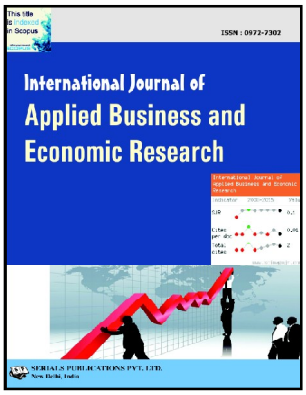

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Enablers for Digital Empowerment in Technology using Interpretive Structural Modeling (ISM) and MICMAC Analysis

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Abstract: *Background/Objectives:* The aim of our paperis to derive mutual relationships among key enablers and develop the conceptual framework for digital empowerment in technology using an interpretive structural model (ISM) and MICMAC analysis.

Methods/Statistical Analysis: Triangulation method is implemented to include extensive content analysis of the 'Digital India' Programme (DIP) initiated by the Government of India; systematic review of existing literature on digital empowerment for technology; and, expert opinion sought from industry and academia to establish the relevance and direction of relationships among key variables forachieving digital empowerment.

Findings: Extensive review of literature on digital empowerment depicts negligible research publications in this field. The study finds that digital empowerment for technology is totally dependent upon ICT infrastructure and digital literacy through the linkage variables such as, technological connectivity, *e*-Governance, and products (goods and services).

Conclusion/Improvements: The study presents complex inter-relationships among key variables contributing a valuable empowerment framework which could be further statistically tested using larger sample size. Also, additional variables could be identified and included in the framework to study varying impacts over digital empowerment in technology as further research directions.

Keywords: Connectivity, Digital Empowerment, Digital India Programme (DIP), Digital Literacy, Enablers, ICT Infrastructure, Interpretive Structural Modeling (ISM), MICMAC, Technology.

1. INTRODUCTION

'Digital India' programme is an initiative aiming inclusive growth of several areas such as products, electronic services, manufacturing and creating employment opportunities etc., and is centered upon three crucial

aspects such as 'digital infrastructure as a utility to every citizen', 'governance and services on demand', and 'digital empowerment of citizens'. It plans to connect about 2.5 lakh villages via broadband internet network in a years' timeline. There are plans for creation of about 28,000 seats for BPOs in different states with at least a Common Service Centre (CSC) in each gram panchayat. The programme aims to propel nine pillars of growth areas, namely broadband highways, public internet access programme, universal access to mobile connectivity, *e*-Governance: reforming Government through technology, *e*-Kranti-electronic delivery of services, electronics manufacturing, information for all, IT for jobs and early harvest programmes[1].

People as citizens of a nation are well thought out to be stakeholders from the society. The empowering approach must view people as individual or community subjects and actors with tremendous potential to develop, as well as gain increased potential with ability to control their lives and coping skills. Access to information and communications technology (ICT) would enable citizens to gain new capabilities and multiple ways to express themselves, participate, coordinate and communicate, thus increasing their competence in a well networked and information society. Hence, digital empowerment of people or communities in the said context refers to enabling citizens to do what is required of them and grow as competent individuals with enhanced control over their life and surroundings. The World Bank understands 'digital empowerment' as, "...the process of increasing the capacity of individuals or groups to make choices and to transform those choices into desired actions and outcomes..." The Government of India envisions to digitally empowering the stakeholders in the field of technology by improving online infrastructure and transformation of the country. The initiative plans to increase internet connectivity to wider geographical areas with high-speed internet networks and thus ensure Government services are provided to citizens electronically. The core components for citizen-centric services include digital infrastructure creation, prompt delivery of electronic services, and enhancing digital literacy. Digital technologies such as cloud computing and mobile applications would act as catalysts for citizen empowerment and rapid economic growth across the globe. These are being increasingly used each day for transactions across retail stores to government offices. It connects us for information sharing and resolving various issues concerning us. Digital empowerment aims to connect the unconnected, reach the unreached and serve the un-served, across nations.

'Digital divide' refers to gaps in information-rich and information-poor societies, technology haves and hav*e*-nots, or those who have and those who do not have access or opportunity to experience technology (such as telephone, computer, internet, etc.), and many others. Societal implications of digital divide can be observed wherein person with computer literacy gains a better chance than those who cannot operate in order to win a profession/job; companies or organizations unable to do good business and undertake *e*-commerce if they have not employed or gained access to electronic data interchange systems; tech-savvy individuals are in a better position to undertake the benefits of online shopping, payment or access to several online services; many urban populations are more privileged with availability and access of information over the internet or modern day electronic gadgets while rural or poor population have to suffer. India is a developing nation with over 1.25 billion population today and about 70% of them live in rural areas.

As per the Census of India, the literacy rate was 74.04% in 2011. Even though there is a strong and fast growing information technology (IT) industry, there is dearth for access to information and communications technologies (ICT) particularly in these rural areas. ICT infrastructure is a critical bottleneck

while access to several technologies is thus constrained by electricity, information technology penetration, internet and overall tele-density. In modern economies, Internet has become the most popular resource and communication medium as its acts as a major integrator due to global access and cross-border electronic transactions for flow of trade services, economic activities, education through information, and several electronic services on demand, and market reach; while, on the other hand it is also a great divider due to acute disparities in access on a larger scale.

The major stakeholders to the digital empowerment include people or communities (citizens), Government, enterprise organizations, non-governmental organizations, and educational institutions. Technology assisted projects need to be implemented on a large scale for access to information and communications technology infrastructure, education, citizen-centric goods and services online, governance, markets and social enterprises, knowledge hub, networking, and research development. The focus of the 'Digital India' Programme is to make technology central to enabling change. It aims to resolve the digital divide by providing high-speed broadband networks and connectivity, achieve net zero imports, public internet access points, wi-fi services in universities and education institutions, public wi-fi hotspots, job creation and employment opportunities, digital inclusion, *e*-Governance and *e*-Services by Government, information technology (IT) use in service industries (namely health, education, banking etc.) with a host of applications and services including cloud computing and public internet access in order to digitally empower the citizens of India.

Interpretive Structural Modeling (ISM) was originally proposed by Warfield in 1973[18]. The model assists in imposing order and direction to a set of related variables and helps arrange these in a systematic hierarchy. For solving problems, it employs expert opinions and their knowledge to decompose complicated systems into subsystems and construct a multilevel model. Experts opine relationships and the directions of the variables which are further synthesized into an interpretive structural model.

The present study is an attempt in understanding key enablers for achieving digital empowerment in technology. In view of the nature of this paper, the researchers aim to address two research objectives, namely:

(a) to derive mutual relationships among key enablers for digital empowerment; and

(b) to develop the conceptual framework for digital empowerment in technology using an interpretive structural model (ISM) and MICMAC analysis.

The paper is further organized as follows. Section 2 on "Review of Literature" systematically reviews key initiatives for digital empowerment through technology initiated through the 'Digital India' programme. Extensive literature search and review of existing studies on digital empowerment published in reputable international journals/databases is done to identify key variables for the study. "Research Method and Framework" in section 3 discusses the methods used to identify key variables, inter-relationships among the constructs and development of the conceptual framework.

The "Results" in section 4 analyzes the key variables, their linkages derived from the interpretive structural modeling and MICMAC analysis method to develop the final model. The "Discussion" in section 5 discusses key findings from the study and its major implications. Finally, we conclude our paper outlining limitations of the study, conclusion and future research directions in "Conclusion and Future Research Directions" as section 6.

2. REVIEW OF LITERATURE

2.1. Digital India Programme (DIP)

The 'Digital India' programme, launched by Government of India in July 2015, envisages providing several government services electronically to its citizens. There is need to improvise online infrastructure, and increase internet connectivity for harnessing the information and communications technology potential. The vision is to transform the entire public services ecosystem into a digitally empowered society and knowledge economy so as to attain digital empowerment in the field of technology. Key areas include digital infrastructure as a core utility to every citizen; governance and services on demand; and digital empowerment of citizens. This demands optimum leveraging of common and support ICT infrastructure, laying down policy guidelines, technical support, capacity building, and research and development. The initiative in terms of *e*-Governance would require serious attention to crucial stages of implementation, namely digitization, transformation, engagement, contextualization, information ethics, open government, and digital citizenship. The 'Digital India' initiative is designed to achieve digital empowerment through the nine pillars of the initiative which include broadband highway, universal access, *e*-Governance, public Internet access, *e*-Kranti, electronics manufacturing, information for all, IT for jobs and early harvest program. The core components are aimed towards creation of digital infrastructure, electronic delivery of services, and enhancing digital literacy[1].

2.2. Initiatives for Digital Empowerment in Technology Through DIP

2.2.1. Broadband highway as ICT and online infrastructure

Aims to provide broadband connectivity for all, namely rural, urban, and urban and National Information Infrastructure (NII). About 2,50,000 village Panchayats to cover most rural areas is estimated for connecting them under the National Optical Fibre Network (NOFN) through the supervision of a nodal government department such as the Department of Telecommunications (DoT). For new urban developments and buildings, leveraging service delivery and communication infrastructure would be done for Virtual Network Operators. NII would assist in integration of network and cloud infrastructure along with all ICT infrastructure components for providing high speed connectivity and cloud platform to several government departments extending to the panchayat level. The highway would provide horizontal access to government offices and service outlets, for managing banking, agriculture, *e*-panchayats, research and development, *e*-health, *e*-education, *e*-governance, electricity distribution management, *e*-commerce, and several other domains/sectors.

2.2.2. Universal access to mobile connectivity

An estimated 55,600 villages in India do not have mobile coverage. The initiative through a comprehensive plan focuses on filling gaps in connectivity and network penetration across the nation to provide mobile coverage to unconnected areas.

2.2.3. Public internet access programme

The programme is divided into sub-components, namely Common Services Centres (CSCs) and Post Offices as multi-service centres. The CSCs would be strengthened through this initiative and the number

of CSCs is proposed to be increased to 2,50,000 centres, with at least one CSC in each gram panchayat. These centres would be improvised for viable, multi-functional end-points for delivery of government and business services. Approximate 1.5 lakh post offices are proposed to be transformed into multi-service centres managed by the Department of Posts. The public internet access programme is aimed towards maximizing delivery of *e*-services to citizens.

2.2.4. e-Governance-reforming Government through technology

e-Governance leading to Government Process Re-engineering using information technology is aimed to simplify government processes thereby making it more efficient. Reforming the government through the use of technology is critical for transformation and delivery of government services more effectively across multiple government domains which need to be implemented by all Ministries/Departments simultaneously. In the words of Hon'ble Prime Minister Shri Narendra Modi, "access to governance has to be guaranteed with transparent systems that deliver responses and outcomes. The strengthening of democratic governance empowers the population to become active partners in the growth process". Few aspects of reforming government through technology would be to assist in form simplification and field reduction, online applications and tracking, online repositories, and integration of several services and platforms. This would facilitate businesses and citizens to access integrated and interoperable service delivery. The need is to use information technology for automation, response and data analysis in order to identify and resolve persistent problems. Entire databases and information need to be maintained in electronic form alongwith automation of workflow inside government departments and agencies for efficient government processes and allow process visibility to citizens.

2.2.5. e-Kranti-Electronic delivery of services

It is an initiative to provide electronic delivery of services. Under the National *e*-Governance Plan (NeGP) multiple initiatives have been implemented by numerous Central/State government ministries for better performance in *e*-Government era. Sustained efforts at multiple levels are aimed for improvised and simplified access to provide citizen-centric, service orientation and transparency for delivery of public services. The approach has massive potential for cost savings through sharing core and support infrastructure, interoperability enabled through standards, and exhibiting a seamless view of Government to citizens.

2.2.6. Information for All

An open data platform facilitates use, reuse and redistribution through proactive release of datasets in an open format by the government offices. Hosting of information and documents online using existing infrastructure would enable open and easy access to information for all citizens. The Government would be in a position to pro-actively inform, interact, and engage with all citizens through social media and web based platforms to exchange ideas and suggestions with Government facilitating two-way communication between Government and citizens to achieve good governance and enhance digital literacy too.

2.2.7. Electronics manufacturing

There is an increasing demand for electronic goods at 22% Compound Annual Growth Rate (CAGR) which is expected to reach 400 Billion USD by 2020. A striking demonstration of intent is the focus on promotion of electronics manufacturing in the country targeting net zero imports by year 2020. This could

be achieved through coordination of several aspects, such as taxation, incentives, economies of scale, electronic gadgets and equipment, incubators, clusters, skill development and doctoral programmes, government procurements, safety standards, national brand building, national centres for flexible electronics and security forces, research and development in electronics, and many more.

2.2.8. IT for jobs

The focus is on skilling youth for harnessing employment opportunities in the IT/ITES sector. IT trainings are aimed for about one crore students from smaller towns and villages. The initiative aims setting up of BPOs (Business Process Outsources) extending into the North-Eastern states of India for ICT-enabled growth, training to about estimated 3 lakh service delivery agents for viable businesses in delivering IT services; and training rural workforce with respect to telecom and telecom related services/telecom service providers.

2.2.9. Early Harvest Program

It covers projects which need to be implemented in short timelines such as IT platform for messages, Government *e*-Greetings, biometric attendance systems, wi-fi in all universities, secure email with Government, public wi-fi spots, school *e*-Books, SMS based messaging weather information and disaster alerts, and national portal for lost and found children.

An analysis of the nine pillars of the 'Digital India' programme as discussed above leads to identification of important variables that could have an effect on digital empowerment in technology envisaged by the initiative. The key enablers for digital empowerment in technology identified through the 'Digital India' Programme are listed in Table 1.

Table 1
Key enablers for digital empowerment in technology identified through 'Digital India' Programme initiative

DIP initiatives	*Key enablers*
Broadband highway as ICT and online infrastructure	ICT infrastructure
Universal access - mobile connectivity	Technological connectivity
Public internet access	Technological connectivity
e-Governance-reforming Government through technology	*e*-Governance
e-Kranti-Electronic delivery of services	Product (Services)
Information for All	Digital literacy
Electronics manufacturing	Product (Goods)
IT for jobs	Product (Service)
Early Harvest Program	Technological connectivity
Digital Empowerment in Technology	Digital Empowerment

Source: Compiled by author

2.3. Systematic Literature Review on Digital Empowerment

In a study about the usefulness of technology in healthcare industry, it was found that internet is a powerful innovation and will continue to shape the future of healthcare industry. Doctors too have been digitally

empowered through the use of internet with enhanced ability to care for their patients, such as maintaining medical records, web-based display environment, and add value to their practices. The internet also brings power of information to the patients and creates a balance in the doctor-patient relationship[2]. The case study on a group of villages in southern India about the use of information systems, to find if social processes could form viable basis for sustainability to ICT initiatives and economic value add in rural settings, it was found that social changes formed the basis for empowerment and a strong reason to maintain the ICT infrastructure[3]. With the advent of ICT revolution, rural India is slowly but steadily getting connected to urban, emerging as a powerful knowledge economy. The corporate sector, Government, NGOs and educational institutions have together supported rural development through digital libraries, *e*-business, *e*-learning and *e*-governance thus empowering the entire nation[4]. Findings about the introduction and use of digital libraries studied through focus group discussions and in-depth interviews in clinical and academic settings referred to as communities of practice, it was found that technology could empower or discard its users owing to interactions between system design, social context, and implementation. While technology implemented with poor design, support or implementation procedures was seen to be a threat for organizational structures, vic*e*-versa technology implemented where it could adapt and change practices according to group or individual needs, supported by information intermediary, empowered both individual and community[5].

In a literature review on information and communications technology concluded that increased use of ICT led to consumer empowerment with market power shifting from suppliers to consumers. Gap analysis was implemented to understand ongoing power struggle between suppliers and consumers. The study found that while designing marketing strategies, consumers' familiarity about use of ICT should both be strengthened and widened[6]. It is also found that citizen as well as community-oriented approachestowards using information technology to improve abilities enabled to express themselves and participate in a networked society, leading to digital empowerment. It is not the technical facilities, but a multi-phased route to gain better networking, communication and cooperation opportunities helped increase the competence of individuals and communities as influential participants in the information society[7].

A case study of Chattisgarh Online Information System for Citizen Empowerment (CHOICE) project of Chhatisgarh State of India with respect to *e*-Governance finds that IT enabled *e*-governance seeks to achieve more equitable, transparent, speedy, efficient, and corruption free service delivery system and achieve citizen empowerment[8]. It was argued about empowerment of rural communities via ICT studying the data and observations collected from best tel*e*-centres in Malaysia during 2007-08that with increased use of technology and ICT in daily lives there is also great tendency for marginalized groups to be left out of inclusion owing to geographical limitations and limited ICT literacy levels. Hence, the users must have access to internet, digital skills and ICT competencies to use online services and information[9]. Aggregate status of information and digital illiteracy (IDL) in Pakistan to demonstrate the endemic state of deprived information and digital literacy, found that information and digital literacy practice or training are lacking in libraries or in education and thus not leading to digital empowerment[10]. Review of South African *e*-government initiatives using descriptive and analytical approach, case studies, and scholarly literature with respect to *e*-Government applications as a new reform and finds usefulness for combating corruption, increased service delivery leading to better *e*-governance[11]. Wireless technologies could provide cost-effective internet connectivity for dispersed communities situated in challenging and remote terrains[12]. The effect of ICT usage on digital empowerment finds that digitalization could drive productivity and employment

growth to achieve future targets of the European economy. It is argued that while mere accessibility to ICT facilities is a prerequisite towards a digitalized society, the level and quality of use of these technologies, and the conditions facilitating it would decide the digital empowerment[13]. A survey of Digital Government literature available in Government Information Quarterly during years 1992 through 2014 provides a digital government stage analysis framework to elucidate the evolution comprising digitization, transformation, engagement, and contextualization stages[14].

An exploratory in-depth case study of two villages in China sharing similar economic woes, ICT impacts - but with different *e*-commerce offerings as well as approaches to ICT-enabled economic performances was explored. The study found that ICT-enablement could aid self-development in rural *e*-commerce ecosystems[15]. Various factors that significantly affect the design and implementation of last-mile telecommunication networks such as interfering factors, technology options, and deployment trends in rural areas and discuss how computing technologies could be employed for different applications to achieve rural empowerment were identified. It was argued that ICT can play a prominent role for enhanced economic and educational exposures, which could be achieved through dissemination of knowledge, resources, and technology. This would also globally integrate millions of stakeholders in rural/remote areas[16].

Present narrative stories with rich description about digital skilling through information and communication technology (ICT)–assisted learning and the sustenance of these skills later in adulthoodindicate three specific types of digital skills, namely, technological resourcefulness, open-mindedness toward technology, and digital self-efficacy or empowerment, emerging as key elements for participant academic or career success[17].

Table 2
Key enablers for digital empowerment in technology identified through systematic literature review.

Earlier studies on digital empowerment in technology(References)	*Key variable*
[Kanungo (2004); Pires *et. al.* (2006); Evangelista *et. al.* (2014); Leong *et. al.* (2016)][3,6,13,15]	ICT infrastructure
[Chin (2000); Nikam *et. al.* (2004); Singh (2012); Nandi *et. al.* (2016)][2,4,12,16]	Technological connectivity
[Subramanian and Saxena (2008); Vyas-Doorgapersad (2009); Janowski (2015)][8,11,14]	*e*-Governance
[Ameen and Gorman (2009); Léger and Freiman (2016)][10,17]	Digital literacy
[Adams *et. al.* (2005); Mäkinen (2006); Razak (2009)][5,7,9]	Empowerment

Source: Compiled by author.

3. RESEARCH METHODS AND FRAMEWORK

3.1. Theoretical Foundation

There has been major attraction for the scientific community in the past for systems theory in order to model complex problems such as the interpretive structural modeling technique and used graph theory to solve complex social issues[18]. The method has gained immense popularity for its ability to solve complex problems based on discrete mathematics. On the contrary, it has also attracted several criticisms from scholars for lack of consensus in terms of confidence levels in results and attributed to variations in experts' opinion. Fundamental limitations of the ISM method in terms of transparency and suggests using

TISM as an alternative approach to build theory which has been gained significant attraction for scholars[19]. Interpretive structural modeling along with MICMAC analysis methods in few cases have been used by researchers in past studies, namely modeling continuity and change forces in private higher technical education[20], continuity and change forces in *e*-Government[21], strategic performance management of Indian telecom service providers[22], enablers of a flexible control systems for industry[23], strategic technology management in an automobile industry[24], flexible decision approach for analyzing performance of sustainable supply chains under risks/uncertainty[25], green strategy, supplier relationship building and supply chain performance[26], modeling and analysis of FMS flexibility factors[27], bionic model of organizational excellence[28], critical success factors in ERP implementation and their interrelationship[29], theory of Green Supply Chain Management[30], emotional intelligence at workplace[31], structural behavior of inhibitors of cloud computing[32], enablers and barriers of mobile banking opportunities[33], and more.

However, till date interpretive structural model has not been much exploited to study digital empowerment in technology. Hence, the researchers have employed interpretive structural model and MICMAC analysis as an alternative scientific method for the study.

3.2. Research Design

3.2.1. Identification of study variables for digital empowerment in technology

In this paper, the researchers have attempted to triangulate multiple sources of the data, namely the primary variables involved in the 'Digital India' Programme initiative by Government of India and that of past studies on same variables related to digital empowerment for technology from survey of extensive literature published in reputed journals/databases; alongwith seeking opinion from domain experts on the relevance and relationships among variables used in the study.

3.2.2. Expert opinion from academia and industry

The researchers sought expert opinion on the levels of relevance of the variables under study and its effect on digital empowerment in technology based on their opinion and expertise in the field of technology. One teaching expert with about 14 years of teaching and training experience in subjects related to ICT, computer sciences and networking; one senior faculty in charge for IT department/EDP implementation, each from reputed Universities were interviewed to seek their expert knowledge. Further, two industry senior management at top management levels who are engaged in the implementation, training and development of digital services in the said domain were also interviewed for seeking their expert opinion on the study.

3.2.3. Triangulation

Triangulation method has been adopted in this study. Triangulation in research has been defined as a combination of two or more methods, theories, data sources, or investigators in the study of a single phenomenon[34]. The study triangulates the key variables identified from the 'Digital India' programme with those found in systematic literature review and further expert opinion is compared to finalize the key enablers to be used in the interpretive structural modeling and MICMAC analysis.

4. RESULTS

4.1. Interpretive Structural Model (ISM) - Identification of study variables

The researchers employed a two-pronged strategy to identify the key variables for digital empowerment in technology. First, an extensive literature review of past studies is undertaken to identify the enabling variables for digital empowerment. Second, the 'Digital India' Programme by Government of India is analyzed for the various initiatives leading to digital empowerment.

The key variables identical to both sources is further subjected to expert opinion through consultation with four experts, namely two from academia and two from industry who are all engaged and professionals in teaching, training and work employing digital technologies. The triangulation method was used to assimilate and finalize the key variables to be employed in the interpretive structural model for establishing the inter-relationships among the constructs and deriving the digital empowerment framework.

4.1.1. The key enablers for digital empowerment were finalized as follows:

(a) ICT infrastructure (*V*1)
(b) Technological connectivity (*V*2)
(c) *e*-Governance (*V*3)
(d) Product (Goods/Services) (*V*4)
(e) Digital Literacy (*V*5)
(f) Empowerment (*V*6)

4.1.2. Contextual relationships among variables -Structural Self-Interaction Matrix (SSIM)

In this study, four management experts identified were teamed for brainstorming sessions to establish the contextual relationships among variables. The expert opinions were crystallized as depicted in Table 3. The relationship is shown as *V*, *A*, *X*, and *O* and the symbols i and j are used to denote direction between the two nodes.

The symbols are represented as follows:

V - *i* is responsible for j; but not vice-versa;

A - *j* is responsible for i; but not vice-versa;

X - *i* and *j* are both responsible for each other; and

O - *i* and *j* are both not responsible for each other.

Table 3
Structural Self-Interaction Matrix (SSIM)

Variables	*V6*	*V5*	*V4*	*V3*	*V2*	*V1*
*V*1	*V*	*O*	*V*	*V*	*V*	–
*V*2	*V*	*O*	*X*	*X*	–	–
*V*3	*V*	*A*	*X*	–	–	–
*V*4	*V*	*X*	–	–	–	–
*V*5	*V*	–	–	–	–	–
*V*6	–	–	–	–	–	–

4.1.3. Interpretation of Comparisons - Reachability Matrix

The output of the SSIM as per Table 3 is further converted into initial and final reachability matrices as depicted in Table 4 and Table 5. The SSIM matrix is converted into a binary matrix known as the initial reachability matrix by substituting *V*, *A*, *X*, and *O* by '1' and '0' in each case as per the following rules:

(a) In case of (i,j) entry in SSIM is *V*, then (i,j) entry in reachability matrix becomes 1 and the (j,i) entry becomes 0.

(b) In case of (i,j) entry in SSIM is *A*, then (i,j) entry in reachability matrix becomes 0 and the (j,i) entry becomes 1.

(c) In case of (i,j) entry in SSIM is *X*, then (i,j) entry in reachability matrix becomes 1 and the (j,i) entry also becomes 1.

(d) In case of (i,j) entry in SSIM is *O*, then (i,j) entry in reachability matrix becomes 0 and the (j,i) entry also becomes 0.

In this paper, first the reachability matrix is derived (see Table 4), which is further partitioned into various levels.

Table 4
Reachability Matrix

Variables	*V*1	*V*2	*V*3	*V*4	*V*5	*V*6	*Driving Power*
*V*1	1	1	1	1	0	1	5
*V*2	0	1	1	1	0	1	4
*V*3	0	1	1	1	0	1	4
*V*4	0	1	1	1	1	1	5
*V*5	0	0	1	1	1	1	4
*V*6	0	0	0	0	0	1	1
Dependence Power	1	4	5	5	2	6	23

4.1.4. Level Partitioning (with iterations)

Table 5
Iteration 1

Factor	*RS (Reachability Set)*	*AS (Antecedent Set)*	*RS II AS (Intersection Set)*	*Level*
*V*1	1, 2, 3, 4, 6	1	1	
*V*2	2, 3, 4, 6	1, 2, 3, 4	2, 3, 4	
*V*3	2, 3, 4, 6	1, 2, 3, 4, 5	2, 3, 4	
*V*4	2, 3, 4, 5, 6	1, 2, 3, 4, 5	2, 3, 4, 5	
*V*5	3, 4, 5, 6	4, 5	4, 5	
*V*6	6	1, 2, 3, 4, 5, 6	6	1

Table 6
Iteration 2

Factor	*RS (Reachability Set)*	*AS (Antecedent Set)*	*RS II AS (Intersection Set)*	*Level*
*V*1	1, 2, 3, 4	1	1	
*V*2	2, 3, 4	1, 2, 3, 4	2, 3, 4	2
*V*3	2, 3, 4	1, 2, 3, 4, 5	2, 3, 4	2
*V*4	2, 3, 4, 5	1, 2, 3, 4, 5	2, 3, 4, 5	2
*V*5	3, 4, 5,	4, 5	4, 5	

Table 7
Iteration 3

Factor	*RS (Reachability Set)*	*AS (Antecedent Set)*	*RS II AS (Intersection Set)*	*Level*
*V*1	1	1	1	3
*V*5	5	5	5	3

4.1.5. Formation of ISM Digraph and MICMAC Analysis

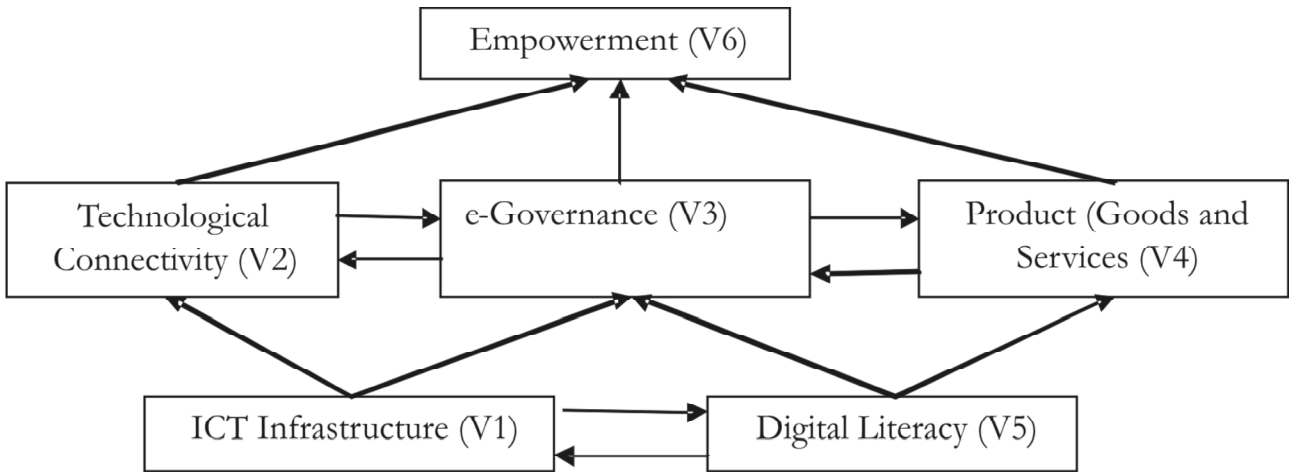

Figure 1: Interpretive structural model digraph for digital empowerment in technology

MICMAC Analysis

A MICMAC analysis assists in grouping variables involved in the study according to the driving and dependence power. From the resulting driving and dependence power of the variables derived from the reachability matrix, these are translated into four different clusters (refer Table 4). Figure 2 as a graph, depicts the dependence and driving power of variables in accordance with the MICMAC analysis. The "autonomous variables" are grouped into the first clusters that have weak driving dependence powers. The result shows none of the variables in the autonomous cluster. "Dependent variables" with weak driving

and strong dependence power is grouped in second cluster. In this study, variable *V*6 – Empowerment is totally dependent on all the other variables. "Linkage variables" with strong driving and dependence powers are grouped in the third cluster. The variables such as *V*2 – technological connectivity, *V*3 – *e*-Governance, and *V*4 – Products (Goods/Services) form a linkage between the independent and dependent variables. "Independent variables" with strong driving and weak dependence power are finally grouped in the fourth cluster. *V*1 – ICT infrastructure, and *V*5 – Digital Literacy are the fundamental inputs which are assisted by connectivity, governance and the products to achieve digital empowerment.

5. DISCUSSION

It is of high importance to understand the key enablers which lead to digital empowerment in technology. Analysis of the reachability matrix identifies digital empowerment with highest dependence and lowest driving power depicting that it is totally dependent upon all other variables in order to enable empowerment. It is also seen that ICT infrastructure and digital literacy are key enablers with low dependence power and high driving power which enable digital empowerment through linkage variables such as technological connectivity, *e*-Governance, and products (goods/services) which have high driving and dependence powers. An absence of autonomous variables in the analysis indicates a total influence of all the identified variables as enablers towards digital empowerment in technology.

5.1. Managerial Implications

Organizations need to pay serious attention towards the key enablers which have a direct impact on achieving digital empowerment in technology. While ICT infrastructure is an inevitable requirement, it also involves high investments and costs to implement such infrastructure. Further, users need to be empowered with

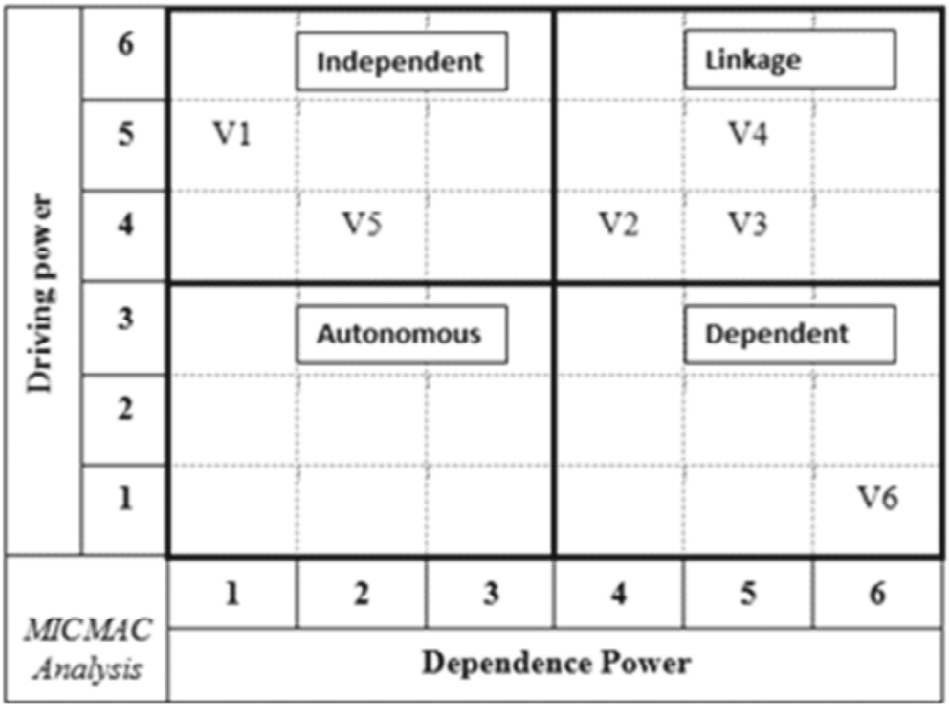

Figure 2: Driving power and dependence power - MICMAC analysis

digital literacy for effective and efficient usage of these ICT infrastructures. Technological connectivity ensures transfer of products (goods and services) through the digital mode, as well as enables in electronic governance for providing citizen-centric services. An aggregate control over all these enablers thereby has a drastic effect on empowerment.

6. CONCLUSION AND FUTURE RESEARCH DIRECTIONS

The key enablers from the 'Digital India' Programme initiative are a clear indication about the intent and provision of an infrastructure which could play decisive roles in achieving digital empowerment. A comparison of past studies reviewed from literature reveals few studies in digital empowerment laying emphasis on such key variables making an impact on empowerment. The key variables for digital empowerment in technology are identified as ICT infrastructure, digital literacy, technological connectivity, *e*-Governance, and products in the form of goods and services. The interpretive structural model and MICMAC analysis derived through triangulation of the initiative, literature review and expert opinion as employed in this study confirms the inter-relationships among the key variables and their direction of effect in achieving digital empowerment in technology. From the analysis, it can be concluded that all the five key variables in the study (with some varying degrees) could have serious effect on achieving digital empowerment. All these variables are identified in pairs at three levels of the interpretive model thus assisting in constructing the framework.

6.1 Limitations of the Present Study and Future Research Directions

While there could be several other variables affecting digital empowerment in technology, the identification of such key variables and use of ISM as well as MICMAC analysis has assisted in development of the digital empowerment framework. Even though five key variables have been identified in this study, researchers in further studies could identify more of such other crucial variables that may have a bearing on the digital empowerment and include these in the interpretive models. Also, the relationship model needs to be statistically tested for validation. The interpretive structural modeling approach has assisted in drawing the inter-relationships among the key variables and development of the final structural framework. It could be possible to validate the model using other tools such as structural equation modeling (SEM) for testing the capability and validity of the empowerment framework as scope for further research.

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