assumed. All relevant values for row for ‘equality of variance not assumed’ are used for further analysis. There were significant differences ($t(220.957) = 2.053$, $p = 0.041$) in the scores with mean score for beneficiaries ($M = 3.852$, $SD = 1.078$) being higher than the mean score of implementers ($M = 3.653$, $SD = 0.890$). The magnitude of the differences in the means (mean difference = 0.199, 95% CI: 0.008 to 0.391) is significant. It shows that there is significant difference in perceptions of implementers and beneficiaries. ‘*Transparency*’ as perceived by beneficiaries is found to be higher than that perceived by implementers in ‘e-governance projects using big data’.

Table 6.26: Independent Samples Test for ‘Transparency’ of ‘E-Governance Projects using Big Data’

Transparency	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					One-Sided p	Two-Sided p			Lower	Upper
Equal variances assumed	8.717	0.003	1.843	543	0.033	0.066	0.199	0.108	-0.013	0.412
Equal variances not assumed			2.053	220.957	0.021	0.041	0.199	0.097	0.008	0.391

Table 6.27: Independent Samples Test for ‘Interactivity’ of ‘E-Governance Projects using Big Data’

Interactivity	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					One-Sided p	Two-Sided p			Lower	Upper
Equal variances assumed	12.305	<.001	2.336	543	0.010	0.020	0.253	0.108	0.040	0.465
Equal variances not assumed			2.692	235.238	0.004	0.008	0.253	0.094	0.068	0.438

'Interactivity' of **E-Governance Projects using Big Data**

Table 6.27 shows the results for independent samples test for 'Interactivity' of 'e-governance projects using big data'. Since $p<0.05$ in Levene's Test for 'equality of variance' that means equality of variance is not assumed. All relevant values for row for 'equality of variance not assumed' are used for further analysis. There were significant differences ($t(235.238) = 2.053$, $p = 0.041$) in the scores with mean score for beneficiaries ($M = 3.792$, $SD = 1.088$) being higher than the mean score of implementers ($M = 3.540$, $SD = 0.844$). The magnitude of the differences in the means (mean difference = 0.253, 95% CI: 0.068 to 0.438) is significant. It shows that there is significant difference in perceptions of implementers and beneficiaries. '*Interactivity*' as perceived by beneficiaries is found to be higher than that perceived by implementers in 'e-governance projects using big data'. Table 6.28 shows the results for the group statistics for the independent samples t-test for 'Interactivity' of 'e-governance projects using big data'.

Table 6.28: Group Statistics for Independent Samples T-Test for 'Interactivity' of 'E-Governance Projects using Big Data'

	Role	N	Mean	Std. Deviation	Std. Error Mean
Interactivity	B	427	3.792	1.088	0.053
	I	118	3.540	0.844	0.078

'*Decision support***'** of **E-Governance Projects using Big Data**

Table 6.29 shows the results for independent samples test for 'Decision support' of 'e-governance projects using big data'. Since $p<0.05$ in Levene's Test for 'equality of variance' that means equality of variance is not assumed. All relevant values for row for 'equality of variance not assumed' are used for further analysis. There were no significant differences ($t(215.262) = 1.477$, $p = 0.141$) in the scores with mean score for beneficiaries ($M = 3. 3.914$, $SD = 1.073$) and the mean score of implementers ($M = 3.768$, $SD = 0.911$). The magnitude of the differences in the means (mean difference = 0.146, 95% CI: -0.049 to 0.340) was very small. It shows that there is no significant difference in perceptions of implementers and beneficiaries and '*Decision support'* improvement perception by using big data in e-governance projects is same for beneficiaries as well as implementers.

Table 6.29: Independent Samples Test for ‘Decision support’ of ‘E-Governance Projects using Big Data’

DecisionSupport	Levene's Test for Equality of Variances		t-test for Equality of Means							
	F	Sig.	t	df	Significance		Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
					One-Sided p	Two-Sided p			Lower	Upper
Equal variances assumed	5.971	0.015	1.347	543	0.089	0.179	0.146	0.108	-0.067	0.358
Equal variances not assumed			1.477	215.262	0.071	0.141	0.146	0.099	-0.049	0.340

Table 6.30 shows the results for the group statistics for the independent samples t-test for ‘Decision support’ of ‘e-governance projects using big data’..

Table 6.30: Group Statistics for Independent Samples T-Test for ‘Decision support’ of ‘E-Governance Projects using Big Data’

	Role	N	Mean	Std. Deviation	Std. Error Mean
DecisionSupport	B	427	3.914	1.073	0.052
	I	118	3.768	0.911	0.084

6.8 Findings of the Empirical Survey

Based on the validation of the conceptual research framework of ‘e-governance performance using big data’ through measurement and structural model. Following important findings have emerged from PLS-SEM analyses:

- All the four macro variables, viz. ‘Efficiency’ (EF), ‘Transparency’ (TR) and ‘Interactivity’ (IN) and ‘Decision support’ (DS) for the study of outcome variable ‘e-governance performance’ (EGP) have been validated empirically.
- There are fifteen micro variables constituted for four macro variables stated above, viz. four under ‘Efficiency’ (EF): ‘Fast execution of core process’ (FEP), ‘Reduced cost’ (REC), ‘Reduced paperwork’ (REP) and ‘Simplification of processes’ (SOP); four under ‘Transparency’ (TR): ‘Comprehensive information’ (COI), ‘Easy access to information’ (EAI), ‘Fairness’ (FAR) and ‘Reliable information’ (REI); three under ‘Interactivity’ (IN): ‘Consensus-oriented’ (COO), ‘Improved interaction’ (IMI) and ‘Participative’ (PAR); four under ‘Decision support’ (DS): ‘Better monitoring and control’ (BMC), ‘Improved decision-making’ (IDM), ‘Improved planning’ (IMP) and ‘Accountability’ (ACC). These have been empirically validated.
- Two out of five formulated alternate hypotheses for influence of big data related factors on ‘Performance of e-governance projects using big data’ are found statistically supported. ‘Information and data’ (ID) emerged as most significant factor, followed by ‘Organization and management’ (OM). ‘Information technology’ (IT), ‘Institution and environment’ (IE). ‘Law and regulation’ (LR) have been statistically insignificant. Hence the hypotheses for influence of Information technology’ (IT), ‘Institution and environment’ (IE). ‘Law and regulation’ (LR) on ‘Performance of e-governance using big data’ are not supported.

- Out of twenty five alternate hypotheses formulated for influence of big data related factors on the components of ‘e-governance performance’, viz. ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS), there are seven hypotheses that are supported: ‘Information and data’ (ID) does significantly influence three components of ‘e-governance performance’ except ‘Efficiency’ (EF), ‘Information technology’ (IT) significantly influence three components of ‘e-governance performance’ except ‘Decision support’ (DS), ‘Organization and management’ (OM) significantly influence only ‘Decision support’ (DS) component of ‘e-governance performance’. Rest of the hypotheses are not supported: ‘Information and data’ (ID) does not influence ‘Efficiency’ (EF), ‘Information technology’ (IT) does not influence ‘Decision support’ (DS), ‘Organization and management’ (OM) does not influence ‘Efficiency” (EF), ‘Transparency’ (TR) and ‘Interactivity’ (IN), ‘Law and regulation’ (LR) does not influence any component of ‘e-governance performance’, ‘Institution and environment’ (IE) does not influence any component of ‘e-governance performance’.

6.9 Concluding Remarks

The proposed research framework has been empirically validated in this chapter. To assess the measurement model reliability and validity of the construct are measured with the recommended statistical tools with the prescribed values. For checking the internal consistency of constructs, the value of Cronbach’s alpha and the composite reliability have been computed and all results are found within the prescribed thresholds. To establish the validity of the construct, convergent validity and discriminant validity have been computed and are also found to be within the recommended thresholds. All macro variables included in the study have been validated through empirical analysis.

The structural relationship of the model has been tested for variance, error probability, path-relationship, determinant of coefficient, effect size, and predictive relevance. Statistical tools comprised of t-value, path coefficient, R^2, f^2 and Q^2 for testing have been used. All values are found to be within the prescribed ranges. The hypotheses based on the structural model have also been tested. The respective t-values and p-values are found to be within the recommended threshold resulting in support of hypotheses.

Two out of five formulated alternate hypotheses for ‘e-governance performance’ by big data related factors are found statistically supported. ‘Information and Data (ID) emerged as most significant factor, followed by ‘Organization and Management’ (OM), ‘Institution and Environment' (IE). 'Law and Regulation' (LR) have been statistically insignificant. Hence the hypotheses for 'e-governance performance' through 'Law and Regulation' is not supported. Out of twenty five alternate hypotheses formulated for influence of big data related factors on the components of 'e-governance performance', viz. 'Efficiency' (EF), 'Transparenc***y***' (TR), 'Interactivity' (IN) and 'Decision support' (DS), there are seven hypotheses that are supported and thirteen are not supported statistically. The next Chapter presents synthesis of learnings, conclusions, recommendations and scope for future research.

Chapter 7

Learnings, Conclusions, Recommendations and Scope for Future Research

7.1 Introduction

The current study is an attempt to develop a validated framework for analyzing the ‘Performance of e-governance projects using big data’. For this, a mixed-method research approach has been used that involves both qualitative as well as quantitative methodology. In this chapter, the key learnings from both qualitative study and quantitative study are presented. For the qualitative study, the TISM-P method has been used. For the quantitative study, PLS-SEM has been used to analyze the data and present the results. Later in the subsequent section, the key learnings have been synthesized to suggest a validated framework for assessing the performance of e-governance projects in India that make use of big data. The proposed conceptual research framework (*Chapter 4, Figure: 4.1*) has been validated and the results are presented in the previous chapters (Chapter 5 and Chapter 6). The section ahead presents the gist of the research work starting from the research objectives and its achievement along with broad conclusions, significant research contributions, implications for researchers and practitioners, limitations of the study and possible directions for future research work.

7.2 Key Learnings from the Qualitative Study

Four macro variables and fifteen micro variables of ‘performance of e-governance projects using big data’ and five macro variables and twenty-two micro variables of big data related factors have been identified based on the literature review. These identified dimensions were then modeled into a hierarchical level using the TISM-P. TISM-P model for ‘Performance of e-governance projects using big data’ was developed to have deeper insights into the interrelationships of all big data related factors and components of ‘Performance of e-governance projects using big data’.

The four macro variables constituting the outcome variable of ‘Performance of e-governance projects using big data’ along with five big data related macro variables were hierarchically structured into multiple levels with ‘Efficiency’ (EF) placed at the top of the model having interrelationships with all other macro variables of the TISM-P. The final TISM-P big data model in e-governance with polarity of relationships shows the relationship between these macro variables. A construct placed at the top of the model means that it is a dependent and is categorized as the main outcome variable. The interpretation of the nodes and links gives the final total interpretive structural. 'Institution and environment' (IE) is shown at the bottom of the model. The variable at the top of the model have higher dependence and those at the bottom have a high driving capability. In final TISM-P model, 'Institution and environment' (IE) positively influences 'Law and regulation' (LR) that further influences 'Transparency' (TR) and in turn finally the 'Efficiency' (EF) of e-governance is improved. The TISM model with polarity (TISM-P) is more explanatory both regarding the interpretation of relationships and their polarity than ISM.

7.3 Key Learnings from the Quantitative Study

The quantitative study involved the empirical validation of the structural model through PLS-SEM. The SmartPLS software version 4.0 has been used to test the research hypotheses. The questionnaire was circulated to around 600 respondents (beneficiaries). However, 439 of them responded. Out of 439 responses, 12 forms were found to be incomplete. Hence, valid responses collected for the study were 427. The sample size of 427 was considered suitable for the study (Hair et al., 2010; Sarstedt et al., 2017). Regarding the data collection from the implementers of e-governance services of the selected e-governance projects, the questionnaire was circulated to around 150 implementers. However, 120 of the implementers responded. Out of 120 responses, 02 forms were found to be incomplete. Hence, valid responses were 118. The sample size of 118 (implementers) was considered suitable for the study (Hair et al., 2010; Sarstedt et al., 2017). Based on the reliability and validity assessment of all the constructs and matching with all the recommended threshold criteria, all constructs are included for assessment. The key learnings are summarized as follows:

- All the four macro variables constituting 'Performance of e-governance projects using big data' (EGP), viz. 'Efficiency' (EF), 'Transparency' (TR) and 'Interactivity' (IN) and 'Decision support' (DS) have been validated empirically.
- There are fifteen micro variables constituted for four macro variables stated above:
    - four under 'Efficiency' (EF): 'Fast execution of core process' (FEP), 'Reduced cost' (REC), 'Reduced paperwork' (REP) and 'Simplification of processes' (SOP);

    - four under ‘Transparency’ (TR): ‘Comprehensive information’ (COI), ‘Easy access to information’ (EAI), ‘Fairness’ (FAR) and ‘Reliable information’ (REI);
    - three under ‘Interactivity’ (IN): ‘Consensus-oriented’ (COO), ‘Improved interaction’ (IMI) and ‘Participative’ (PAR);
    - four under ‘Decision support’ (DS): ‘Accountability’ (ACC), ‘Better monitoring and control’ (BMC), ‘Improved decision-making’ (IDM) and ‘Improved planning’ (IMP). These have been empirically validated.
- Two out of five formulated alternate hypotheses for influence of big data related factors on ‘Performance of e-governance using big data’ (EGP), are found to be statistically supported:
    - ‘Information and data’ (ID) emerged as most significant factor, followed by ‘Organization and management’ (OM).
    - ‘Information technology’ (IT), ‘Law and regulation’ (LR) and ‘Institution and environment’ (IE) have been found to be having no significant influence on ‘Performance of e-governance projects using big data’ (EGP). Hence the hypotheses for ‘e-governance performance’ through ‘Information technology’ (IT), ‘Law and regulation’ (LR) and ‘Institution and environment’ (IE) are not supported.
    - Though ‘Information technology’ (IT) has significant influence on constituents of ‘e-governance performance’, viz., ‘Efficiency’ (EF), ‘Transparency’ (TR) and ‘Interactivity’ (IN) but the overall influence has not found to be significant.
- Out of twenty alternate hypotheses formulated for analysing influence of big data related factors on the components of ‘Performance of e-governance using big data’ (EGP), viz. ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS), there are seven hypotheses that are supported in the study context:
    - ‘Information and data’ (ID) does significantly influence three components of ‘‘Performance of e-governance using big data’ (EGP), viz. ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS).
    - ‘Information technology’ (IT) significantly influence three components of ‘Performance of e-governance using big data’ (EGP), viz. ‘Efficiency’ (EF), ‘Transparency’ (TR) and ‘Interactivity’ (IN).
    - ‘Organization and management’ (OM) significantly influence only the ‘Decision support’ (DS) component of ‘‘Performance of e-governance using big data’ (EGP).
    - ‘Law and regulation’ (LR) and ‘Institution and environment’ (IE) do not influence any component of ‘‘Performance of e-governance using big data’ (EGP).

- ‘Information and data’ (ID) does not influence ‘Efficiency’ (EF). ‘Efficiency’ (EF) consists of fast and simplified processes that reduce paperwork and cost. These components are not directly influenced by constituents of ‘Information and data’ (ID) like the information and data quality, privacy and security.
- ‘Information technology’ (IT) does not influence ‘Decision support’ (DS). ‘Decision support’ (DS) includes ‘Improved planning’ for different set of stakeholders like departments, policy makers, staff, etc. that depends on many other indicators and parameters apart from the constituents of ‘Information technology’ (IT) like system usability, security, technology interoperability, complexity and algorithms. Similarly the other components of ‘Decision support’ (DS) like ‘Improved decision-making’, ‘Better monitoring and control’ by different government bodies and ‘Accountability’ do not depend on or get influenced by the components of ‘Information technology’ (IT).
- ‘Organization and management’ (OM) does not influence ‘Efficiency’ (EF), ‘Interactivity’ (IN) and ‘Transparency’ (TR). The constituents of ‘Organization and management’ (OM) like Project size, management support, leadership, goals, conflict management and personnel are more likely to influence during the e-governance development phase rather than the implementation phase.
- ‘Law and regulation’ (LR) issues do not influence the ‘Performance of e-governance projects using big data’ (EGP) significantly. This is also very clear from the facts that it does not influence any of the components of e-governance performance, viz. ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS). ‘Law and regulation’ (LR) consists of conducive laws and regulations (legal frameworks, IT policies and standards, big data evaluation and benchmarking, etc.), cost structures and budgeting, budget allocation & disbursement and intergovernmental relationships that are more instrumental during the e-governance project development phase instead of the implementation phase. This may be the probable reason for no significant influence of ‘Law and regulation’ (LR) on ‘Performance of e-governance projects using big data’ (EGP) or on any of the components of e-governance performance, viz. ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS). These issues should be handled properly for the faster and effective development.
- ‘Institution and environment’ (IE) issues do not influence ‘Performance of e-governance projects using big data’ significantly. This is also very clear from the facts that it does not influence any of the components of e-governance performance, viz.

'Efficiency' (EF), 'Transparency' (TR), 'Interactivity' (IN) and 'Decision support' (DS). 'Institution and environment' (IE) consists of legislative support and rules for privacy and security concerns, autonomy of agencies, policy and political pressures and environmental issues. All these are more instrumental during the e-governance project development phase instead of the implementation phase. This may be the probable reason for no significant influence of 'Institution and environment' (IE) on 'Performance of e-governance projects using big data' (EGP) or on any of the components of e-governance performance, viz. 'Efficiency' (EF), 'Transparency' (TR), 'Interactivity' (IN) and 'Decision support' (DS). These issues should be handled properly for the faster and effective development.

7.4 Triangulation: Qualitative and Quantitative Methods

The triangulation method is applied through the mixing of data or methods so that diverse viewpoints can shed light on the research topic. The mixing of data types, known as data triangulation, is often thought to help in validating the claims that might arise from an initial pilot study. The mixing of methodologies, e.g., mixing the use of survey data with interviews, is a more profound form of triangulation (Jick, 1979; Olsen, 2004; Fielding, 2012). Triangulation refers to the use of more than one approach to the investigation of a research question in order to enhance confidence in the ensuing findings. Since much social research is founded on the use of a single research method and as such may suffer from limitations associated with that method or from the specific application of it, triangulation offers the prospect of enhanced confidence. Triangulation is one of the several rationales for multimethod research. The term derives from surveying, where it refers to the use of a series of triangles to map out an area (Bryman, 2004). Table 7.1 shows the triangulation results of the survey conducted through a qualitative and quantitative approach. Key highlights are listed below:

- Research started with the identification of research variables (nine macro and thirty seven micro variables) through an extensive literature review. These research variables have been included in the study.

Table 7.1: Triangulation Results for 'Performance of E-Governance Projects using Big Data'

Macro Variables	**Micro Variables**	**Initial phase (Literature Review)**	**Qualitative Method (TISM-P)**	**Quantitative Method (PLS-SEM)**
'E-Governance Performance' Constructs				
'Efficiency' (EF)	• Fast execution of core process (FEP) • Simplification of processes (SOP) • Reduced paperwork (REP) • Reduced cost (REC)	One macro variable 'Efficiency' (EF) and four micro variables were identified from the literature review	• All macro variables identified from the literature review have also been confirmed by the experts. • 'Efficiency' (EF) of 'e-governance performance' placed at the top of the model (having high dependence) having interrelationships with all other macro variables of the TISM-P.	• All macro variables confirmed by the experts have also emerged as significant constituents of 'e-governance performance'. • 'Efficiency' (EF) was the most significant factor of 'e-governance performance'
'Transparency' (TR)	• Reliable information (REI) • Comprehensive information (COI) • Easy access to information (EAI) • Fairness/Reduced corruption (FAR)	One macro variable 'Transparency' (TR) and four micro variables were identified from the literature review		
'Interactivity' (IN)	• Improved interaction (IMI) • Participative (PAR) • Consensus-oriented (COO)	One macro variable 'Interactivity' (IN) and three micro variables were identified from the literature review		
'Decision support' (DS)	• Improved planning (IMP) • Improved decision-making (IDM) • Better Monitoring & control (BMC) • Accountability (ACC)	One macro variable 'Decision support' (DS) and four micro variables were identified from the literature review		

Big Data related Constructs				
‘Information and data’ (ID)	• Information and data quality (IDQ) • Dynamic information (DYI) • Privacy and security (PAS)	One macro variable ‘Information and data’ (ID) and three micro variables were identified from the literature review	• All macro variables identified from the literature review have also been confirmed by the experts. • ‘Institution and environment’ (IE) is shown at the bottom of the model having high driving capability	• All macro variables confirmed by the experts have also emerged as significant constituents of ‘e-governance performance’. • ‘Information and Data’ (ID) was the most significant of big data related variables • ‘Law and Regulation’ (LR) and ‘Institution and environment’ (IE) were found to be insignificant variables
‘Information technology’ (IT)	• Usability (USE) • Security issues (SEI) • Technological compatibility (TEC) • Technology complexity/Newness (TEN) • Technical skills and experience (TSE) • Techniques, Algorithms & scalability (TAS)	One macro variable ‘Information technology’ (IT) and six micro variables were identified from the literature review		
‘Organization and management’ (OM)	• Project size (PRS) • Manager’s attitudes & behavior (MAB) • Users or organizational diversity (UOD) • Alignment & Awareness of organizational goals (AOG) • Resistance to change/internal conflicts (RTC) • Qualified Personnel/ Talent (QUP)	One macro variable ‘Organization and management’ (OM) and six micro variables were identified from the literature review		
‘Law and regulation’ (LR)	• Conducive laws and regulations (CLR) • Cost structures, Budgeting, Budget	One macro variable ‘Law and regulation’ (LR) and		

	allocation & disbursement (CSB) • Intergovernmental relationships (IGR)	three micro variables were identified from the literature review		
‘Institution and environment’ (IE)	• Privacy and related security concerns (PSC) • Autonomy of agencies (AOA) • Policy and political pressures (PPP) • Environmental (ENV)	One macro variable ‘Institution and environment’ (IE) and four micro variables were identified from the literature review		

- A comparison of research assessment through the triangulation method, i.e., qualitative, by using TISM-P and quantitative by using PLS-SEM showed that results from both approaches are reliable.
- Most of the resultant hypotheses are supported by both studies. And thus, cross-validation of the conceptual research framework has got validated.

7.4.1 Synthesis of Qualitative and Quantitative Methods

The synthesis of qualitative method (TISM-P) and quantitative method (PLS-SEM) is summarised in Table 7.2 below. This synthesis uses the final model for 'Performance of e-governance projects using big data' developed after following eleven step approach of TISM-P (*Chapter 5, Figure 5.3*) and hypotheses formulated (*Chapter 6, Table 6.15 and Table 6.20*).

Table 7.2: Triangulation Method for 'Performance of E-Governance Projects using Big Data'

Relationship	**Qualitative TISM-P (Influence)**	**Quantitative PLS-SEM**	**Match (Yes/No)**	**Reason for Variations**
IT->EF	Direct	Significant	Yes	Matching
ID->TR	Reverse (TR->ID)	Significant	No	'Transparency' (TR) drives 'Information and data' (ID)
IT->TR	No	Significant	No	'Information technology' (IT) is considered as a logical construct by experts for use in e-governance.
ID->IN	ID-> DS->IN	Significant	No	Though there is not a direct path but 'Information and data' (ID) does influence 'Interactivity' (IN) through 'Decision support' (DS).
IT->IN	Reverse (IN->IT)	Significant	No	'Interactivity' (IN) drives 'Information technology' (IT) and may dictate the architecture and the technologies to be used for implementation.
ID->DS	Direct	Significant	Yes	Matching

OM->DS	Direct	Significant	Yes	Matching
LR->ID	Transitive	Not Significant	No	‘Law and regulation’ (LR) does not influence ‘Information and data’ (ID) directly but this may impact the kind of formats, compliance and guidelines required for the ‘e-governance projects using big data’.
LR->TR	Direct	Not Significant	No	‘Law and regulation’ (LR) does influence ‘Transparency’ (TR) as it impacts the kind of formats, compliance and guidelines required for maintaining the transparency for what all has to be shared and with whom dependeing the access levels and roles for the ‘e-governance projects using big data’.
LR->IT	Direct	Not Significant	No	‘Law and regulation’ (LR) does influence ‘Information and technology’ (IT) as this may impact the kind of formats, compliance, guidelines and roles required for the ‘e-governance projects using big data’.
IE to All	Direct (IE->LR) Rest Transitive	Not Significant	No	‘Institution and environment’ (IE) inherently influence all other factors but the influence may not be that significant from perspective of enhancing the ‘Performance of e-governance projects using big data’.

TR->OM	Direct	Not feasible	No	‘Transparency’ (TR) drives various micro variables of ‘Organization and management’ (OM).
TR->ID	Direct	Not feasible	No	‘Transparency’ (TR) drives various micro variables of ‘Information and data’ (ID).
ID->DS	Direct	Not Significant	No	‘Information and data’ (ID) will drive the ‘Decision support’ (DS) in terms of what all information and data needs are there for decision making and planning.
DS->IN	Direct	Not feasible	No	‘Decision support’ (DS) may drive the ‘Interactivity’ (IN) in terms of giving more options and formats for consensus through improved decisions and planning.
IN->IT	Direct	Not feasible	No	‘Interactivity’ (IN) drives the kind of technologies and algorithms required in ‘Information technology’ (IT).
OM->IT	Transitive	Not feasible	No	‘Organization and management’ (OM) will drive either through facilitation or through challenges for the different micro variables of ‘Information technology’ (IT).
DS->EF	Transitive	Not feasible	No	‘Decision support’ (DS) may drive the ‘Efficiency’ (EF) by providing improved planning and better monitoring and control to make ‘e-governance projects using big data’ more efficient, fast, simple and less expensive.

DS->IT	Transitive	Not feasible	No	'Decision support' (DS) may drive the 'Information technology' (IT) as improved planning, monitoring, control and accountability will dictate the corresponding systems, algorithms, scales and techniques.

7.5 Research Objectives and Findings

Before concluding the study and final remarks, it is imperative to revisit the research objectives which were set at the beginning of the study and had to be achieved. This section recapitulates the research objectives along with the findings.

Research objective 1: To identify the variables for measuring the 'Performance of e-governance projects using big data' in India.

The first key question to achieve the objectives of the study, was to understand the concept of the e-governance performance, big data and the relevance of big data in the context of e-governance. The answer to it was formulated as the first objective of the study, i.e., "To identify the variables for measuring the 'Performance of e-governance projects using big data' in India." Through literature review, four components to measure the e-governance performance were identified. These were 'Efficiency' (EF), 'Transparency' (TR), 'Interactivity' (IN) and 'Decision support' (DS).

- Variables related to 'Efficiency' (EF) were included in the study so as to understand the fast execution of core processes, simplification of processes, reduced paperwork and reduced cost as all these together make the e-governance systems more efficient that is one of the drivers for the e-governance performance.
- Variables related to 'Transparency' (TR) were included in the study to understand the reliable information, comprehensive information, easy access to information and fairness or reduced corruption.
- Variables related to 'Interactivity' (IN) were included in the study to understand the improved interaction, participation and consensus-orientation.
- Variables related to 'Decision support' (DS) were included in the study to understand the accountability, improved planning, improved decision-making and

better monitoring and control of the e-governance systems so as to make them perform better.

Finally in line with the objectives of the study four key macro variables, viz. 'Efficiency' (EF) with its four constituents, 'Transparency' (TR) with its four constituents, 'Interactivity' (IN) with its three constituents and 'Decision support' (DS) with its four constituents were adopted.

Research objective 2: To identify the variables for successful implementation of 'e-governance projects using big data' in India.

To achieve the second research objective of identifying the variables for successful implementation of 'e-governance projects using big data' in India, an extensive literature review was conducted to explore the variables that play the role of critical success factors (CSFs) for the e-governance implementation that make use of big data. There were five factors or macro variables that do drive the e-governance implementation. These were 'Information and data' (ID), 'Information technology' (IT), 'Organization and management' (OM), 'Law and regulation' (LR) and 'Institution and environment' (IE).

- Variables related to 'Information and data' (ID) were included in the study to understand the information and data quality, dynamic information, data privacy and security and open data.
- Variables related to 'Information technology' (IT) were included in the study to understand the system usability, system security issues, technological compatibility and/or interoperability, technology complexity and/or newness, technical skills and/or experience required and finally, technical techniques, algorithms and system scalability.
- Variables related to 'Organization and management' (OM) were included in the study to understand the project size, organization manager's attitudes and behaviour, users and/or organizational diversity, alignment and awareness of organizational goals, resistance to change/internal conflicts and qualified personnel and/or talent.
- Variables related to 'Law and regulation' (LR) were included in the study to understand the conducive laws and regulations, cost structures, budgeting, budget allocation and disbursement and finally, the intergovernmental relationships.

- Variables related to ‘Institution and environment’ (IE) were included in the study to understand the privacy and related security concerns, autonomy of agencies, policy and political pressures and environmental issues like strategic outsourcing, social economic and demographic concerns.

Finally in line with the objectives of the study five key macro variables as ‘Information and data’ (ID) with its three constituents or micro variables, ‘Information technology’ (IT) with its six constituents, ‘Organization and management’ (OM) with its six constituents, ‘Law and regulation’ (LR) with its three constituents and ‘Institution and environment’ (IE) with its four constituents were adopted.

Research objective 3: To explore the relationship between variables for successful implementation and ‘Performance of e-governance projects using big data’ in India.

To achieve the third research objective of understanding the relationship between variable for successful implementation and ‘Performance of e-governance projects using big data’ (EGP) in India, four macro variables constituting the ‘Performance of e-governance projects using big data’ (EGP) and five macro variable as CSFs of e-governance implementation were adopted for the study. Considering the macro variables for ‘Performance of e-governance projects using big data’ (EGP):

- Four micro variables, ‘Fast execution of core processes’ (FEP), ‘Simplification of processes’ (SOP), ‘Reduced paperwork’ (REP) and ‘Reduced cost’ (REC) were identified under ‘Efficiency’ (EF).
- Four micro variables, ‘Reliable information’ (REI), ‘Comprehensive information’ (COI), ‘Easy access to information’ (EAI) and ‘Fairness or reduced corruption’ (FAR) were identified under ‘Transparency’ (TR).
- Three micro variables, ‘Improved interaction’ (IMI), ‘Participation’ (PAR) and ‘Consensus-orientated’ (COO) were identified under ‘Interactivity’ (IN).
- Four micro variables, ‘Improved planning’ (IMP), ‘Improved decision-making’ (IDM), ‘Better monitoring and control’ (BMC) and ‘Accountability’ (ACC) were identified under ‘Decision support’ (DS).

Considering the big data related factors that influence the ‘Performance of e-governance projects using big data’:

- Three micro variables, ‘Information and data quality’ (IDQ), ‘Dynamic information’ (DYI) and ‘Privacy and security’ (PAS) were identified under ‘Information and data’ (ID).
- Six micro variables, ‘Usability’ (USE), ‘Security issues’ (SEI), ‘Technological compatibility’ (TEC), ‘Technology complexity/Newness’ (TEN), ‘Technical skills and experience’ (TSE) and ‘Techniques, Algorithms and scalability’ (TAS) were identified under ‘Information technology’ (IT).
- Six micro variables, ‘Project size’ (PRS), ‘Manager’s attitudes and behavior’ (MAB), ‘Users or organizational diversity’ (UOD), ‘Alignment and Awareness of organizational goals’ (AOG), ‘Resistance to change/internal conflicts’ (RTC) and ‘Qualified Personnel/ Talent’ (QUP) were identified under ‘Organization and management’ (OM).
- Three micro variables, ‘Conducive laws and regulations’ (CLR), ‘Cost structures, Budgeting, Budget allocation and disbursement’ (CSB) and ‘Intergovernmental relationships’ (IGR) were identified under ‘Law and regulation’ (LR).
- Four micro variables, ‘Privacy and related security concerns’ (PSC), ‘Autonomy of agencies’ (AOA), ‘Policy and political pressures’ (PPP) and ‘Environmental’ (ENV) were identified under ‘Institution and environment’ (IE) (*Chapter 4*).

To analyze the relationship among selected variables, apart from the literature source, recommendations of domain experts were also obtained. A conceptual research framework is thereby prepared which was assessed through the qualitative research technique, TISM-P. Domain experts’ opinions in the form of responses to the questionnaire were obtained and a logic-knowledge base was prepared. By following the set procedure of evaluating a model through eleven steps of TISM-P, a hierarchical model for ‘Performance of e-governance projects using big data’ was developed. The result of the TISM-P analysis revealed that all the variables adopted for the study have a sound relationship among them (*Chapter 5*).

Research objective 4: To propose an empirically validated framework for improving the ‘Performance of e-governance projects using big data’ in India.

The proposed conceptual research framework (*Chapter 4*) was empirically validated by using both qualitative as well as quantitative approaches. Validation through the qualitative method was done through TISM-P (*Chapter 5*) whereas, PLS-SEM was used to validate the model statistically (*Chapter 6*). Empirical validation was done through the measurement and structural models. SmartPLS version 4.0 software has been used to run the model for validation.

To assess the measurement model, reliability and validity tests for constructs taken for the study were conducted. All the necessary statistical values in terms of Cronbach's alpha, Rho, and Composite Reliability for reliability checks were obtained and checked for meeting the threshold values. Similarly, for the construct validity check, the recommended threshold values for convergent validity and discriminant validity were computed. All values obtained for the assessment of the measurement model are found to be within the recommended thresholds. To assess the structural model, all formulated hypotheses were tested through appropriate statistical tools for path significance, error probability, coefficients of determination, effect size and predictive relevance. The required statistical values such as path-coefficients, t-statistic, the value of R^2, value of f^2 and the value of Q^2 were computed. Nine out of twenty five hypotheses were found to be statistically supported and accepted (*Chapter 6*).

7.6 Conclusions

India has made significant strides in implementing PAN India e-governance projects that have started leveraging big data and analytics to improve government service delivery and citizen engagement. Overall, the use of big data may enable the Indian government to improve the efficiency and effectiveness of its e-governance projects and enhance citizen engagement and participation in governance. While there have been some concerns around privacy and data security, the government may have to take steps to address these issues and ensure the responsible use of citizen data.

Through literature review, issues of big data in the context of e-governance implementation and its performance have been studied and research gaps identified. Accordingly, constructs were identified and a research framework was conceptualized for empirical validation. The findings of the study are summarized as follows:

- The outcome variable ‘Performance of e-governance projects using big data’ (EGP) and all nine macro variables and thirty seven micro variables identified through the literature review were also confirmed by the experts.

- Interrelationships among 'Performance of e-governance projects using big data' (EGP) and macro and micro variables were brought out using Total Interpretive Structural Modeling using Polarity of relationships called TISM-P (*Chapter 5*).
- The proposed conceptual research framework was validated through the measurement and structural models empirically. PLS-SEM has been applied for validating the model. All the recommended thresholds for the statistical measures were fulfilled (*Chapter 6*).
- All the formulated hypotheses were tested but only nine out of twenty five were supported statistically.
- 'Efficiency' (EF) of e-governance projects has emerged as the key macro variable for the 'e-governance performance' from both research techniques adopted for the study, i.e., the qualitative (TISM-P) as well as quantitative (PLS-SEM).
- For big data related factors for e-governance, 'Information and data' (ID), 'Information technology' (IT) and 'Organization and management' (OM) have emerged as the important factors from both the research techniques, i.e., TISM-P as well as PLS-SEM.

7.7 Recommendations

Key factors identified from the literature review and endorsed by the experts for 'Performance of e-governance projects using big data' are also validated through both the qualitative as well as quantitative research methods. This reveals that all the findings of the research outcome are relevant. Government organizations offering services through e-governance/service websites may, therefore, focus on use of big data related factors like 'Information and data' (ID), 'Information technology' (IT) and 'Organization and management' (OM) to enhance the e-governance performance through 'Efficiency' (EF), 'Transparency' (TR), 'Interactivity' (IN) and 'Decision support' (DS). Key recommendations based on the validation of the model are presented below.

- 'Information and data' (ID) and 'Information technology' (IT) emerged as the key factors as per the domain experts opinions during TISM-P assessments. This is also substantiated through the statistical analysis.
- It is also seen that 'Information and data' (ID) play an appreciable role in influencing the 'Transparency' (TR), 'Interactivity' (IN) and 'Decision support' (DS) of the e-governance projects to enhance their performance. The government organizations are expected to take care of the information and data quality, data privacy and security during the multiple steps for reliable and comprehensive information that may increase

transparency and reduce corruption, improve interaction and make the e-governance projects more participative that may be used for improved planning at various levels of government and other stakeholders like policy makers.

- ‘Information technology’ (IT) plays an important role in influencing ‘Efficiency’ (EF), ‘Transparency’ (TR) and ‘Interactivity’ (IN). The government organizations are expected to take care of all related aspects like system usability, interoperability, compatibility and security to have fast execution of core processes, simplification of processes, reduced paperwork, reduced cost, reliable information, comprehensive information, easy access to information and reduced corruption and having participative and transparent e-governance projects for all stakeholders involved.
- It has emerged from the study that ‘Organization and management’ (OM) issues though do not influence ‘Efficiency’ (EF), ‘Interactivity’ (IN) and ‘Transparency’ (TR) significantly but it does influence the ‘Decision support’ (DS). Government organizations need to work on these ‘Organization and management’ issues to enhance the e-governance performance by empowering the citizens by providing the ‘Decision support’ through improved planning, improved decision-making with better monitoring and control by the government through use of big data
- ‘Law and regulation’ (LR) issues do not influence the ‘Performance of e-governance projects using big data’ (EGP) significantly. This is also very clear from the facts that it does not influence any of the components of e-governance performance, viz. ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS). ‘Law and regulation’ (LR) consists of conducive laws and regulations (legal frameworks, IT policies and standards, big data evaluation and benchmarking, etc.), cost structures and budgeting, budget allocation & disbursement and intergovernmental relationships that are more instrumental during the e-governance project development phase instead of the implementation phase. This may be the probable reason for no significant influence of ‘Law and regulation’ (LR) on ‘Performance of e-governance projects using big data’ (EGP) or on any of the components of e-governance performance, viz. ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS). These issues should be handled properly for the faster and effective development.
- ‘Institution and environment’ (IE) issues do not influence ‘Performance of e-governance projects using big data’ significantly. This is also very clear from the facts that it does not influence any of the components of e-governance performance, viz.

‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS). ‘Institution and environment’ (IE) consists of legislative support and rules for privacy and security concerns, autonomy of agencies, policy and political pressures and environmental issues. All these are more instrumental during the e-governance project development phase instead of the implementation phase. This may be the probable reason for no significant influence of ‘Institution and environment’ (IE) on ‘Performance of e-governance projects using big data’ (EGP) or on any of the components of e-governance performance, viz. ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS). These issues should be handled properly for the faster and effective development.

7.8 Research Implications

This research work has major implications for several stakeholders as policymakers for government, e-governance practitioners or service providers, beneficiaries and/or society and researchers.

7.8.1 Research Implication for Policymakers

Policymakers generally belong to the senior cadre of a government organization or concerned authority in that domain. These members plan and formulate the policies for implementation through various channels. The inclusion of experts from diverse domains comprising of senior officers, academicians, and managers with their valuable inputs is expected to bring due improvement in the planning and policy formulation for improving ‘Performance of e-governance projects using big data’. The outcome of the study particularly with no significant influence of ‘Law and regulation’ (LR) and ‘Institution and environment’ (IE) on the ‘e-governance performance’ (EGP) which got lowest and insignificant t-statistic value among all constructs of big data related factors shall be the point of attraction for the policy makers to frame such conducive laws and regulations that influence the ‘e-governance performance’ positively.

7.8.2 Research Implication for Practitioners

Digital India is a flagship program launched by the Indian government to transform India into a digitally empowered society and knowledge economy. The program aims to leverage technology to enhance the delivery of government services, promote digital literacy and entrepreneurship, and increase digital access and connectivity across the country. Big data and analytics is a key component of the Digital India program and has significant research implications in the field of e-governance. Here are some research implications of big data in e-governance in the context of the Digital India program:

- **Data-driven decision making:** It becomes imperative for government to focus on information and data quality, privacy and security as 'Information and data' and 'Information technology' in big data have the most significant influence on 'e-governance performance'. The use of big data and analytics enables government agencies to collect and analyze large amounts of data in real-time, providing insights that can inform policy decisions and improve service delivery. The outcome of this study shows the impact of data-driven decision making on the efficiency and transparency as well.
- **Privacy and security:** The collection and use of big data in e-governance raise concerns around privacy and data security. Practitioners may further explore the ethical and legal implications of data collection and use in e-governance, and identify ways to ensure the responsible use of citizen data.
- **Capacity building:** The success of the Digital India program depends on the availability of skilled personnel who can design, implement and maintain digital systems. This study included the organization and management factors for considering the skilled human resources in big data in e-governance.

7.8.3 Research Implication for Beneficiaries/Society

Target beneficiaries play an important role in enhancing the e-governance service delivery system with the use of big data. An aware citizen keeps pushing government and constantly presses for improved services. Data from citizens with their transactions, valuable suggestions and/or feedback can help e-governance to improve its performance. Citizens availing government services and their participation in various decisions making can help governments to provide customized services for their specific and shall help in improving e-governance performance through use of insights into the collected big data.

7.8.4 Research Implication for Researchers

Overall, the use of big data in e-governance has significant research implications, and researchers can contribute to the development of effective and sustainable e-governance systems that promote citizen engagement, transparency, and accountability. There are several studies conducted on the evaluation of e-governance. Most of these studies are focused primarily on the issue of evaluating e-governance in terms of service delivery, service adoption, performance, etc. There is a dearth of research conducted on use of big data in e-governance. This study shall help researchers to further investigate the issue of ‘Performance of e-governance projects using big data‘. Researchers are also expected to recognize the benefits of a mixed method of validation by adopting both qualitative and quantitative techniques in evaluating their proposed model taken for research.

7.9 Significant Research Contributions

The study identifies the main indicators and factors of the big data model for assessing the ‘Performance of e-governance projects using big data’, thereby contributing to the existing literature on assessing e-governance performance in the context of big data. This study has several research contributions both from theoretical and practical points of view as follows:

- Theoretically, big data covers a vast area and is mainly studied as part of core technology. However, this study has identified ‘Performance of e-governance using big data’ by combining ‘e-governance performance’ and big data based on technology as well as public administration. This was also mentioned as one of the research gaps (*Chapter 2, Section 2.15*).
- From a practical point of view, the outcomes of this research are expected to help the key stakeholders to draw a lesson for improvising their work performance areas.
- The research has used the triangulation method of research methodology by using both qualitative as well as quantitative approaches for validating the research model. The use of a mixed-method approach can also be adopted by prospective researchers in the field of ‘e-governance performance using big data’.

7.10 Limitations of the Study

An attempt has been made to validate the proposed conceptualized research framework by applying the mixed-method research approach. Despite the efforts put into establishing the validity, the study is not free from limitations. Some of the limitations are listed below.

- ‘Performance of e-governance using big data’ might have more linkages with other parameters apart from the constructs chosen for this study, i.e., ‘Efficiency’ (EF), ‘Transparency’ (TR), ‘Interactivity’ (IN) and ‘Decision support’ (DS).
- Big data related variables might have more linkages with other parameters apart from the constructs chosen for this study, i.e., ‘Information and data’, ‘Information technology’, ‘Organization and management’, ‘Law and regulation’ and ‘Institution

and environment'.

- The study is based on a few projects in 'Government-to-Citizen (G2C) category. Projects belonging to 'Government-to-Business' (G2B) and 'Government-to-Government' (G2G) could not be covered.
- It should also be noted that this study was more in the context of developing countries where the knowledge about big data and its ecosystem is in the growth stage; therefore, validation from other countries/regions is still needed.
- The purposive sampling technique used for this study is a non-probability sampling technique which has limitations in terms of model generalization.

7.11 Directions for Future Research

E-governance being an interdisciplinary area has a wider scope for research. Though sincere efforts have been made to cover the relevant and related areas of big data and e-governance assessment. However, there are still some areas that remained untouched, therefore, a possible direction for future scope of research would be as follows:

- Through suitable modifications, this study can be further conducted for G2B and G2G initiatives.
- The study has been conducted in Indian context with a limited scope and as such the research findings are specific to the context of the study. The scope can be extended to other developing countries for generalized findings.
- While the e-governance aims to promote digital access and connectivity across the country, there is a risk of creating a digital divide between those who have access to technology and those who do not. Research can examine the impact of the 'e-governance using big data' on digital inclusion and identify strategies to bridge the digital divide.
- The collection and use of big data in e-governance raise concerns around privacy and data security. Practitioners may further explore the ethical and legal implications of data collection and use in e-governance, and identify ways to ensure the responsible use of citizen data.
- The 'e-governance using big data' aims to promote citizen engagement and participation in governance through the use of digital platforms. Big data and analytics can be used to analyze citizen feedback and engagement patterns, enabling policymakers to design more responsive and citizen-centric services.
- The findings may be validated through interpretation in specific project contexts in

the form of caselets by further interacting with policy makers, project officials and beneficiaries.

7.12 Concluding Remarks

This study is conducted by adopting a mixed-method approach. An overview of the triangulation method approach for the research work has been presented in this chapter. Findings based on the assessment through the triangulation approach is also summarised. The summary is based on the qualitative method using TISM-P as a tool for validation and the quantitative method using PLS-SEM as a tool for empirical validation. Findings show that the result through both approaches are almost same and the minor differences were explained in this chapter.

The primary objective of this study was to empirically test and validate conceptualized research framework for ‘Performance of e-governance projects using big data’ through a study of select projects in India. A mixed-method approach has been adopted for the study to validate the framework qualitatively and statistically. The validated framework is expected to serve for the improvement in ‘Performance of e-governance projects using big data’ in India. The research may be viewed as a modest step forward in reinstating the big data frameworks for citizen-centric e-governance projects for effective and efficient e-governance.

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Appendix I: Research Questionnaire for Beneficiary

Survey on 'Performance of E-Governance Projects using Big Data'

Objective: The aim of this research is to assess the 'Performance of e-governance projects using big data (extremely large data sets)' analysis.

Declaration: The information collected through this survey will be used only for academic purposes. The identity of the respondent will not be disclosed in any circumstances.

The survey comprises of different kind of questions and there is no right or wrong answer to each question. I am only interested in your personal opinions. Thank you very much for sparing your valuable time. Any queries may be addressed to charuv@gmail.com.

* Required

Please select one government online service availed by you recently, where large data is involved. * **(Note: Please fill separate questionnaire for each online service availed)**		
	A. Aadhaar card	
	B. CGHS	
	C. Passport	
	D. IT Return Filing	
	E. Indian Railway Catering and Tourism Corporation (IRCTC)	
Section A: Demographic/General Information		
1.	Gender	
	Male	
	Female	
	Other	
2.	Age (years)	
	18-30	
	31-45	
	46-60	
	More than 60	
3.	Education level *	
	No schooling	
	Till Class X	

	Till Class XII	
	Undergraduate	
	Postgraduate	
	Professional	
	Doctoral	
4.	Employment status	
	Employed	
	Unemployed	
	Retired	
	Business	
	Student	
	Not Applicable	
5.	Area of occupation - *	
	Information Technology (IT)	
	Medical/Health	
	Education	
	Financial Institution	
	Student	
	Government	
	Other	
6.	Annual approximate earning (INR) - *	
	Less than 2 lacs	
	2 lacs – 5 lacs	
	5 lacs – 10 lacs	
	10 lacs – 20 lacs	
	More than 20 lacs	
	Not Applicable	
7.	Organization -	
	Central Government	
	State Government	
	Autonomous	
	Private Industry	

	Business	
	Not Applicable	
8.	Work experience (years)	
	Less than 5	
	5 – 10	
	11 – 15	
	16 – 20	
	More than 21	
	Not Applicable	

Section B: Section B: Your experience with government services availed in online mode

Please tick on the scale below to express your opinion:

1=Strongly Disagree, 2=Disagree, 3=Can't Say, 4=Agree, 5=Strongly Agree

In my opinion,

9.	Advantages of online services are -	1	2	3	4	5
9a	Faster service delivery					
9b	Reduced duplicate tasks					
9c	Improved work efficiency					
9d	Improved service quality					
9e	Faster response to queries					
10.	Processes in online services are -					
10a	Simple to understand					
10b	Simple to follow					
10c	User-centric					
10d	Improved and flexible					
10e	Having minimal data loss					
11.	In online services there are less -					
11a	Dependencies on multiple departments					
11b	Documents required to fill					
11c	Supporting documents to submit					
11d	Dependencies on printed material					
11e	Integration isues with Aadhaar					
12.	There is reduced cost in online system to -					

12a	Citizen					
12b	Government (as less resources are used)					
12c	Communicate					
12d	Use of IT					
12e	Reduced time for service					
13.	Information in online system is -					
13a	Not ambiguous					
13b	Trustworthy					
13c	Citizens' opinion					
13d	Credible					
13e	Satisfactory					
14.	Online system has -					
14a	Information sharing through policies, processes, agreements & tenders					
14b	Clear policies					
14c	Thorough information					
14d	Information available from all possible sources					
14e	Relevant information					
15.	Information in online system is -					
15a	Easily accessible					
15b	Anywhere accessible					
15c	Better distributed					
15d	Up-to-date					
15e	Accessible without difficulty					
16.	Online system has -					
16a	Reduced corruption					
16b	No middlemen					
16c	Unbiased information					
16d	Overall transparency in processes					
16e	Quality of information					
17.	By using the online system there is improved interaction with -					
17a	Increased transactions					

17b	Internal staff					
17c	Department					
17d	Officials from different departments					
17e	Citizens					
17f	Government					
18.	By using the online system there is participation in government -					
18a	Processes					
18b	Plans					
18c	Major decisions					
18d	Free and open dialogues					
18e	System for making it responsive					
19.	The online system meets the expectations of -					
19a	Citizens					
19b	Community					
19c	Cultural diversity					
19d	Social diversity					
19e	Historical diversity					
20.	The online system provides improved planning for -					
20a	Citizens					
20b	Departments					
20c	Policy makers					
20d	Staff					
20e	Country					
21.	The online system provides decision-making that is -					
21a	Timely					
21b	Fast					
21c	Accurate					
21d	Rationale					
21e	Informed					
22.	The online system has better monitoring and control by -					
22a	Internal staff					

22b	Citizens					
22c	Government					
22d	Monitoring departments					
22e	Monitoring committees					
23.	Online system has -					
23a	Easy access					
23b	Met stated objectives					
23c	Effectiveness					
23d	Increased response					
23e	Safeguarded interests					

Appendix II: Research Questionnaire for Implementer

Survey on 'Performance of E-Governance Projects using Big Data'

Objective: The aim of this research is to assess the 'Performance of e-governance projects using big data' (extremely large data sets that can be analysed with conventional systems) analysis.

Declaration: The information collected through this survey will be used only for academic purposes. The identity of the respondent will not be disclosed in any circumstances.

The survey comprises of different kind of questions and there is no right or wrong answer to each question. I am only interested in your personal opinions. Thank you very much for sparing your valuable time. Any queries may be addressed to charuv@gmail.com.

* Required

Please select one government online service where you were involved as an implementer. Data here means big data with huge volume, coming with speed and may have variety of formats. * **(Note: Please fill separate questionnaire for each online service)**		
	A. Aadhaar card	
	B. CGHS	
	C. Passport	
	D. IT Return Filing	
	E. Indian Railway Catering and Tourism Corporation (IRCTC)	
Section A: Demographic/General Information		
1.	Gender	
	Male	
	Female	
	Other	
2.	Age (years)	
	18-30	
	31-45	
	46-60	
	More than 60	
3.	Education level *	

	Undergraduate	
	Postgraduate	
	Professional	
	Doctoral	
4.	Employment status	
	Employed	
	Unemployed	
	Retired	
	Business	
	Student	
	Not Applicable	
5.	Area of occupation - *	
	Information Technology (IT)	
	Medical/Health	
	Education	
	Financial Institution	
	Government	
	Other	
6.	Annual approximate earning (INR) - *	
	Less than 2 lacs	
	2 lacs – 5 lacs	
	5 lacs – 10 lacs	
	10 lacs – 20 lacs	
	More than 20 lacs	
	Not Applicable	
7.	Organization -	
	Central Government	
	State Government	
	Autonomous	
	Private Industry	
	Business	
	Not Applicable	

8.	Work experience (years)						
	Less than 5						
	5 – 10						
	11 – 15						
	16 – 20						
	More than 21						
	Not Applicable						
Section B: Section B: Your experience with government services availed in online mode							
Please tick on the scale below to express your opinion: **1=Strongly Disagree, 2=Disagree, 3=Can't Say, 4=Agree, 5=Strongly Agree**							
9.	Advantages of online services are -	1	2	3	4	5	
9a	Faster service delivery						
9b	Reduced duplicate tasks						
9c	Improved work efficiency						
9d	Improved service quality						
9e	Faster response to queries						
10.	Processes in online services are -						
10a	Simple to understand						
10b	Simple to follow						
10c	User-centric						
10d	Improved and flexible						
10e	Having minimal data loss						
11.	In online services there are less -						
11a	Dependencies on multiple departments						
11b	Documents required to fill						
11c	Supporting documents to submit						
11d	Dependencies on printed material						
11e	Integration isues with Aadhaar						
12.	There is reduced cost in online system to -						
12a	Citizen						
12b	Government (as less resources are used)						
12c	Communicate						

12d	Use of IT					
12e	Reduced time for service					
13.	Information in online system is -					
13a	Not ambiguous					
13b	Trustworthy					
13c	Citizens’ opinion					
13d	Credible					
13e	Satisfactory					
14.	Online system has -					
14a	Information sharing through policies, processes, agreements & tenders					
14b	Clear policies					
14c	Thorough information					
14d	Information available from all possible sources					
14e	Relevant information					
15.	Information in online system is -					
15a	Easily accessible					
15b	Anywhere accessible					
15c	Better distributed					
15d	Up-to-date					
15e	Accessible without difficulty					
16.	Online system has -					
16a	Reduced corruption					
16b	No middlemen					
16c	Unbiased information					
16d	Overall transparency in processes					
16e	Quality of information					
17.	By using the online system there is improved interaction with -					
17a	Increased transactions					
17b	Internal staff					
17c	Department					
17d	Officials from different departments					

17e	Citizens					
17f	Government					
18.	By using the online system there is participation in government -					
18a	Processes					
18b	Plans					
18c	Major decisions					
18d	Free and open dialogues					
18e	System for making it responsive					
19.	The online system meets the expectations of -					
19a	Citizens					
19b	Community					
19c	Cultural diversity					
19d	Social diversity					
19e	Historical diversity					
20.	The online system provides improved planning for -					
20a	Citizens					
20b	Departments					
20c	Policy makers					
20d	Staff					
20e	Country					
21.	The online system provides decision-making that is -					
21a	Timely					
21b	Fast					
21c	Accurate					
21d	Rationale					
21e	Informed					
22.	The online system has better monitoring and control by -					
22a	Internal staff					
22b	Citizens					
22c	Government					
22d	Monitoring departments					

22e	Monitoring committees					
23.	Online system has -					
23a	Easy access					
23b	Met stated objectives					
23c	Effectiveness					
23d	Increased response					
23e	Safeguarded interests					
24.	The information and data in the online system is -					
24a	Complete					
24b	Accurate					
24c	Consistent					
24d	Relevant					
24e	Transparent					
24f	Up-to-date					
25.	For online system information needs there are -					
25a	Data standards					
25b	Access to historical data					
25c	Data formats					
25d	Compliance guidelines					
25e	Continuous feedback from users and partners					
26.	For online system data privacy and security there is -					
26a	Anonymity					
26b	Data preservation					
26c	Data not shared across uers					
26d	Secure system with passwords					
26e	Data ownership					
27.	Online system is -					
27a	User-friendly					
27b	Usable from all operating systems or browsers					
27c	Always available					
27d	Ease to use					

27e	Errors free					
27f	Provided with online training, demonstrations, help, if required					
28.	Online system uses -					
28a	Data ownership					
28b	Open standards					
28c	Secure technology					
28d	Data sharing among users					
28e	Handles legal issues					
28f	Handles privacy issues					
29.	The online system has -					
29a	Having clear interfaces					
29b	Interoperable with different department systems					
29c	Integrated with other department systems					
29d	Different and old systems integration issues in complex systems					
29e	Different and old systems information integration issues in complex systems					
30.	The technology used in the online system is -					
30a	Simple					
30b	Old					
30c	Complex					
30d	Having integration issues					
31.	The staff working with the online system is (w.r.t. Technology) -					
31a	Skilled					
31b	Trained					
31c	Experienced					
31d	Knowledgeable					
31e	Qualified					
32.	Online system is -					
32a	Scalable: Can handle more users comfortably					
32b	Better than manual system					
32c	Faster					
32d	Simple					

32e	Having best methods and techniques					
33.	Online system has support from -					
33a	Management					
33b	Government					
33c	Project planners					
33d	Policy makers					
34.	The online system has -					
34a	Planning					
34b	Investment					
34c	Coordination among stakeholders					
34d	Control					
35.	The management has -					
35a	Leadership					
35b	Diversity of users involved					
35c	Diversity of organizations involved					
35d	Flexible and efficient structure					
36.	The government has					
36a	Clear vision and defined targets					
36b	Measurable deliverables					
36c	Well-defined Goals					
36d	Well-defined objectives					
37.	The staff within concerned department has -					
37a	Individual interest					
37b	Conflicting attitude					
37c	Internal conflicts					
37d	Reluctant to change					
38.	The staff dealing with the online system is -					
38a	Technically knowledgeable					
38b	Service-oriented					
38c	Technically capable					

38d	Efficient					
38e	Trained in online system					
38f	Skilled to handle online system					
39.	For the online system implementation there is/are -					
39a	State/Centre conflict					
39b	Flexible Policy/legal IT frameworks					
39c	Formal checks					
39d	Integration between stakeholders					
39e	Data evaluation & benchmarking					
39f	Executive, judicial and legislation coordination					
40.	The online system costing is -					
40a	Supportive					
40b	Subsidized					
40c	Standardized and benchmarked					
40d	Adequately budgeted					
40e	Timely disbursement					
41.	Different government departments interact through -					
41a	IT					
41b	Policies					
41c	Standards					
41d	Seamless integration					
42.	The online system has privacy and related security through -					
42a	Public policy, leadership or sponsorship					
42b	Legislative support					
42c	Defined laws					
42d	Well-stated privacy and security laws					
43.	The online system has -					
43a	Executive leadership support					
43b	Sponsorship					
43c	Legislative support					
43d	Freedom but does not operate in silos					

44.	The online system has -					
44a	Public-private partnerships					
44b	Political will and support					
44c	Skilled HR					
44d	Transparent systems					
44e	Conducive policies					
45.	The system has taken care of factors -					
45a	Strategic outsourcing					
45b	Social					
45c	Economic					
45d	Demographic					

Appendix III (a): TISM-P Filled-in Questionnaire with Transitivity Checks

S. No.	**Comparison (i, j)**	**i-j**	**j-i**	**i=j**	**0**	**Polarity of Relationships**	
1.	1,2	1-2	2-1	1=2	0	+ve	-ve
2.	2,3	2-3	3-2	2=3	0	**+ve**	-ve
3.	1,3	Is the Relationship Transitive?			Yes/**No**		
		1-3	3-1	1=3	0	**+ve**	-ve
4.	3,4	3-4	4-3	3=4	0	+ve	-ve
5.	2,4	Is the Relationship Transitive?			Yes/**No**		
		2-4	4-2	2=4	0	+ve	-ve
6.	1,4	Is the Relationship Transitive?			**Yes**/No		
		1-4	4-1	1=4	0	+ve	-ve
7.	4,5	4-5	5-4	4=5	0	+ve	-ve
8.	3,5	Is the Relationship Transitive?			Yes/**No**		
		3-5	5-3	3=5	0	+ve	-ve
9.	2,5	Is the Relationship Transitive?			Yes/**No**		
		2-5	5-2	2=5	0	+ve	-ve
10.	1,5	Is the Relationship Transitive?			Yes/**No**		
		1-5	5-1	1=5	0	+ve	-ve
11.	5,6	5-6	6-5	5=6	0	+ve	-ve
12.	4,6	Is the Relationship Transitive?			**Yes**/No		
		4-6	6-4	4=6	0	+ve	-ve
13.	3,6	Is the Relationship Transitive?			Yes/**No**		
		3-6	6-3	3=6	0	+ve	-ve
14.	2,6	Is the Relationship Transitive?			Yes/No		
		2-6	6-2	2=6	0	+ve	-ve
15.	1,6	Is the Relationship Transitive?			**Yes**/No		
		1-6	6-1	1=6	0	+ve	-ve
16.	6,7	6-7	7-6	6=7	0	+ve	-ve
17.	5.7	Is the Relationship Transitive?			**Yes**/No		
		5-7	7-5	5=7	0	+ve	-ve

18.	4,7	Is the Relationship Transitive?			**Yes**/No		
		4-7	7-4	4=7	0	+ve	-ve
19.	3,7	Is the Relationship Transitive?			Yes/No		
		3-7	7-3	3=7	0	+ve	-ve
20.	2,7	Is the Relationship Transitive?			**Yes**/No		
		2-7	7-2	2=7	0	+ve	-ve
21.	1,7	Is the Relationship Transitive?			Yes/**No**		
		1-7	7-1	1=7	0	+ve	-ve
22.	7,8	7-8	8-7	7=8	0	+ve	-ve
23.	6,8	Is the Relationship Transitive?			**Yes**/No		
		6-8	8-6	6=8	0	+ve	-ve
24.	5,8	Is the Relationship Transitive?			**Yes**/No		
		5-8	8-5	5=8	0	+ve	-ve
25.	4,8	Is the Relationship Transitive?			**Yes**/No		
		4-8	8-4	4=8	0	+ve	-ve
26.	3,8	Is the Relationship Transitive?			**Yes**/No		
		3-8	8-3	3=8	0	+ve	-ve
27.	2,8	Is the Relationship Transitive?			**Yes**/No		
		2-8	8-2	2=8	0	+ve	-ve
28.	1,8	Is the Relationship Transitive?			**Yes**/No		
		1-8	8-1	1=8	0	+ve	-ve
29.	8,9	8-9	9-8	8=9	0	+ve	-ve
30.	7,9	Is the Relationship Transitive?			**Yes**/No		
		7-9	9-7	7=9	0	+ve	-ve
31.	6,9	Is the Relationship Transitive?			**Yes**/No		
		6-9	9-6	6=9	0	+ve	-ve
32.	5,9	Is the Relationship Transitive?			**Yes**/No		
		5-9	9-5	5=9	0	+ve	-ve
33.	4,9	Is the Relationship Transitive?			**Yes**/No		
		4-9	9-4	4=9	0	+ve	-ve
34.	3,9	Is the Relationship Transitive?			**Yes**/No		
		3-9	9-3	3=9	0	+ve	-ve
	2,9	Is the Relationship Transitive?			**Yes**/No		

35.		2-9	9-2	2=9	0	+ve	-ve
36.	1,9	Is the Relationship Transitive?			**Yes**/No		
		1-9	9-1	1=9	0	+ve	-ve

Appendix III (b): TISM-P Hierarchical Partitioning of Reachability Matrix

Elements	Reachability Set (Read Row)	Antecedent set (Read Column)	Interaction set	Level
Iteration-1				
1	1	1,2,4,5,6,8,9	1	I
2	1,2,3,4,5,6	2,3,7,8,9	2,3	
3	3,6	2,3,4,5,7,8,9	3	
4	3,4,6	1,2,4,5,7,8,9	4	
5	1,3,4,5,6,7	1,2,5,7,8,9	1,5,7	
6	1,6	2,3,4,5,6,7,8,9	6	
7	2,3,4,5,6,7	5,7,8,9	5,7	
8	1,2,3,4,5,6,7,8	8,9	8	
9	1,2,3,4,5,6,7,8,9	9	9	
Iteration-2				
2	2,3,4,5,6	2,3,7,8,9	2,3	
3	3,6	2,3,4,5,7,8,9	3	
4	3,4,6	2,4,5,7,8,9	4	
5	3,4,5,6,7	2,5,7,8,9	5,7	
6	6	2,3,4,5,6,7,8,9	6	II
7	2,3,4,5,6,7	5,7,8,9	5,7	
8	2,3,4,5,6,7,8	8,9	8	
9	2,3,4,5,6,7,8,9	9	9	
Iteration-3				
2	2,3,4,5	2,3,7,8,9	2,3	
3	3	2,3,4,5,7,8,9	3	III
4	3,4	2,4,5,7,8,9	4	
5	3,4,5,7	2,5,7,8,9	5,7	
7	2,3,4,5,7	5,7,8,9	5,7	
8	2,3,4,5,7,8	8,9	8	
9	2,3,4,5,7,8,9	9	9	
Iteration-4				
2	2,4,5	2,7,8,9	2	
4	4	2,4,5,7,8,9	4	IV

5	4,5,7	2,5,7,8,9	5,7	
7	2,4,5,7	5,7,8,9	5,7	
8	2,4,5,7,8	8,9	8	
9	2,4,5,7,8,9	9	9	
Iteration-5				
2	2,5	2,7,8,9	2	
5	5,7	2,5,7,8,9	5,7	V
7	2,5,7	5,7,8,9	5,7	
8	2,5,7,8	8,9	8	
9	2,5,7,8,9	9	9	
Iteration-6				
2	2	2,7,8,9	2	VI
8	2,8	8,9	8	
9	2,8,9	9	9	
Iteration-7				
8	8	8,9	8	VII
9	8,9	9	9	
Iteration-8				
9	9	9	9	VIII

Annexure IV: Curriculum Vitae

Charu Verma, Chief Scientist (IT/Data Science)
Head, IT; **Member, Director** Secretariat & **Research Cell**;
Co-PI, PRABHASS (Pravasi Bharatiya Academic & Scientific Sampark)
CSIR-NIScPR, Dr K S Krishnan Marg, New Delhi – 110 012, **India**
Mobile 98102 41227 **Email** charu_verma@niscpr.res.in; charuv@gmail.com
Professional Memberships: Senior Member, IEEE; Fellow, IETE; Senior Member, CSI;
DoB: 10 November 1973

More than 27 years of professional work experience in various roles (Head, Project Manager, Team Leader, Architect, Developer, etc.) in IT. Experienced in development, project management, strategy and customer relationships in enterprise software, business intelligence, database design, e-learning and website design. Exceptional inter-personal skills and academic record (President gold medalist in MBA as well as BE). Excellent track record in successful completion of projects and HRD.

Professional Experience

1. Chief Scientist, CSIR-NIScPR (July 2005 – Till date)
2. Team Leader, Interra Information Technologies (August 1997 – July 2005)
3. Software Engineer, Infosys Technologies LTD. (April 1997 – July 1997)
4. AMTS – Trainee, Duet Technologies (India) Pvt. Ltd. (June 1996 – April 1997)

Education

S. No.	Discipline	Year	Institute	Score	Rank/Medals
1.	MBA (Technology Management)	2001	IIT, Delhi	9.875	Gold medal
2.	BE (Electronics and Communication)	1996	DIT (Now NSUT)	91.03%	DU & NSUT President Gold medals

Publications

1. Verma, C. and Suri, P. K. (2022), **"Hierarchical Model for Big Data in E-Governance: Using Delphi and Total Interpretive Structural Modeling with Polarity (TISM-P)"** during **GLOGIFT'22** @ LMTSM, Punjab
2. Verma, C. and Suri, P. K. (2022**), "A Delphi-Analytical Hierarchy Process (AHP) Approach for Important Factors and Indicators Selection for Big Data Model in E-Governance"**, International Journal of Intelligent Defence Support Systems (IJIDSS), Inderscience, 10.1504/IJIDSS.2022.10052082
3. Verma, C. and Suri, P.K. (2021), **"'Big data' patentometrics for R&D decision-making"**, Digital Policy, Regulation and Governance, **Emerald Insight**, https://doi.org/10.1108/DPRG-09-2020-0126
4. Charu Verma and P K Suri (September, 2019) Book Chapter: **BIG DATA Analytics: Transforming Governance for Citizen Empowerment** in Book titled **Transforming Organizations Through Flexible Systems Management** by Springer Nature
5. Charu Verma and P K Suri (December, 2017) **BIG DATA Analytics: Transforming Governance for Citizen Empowerment** during **GLOGIFT'17** @ DTU, New Delhi
6. Charu Verma, Sanjay Burde and Mukesh Pund (May, 2013) **Analyze and Visualize to Decide: Enabling Data Driven Decision Making for R&D institutions** during **MODSOLVE** conference by CSIR, HQ @ CSIR-NISCAIR, S V Marg, New Delhi
7. Charu Verma and Sanjay Burde (May, 2012) **Science Communication in Indian Languages through Information Technology** during International Conference in Hindi on **Vaigyanik Chetna aur Drishtikon Jagane Mein Sanchar Madhyamon ki Bhumika**, organised at the NASC Complex, Pusa, New Delhi, during 29-30 May 2012
8. B. M. Gupta; Avinash Kshitij; Charu Verma (July, 2010) **Mapping of Indian Computer Science Research output 1999 -2008**, Scientometrics, 2011 86:261-283(DOI - 10.1007/s11192-010-0272-y)