

# Exploring the Reasons for Digitalization Not Penetrating the Power Sector to the Extent It Is Expected To Be

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*Abstract—Development and maturity of any technology provides both wounds (lessons learnt to maneuver risks) and wisdom (tactics to steer through opportunities). It is said that one has to choose not to complain on the wounds, instead cherish the wisdom. Same is the story with digitalization in the power sector.*

*Digitalization is akin to electricity, a general-purpose technology, agnostic to sector and is ubiquitous in use (Digital America, McKinsey, 2015).*

*“Electricity changed nearly everything about the way we live and work—and that scale of transformation is possible with the Internet of Things.” Ian Goldin, Director of Oxford Martin School, University of Oxford.*

*Energy is essential for human survival and development. So has become the digitalization. This paper lays out the research proposal which intends to find out the reasons why the marriage between energy, in particular power, and digitalization sectors has not gone a long way, and how to make it happen with longevity using a framework.*

*Keywords - ‘digital transformation’, ‘digitalization’, ‘digitization’, ‘IoT’, ‘Internet of Things’, ‘Industry 4.0’, ‘diagnostics’, ‘remote monitoring’, ‘smart factory’, ‘digital frameworks’, ‘digital transformation’, ‘digital transformation issues’, ‘digital transformation challenges’, ‘digital transformation failures’, ‘research strategy’, ‘research methodology’, ‘research approach’, ‘research nature’.*

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## I. INTRODUCTION

### Background and Context

The 5 Ps of power generation value chain viz., the plant, processes, people, performance, and profit are supposed to be inherently aligned seamlessly. But in reality they are not. There exist inconsistencies, misalignments, opaqueness, and non-compliance in bits and pieces between all these five siloes.

Digitalization helps in brining consistency, alignment, transparency, and compliance in place. It breaks the silos.

The ever increasing list of pathos of power generators viz., lower plant load factors, reduced efficiency at part load operations, delayed and meager recoveries from DISCOMs (distribution companies), non-availability of skilled and trained man power, aged man power, retiring experienced skill pool, ever increasing aspirations of work force for higher wages and salaries, mandatory stricter norms to adhere to emission controls asking for more capital infusion, mandatory guidelines to fire bio-mass co-firing in coal fired plants that need some modifications in the operational regime and added fuel costs, never ending woes of achieving 100% ash utilization which again adds up to additional spending, breach of PPA contracts (power purchase agreements) by some buyers (few state governments), ever increasing coal supply prices in both domestic and international markets, non-availability of spares from OEMs on account of discontinued productions, obsolescence,

changed models/technology or grim geo-political situation prevailing( for example between India and China), increased duties on imports to encourage domestic spares productions (Atmanirbhar Bharat), inability of domestic suppliers / manufactures to gear up to the standards and requirements by the buyers compared to overseas suppliers, etc. is pushing the power sector against wall for survival on one hand and OFI (opportunity for improvement) to enhance the performance and profitability through digitalization is pulling the power sector on the other hand.

The pull factors, the push factors, and the struggles for managing the working capital are creating a trilemma to the power sector managers.

The trio - digitalization, decentralization of power and decarbonization (3D's), if deployed diligently, promotes sustainability, enhances the ESG efficacy and contributes to the triple bottom line-people, profits, and the planet.

The adoption of pertinent digitalization in the power sector value chain helps to enwrap the ‘euphoric GEAR power (green, efficient, affordable, and reliable power)’.

There has been an interplay between digitalization and energy for many years in process optimization, automation, predictive maintenance, improved worker health and safety, optimized O&M costs, enhanced power plant efficiency, reduced MTTR (mean time to repair) and increased MTBF (mean time between failures), reduced forced outages, reduced downtime, and asset lifetime extension.

However, the tug-of-war between the push factors like affordability and availability of data analytics on one hand

the push factors like need of flexibility and cost competition due to the penetration of renewables on the other hand necessitates a balancing act between the pull and push factors and opens up a plethora of new avenues to accelerate the deployment of data analytics in power sector in achieving harmony between these competing factors.

Despite this plethora of benefits in deploying digitalization and prevailing dire need of the hour, digitalization failed to penetrate power generation sector to the extent it is expected to be. Ergo, the need for a holistic review to establish the reasons for the same is pertinent.

### Problem Statement

Though several researchers have enumerated various reasons and challenges for non-adoption of digitization in power sector in India, to the extent expected, the reasons collated so far are not mutually exclusive and collectively exhaustive (MECE) within the set research boundaries.

Boundaries are set in six focus areas to carry out the study, to explore and collate the reasons as to why the deployment of digitalization is lagging behind in power sector in India. These six focus areas are selected based on the preliminary literature review, focused interviews with SMEs, discussions with vendors, end users, and domain experts. Let us give an acronym "SORTIE" to these six focus areas.

- Strategy (realigning business processes for product/service delivery)
- Operational excellence (realigning people, process and tools)
- Regulations (codes, standards, rules, mandates by government, regulators)
- Technology (IT-OT-ET convergence)
- Innovations (that gel well with the needs of the power sector)
- Economic considerations (investment, short term and long term benefits, ROI).

### Research Questions

RQ: What are the salient reasons for digitization not penetrating the power sector in India to the extent it is expected to be?

Further the RQ is dichotomized to below two sub questions (SQ)

SQ1: What are the reasons stemming out from internal and external environment?

SQ2: What is the framework to address these constraints?

### Relevance and Importance of the Research

Digital agility forges operational risk resilience (Livia Wiley, 2020) with strategic advantages.

Agile deployment in the power sector would be a greater benefit to the industry on the end-user end, the customer end and the technology vendor's end. With a deep dive into the various reasons for slower penetration of digital transformation, an effective framework that helps in the penetration of digitalization faster with sense of urgency

overcoming the legacy issues and tardiness is the need of the hour.

FAST (frequently discussed, ambitious, specific and transparent) goals are preferred to SMART (specific, measurable, achievable, realistic and time bound) ones. (Donald Sull et al 2018). The same holds good for digital transformation goals

More emphasis was given to value creation compared to activities undertaken.

## II. LITERATURE REVIEW

The literature review is like looking in to the rear view mirror, finding the gaps on what could have been done better; develop a vision through a wider fore windscreen, creating a new knowledge base to steer in to the future.

Thus the essence of the literature review is analyzing the past literature, with due acknowledgement and respect for the work done by earlier authors, getting actionable insights, preparing for the future with actionable framework, and thereby creating a new body of knowledge.

### Key Concepts, Theories and Studies

The terms digitization, digitalization, and digital transformation, though sound alike, are not interchangeable. According to Gartner glossary, the process of changing data from analog to digital form is digitization. Digitalization on the other hand uses digital technologies to alter a business model yielding novel income. Digital transformation encompasses a wider domain from IT modernization to the development of a new digital business model.

The research assumes a hypothesis that "digitization has not percolated the power sector in India to the extent expected" is true.

This fact is corroborated by a report by PWC's Dr. Marcus Eul et al., 2019, that only 2 percent of utilities in the EMEA region have adopted digitization extensively.

The experience in India is has no difference with sporadic deployment of digitalization seen in bits and pieces, here and there, in some support processes like finance, administration, human resources, spares and service procurement, stores etc., while the core functions like generation, transmission, distribution, coal procurement, ash utilization, trading, and sales are yet to see light of digitalization and gear up.

An index called -World Bank Digital Adoption Index-DAI, measures the adoption rates of technology across the three dimensions of the economy: people, business, and the government in the scale of 0-1. It is 0.51 for India against 0.87 of Singapore for example.

This fact reinforces the point that there is a lot of scope still exists and there is a long way to go for deployment of digitalization in India.

### Key Debates and Controversies

Literature covered various aspects of challenges, bottlenecks, and constraints for slower adoption of digitalisation in the power sector.

FEI Webcast Polling Results, 2017 say “Many organizations are still using manual process like spread sheets, email, and in-person meetings to govern structural changes across enterprise systems”.

Corrigible barriers to the advancement of digitalization are regulation, data standardization and sharing, lack of sense of urgency, failure to do POC quickly, legacy systems, cyber security, and lack of talent. (Greg Bean et al, 2020)

There exist five common challenges faced in the process of digitalization (Michael Porter et al, 2015)

- Features with no benefits to customers. Their reluctance to pay for that.
- Not addressing the customers’ security and privacy concerns.
- Ignoring or not heeding to the superior functionalities of competitors
- Lacking sense of urgency and delaying the POC
- Inflated internal capabilities to undertake the digital transformation.

The extensive implementation of digital technologies in the energy sector is linked with a number of technical challenges, regulatory and policy challenges. (Dr. Lorna Christie, 2021).

Customer expectations, regulations, and investments are the three challenges faced in IoT deployment. (Ramamurthy et al, 2017)

Managers face several dilemmas in the process of digitalization like: (Ciara Heavin et al, 2018)

- Priorities ( competing and conflicting)
- Aggregate data or personalize ( centralization vs. decentralization)
- Providing more resources to IT staff vs. more self-service analytics
- Storing all data vs. selecting data to store that serves a specific purpose
- Work performed by people vs. computing machines
- Security vs. accessibility
- Privacy of individuals vs. understanding of an individual

Lack of effective strategy, absence of strategic alignment, silos with no integration, technological disruption , inapt strategy for roles and responsibilities, non-conductive organizational structure , pitfalls in cross functional collaboration , missing top management engagement , improper knowledge management strategies, absence of change management culture, project team capabilities, IT infrastructure are notable challenges in digitalization transformation (Faisal Mahmood et al 2019).

Legacy systems that do not communicate with each other and share information, and frequently containing distorted data, could create real barriers. (S. Sagayarajan et al, 2019)

A business model is a story about how an organization creates, delivers, and captures value. (Saul Kaplan, 2012). In profiteering from business model innovation, digitalization is only a journey and not a destination (Vinit Parida et al, 2018).

The role of actors (e.g. managers and technology) in endorsing alteration processes and choosing appropriate digital tools, while skilfully balancing the consideration and utilization of resources cannot be ignored (Hess et al. (2016).

Each layer of the three layers, data collection, connectivity and analytics, has challenges in deployment of IoT in power sector (Guneet Bedi et al, 2018).

User privacy, standardization, architecture design, and IoT security, etc. are to be carefully designed alleviate challenges in the IT implementation (Naser Hossein Motlagh et al, 2020).Cyber security threats include malware (to get unauthorized access to ICT), ransom ware (data hacking to exploit and extract ransom), Phishing/whaling, botnets etc. (IEA, Digitalization & Energy, 2017).

A different set of challenges include in digital transformation are inability to monitor the production process, insufficient technology to work people from home( during pandemic and other emergency times), unrelated production with other sectors, unwillingness of employees for education and training, insufficient funds for digitization of the process, non-alignment of existing users, unusable data for business analytics, resource duplication due to physical administration (Nikola Mićunović1 et al, 2021)

Absence of technical infrastructure, inadequate cross-departmental collaboration, cyber security problems, insufficient time for the transformation, inadequate capacities of the resources for the transformation project, a high cost and price pressure in the market, unproductive project and change management, insufficient preparation and training of staff for the digitization are some challenges faced during digital transformation.(Olawole A. Adetayo , 2019 )

The digital pessimists throw their weight on showing digitalization as more entertainment-focused and a failure in economic performance. There have been very long lags from invention to widespread impact due to dearth of practical problem-solving, communication, collaboration, adaptability and worker skills in digitalization process in the past. (Bureau of Communications and Arts Research, BCAR, Australia, 2017).

Both industry and academia are struggling to sort out a clear road map to the Industry 4.0 fulfilment (J. Qin et al, 2016)

Value creation, value capture and value delivery are the three imperative appendages of digitalization business model. (Foss NJ, 2017). In profiteering from business model innovation, digitalization is only a journey and not a destination (Vinit Parida et al, 2018).

### Gaps in Existing Knowledge

Two broad are gaps identified in the existing knowledge.

1. The reasons enumerated by authors so far are not mutually exclusive and collectively exhaustive (MECE) within the set research boundaries SORTIE.
2. There is no framework suggested, that could accelerate the deployment of digitalization.

With this research it is intended discover all reasons for delayed digitization progress in the power sector and develop a framework to alleviate the same and accelerate the adoption of digitization in power sector.

This will be a new knowledge creation adding value to the existing knowledge base in digitization deployment in power arena.

**III. RESEARCH DESIGN AND METHODS**

The approach to the research and steps to be taken for the research to find answers to the research questions are described below.

**Research design**

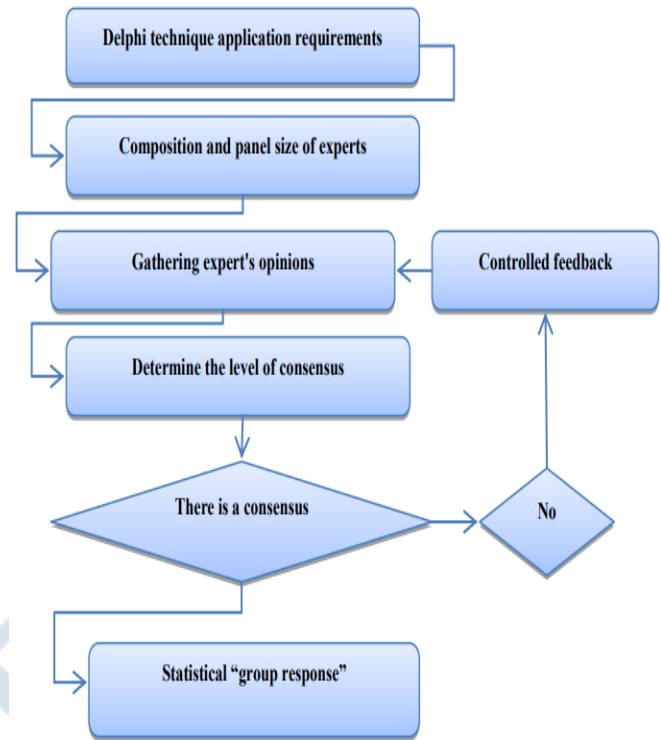
Exploratory research **nature** will be adopted, against an explanatory or a descriptive one, to deep dive into the reasons for non-proliferation of the digitalisation in power sector as they seem to be never converging and ever evolving.

Abductive reasoning **approach** will be adopted, against inductive and deductive ones, because my research begins with an incomplete set of observations and proceeds to the likeliest possible explanation for the collated set of reasons.

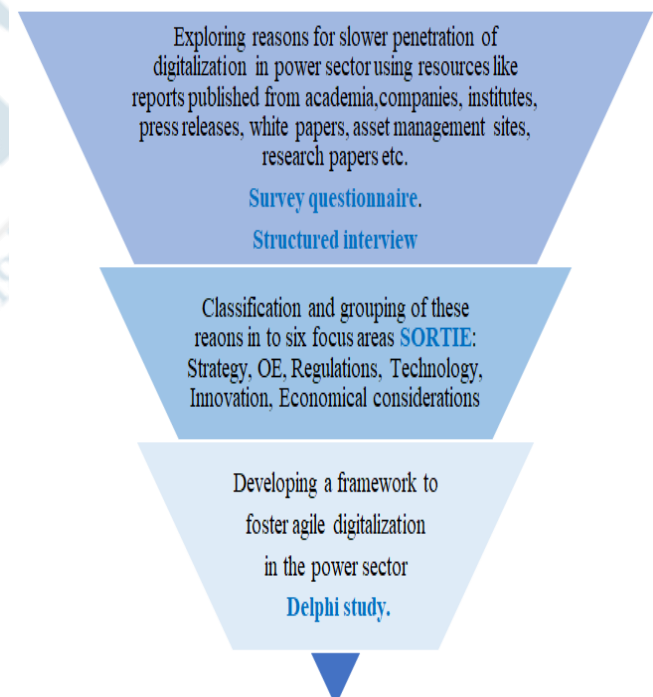
A qualitative research **design** will be adopted as it gels well with an inductive or an abductive research approach where new theories are formulated from the data collected. A qualitative design examines the relationship between entities –people, companies, products or services while a quantitative design focuses on relationships between variables.

The research **strategy** adopted will be survey, structured interview, and Delphi. Survey fits well with exploratory research by having proper sampling size and data collection process. Structured interviews using a predetermined and standardized identical set of questions can be very helpful to find out what is happening and to understand the context, with a pinch of salt to care of biases on both interviewer and interviewee side. The collation of reasons will be based on survey and structured interviews along with reasons collated from the literature review, primary and secondary sources, within the set research boundaries with in the six focus areas (SORTIE).

The Delphi technique, a group knowledge acquisition method, is adopted to formulate a framework that helps to accelerate the digitalization deployment in the power sector. It best suits for a qualitative research approach that is exploratory in nature. (Arash Habibi, Azam Sarafrazi, 2014). Its process is depicted below.



**Methods and Sources**



Survey questionnaire and structured focused interviews are conducted among clients, power plant professionals, customers, vendors, end users, Domain experts, and SMEs. This would form the basis for converging on a framework using Delphi.

The Delphi technique was named after the Ancient Greek oracle, who could predict the future. Delphi technique is primarily used by researchers when the available knowledge is incomplete. The aim is to collect expert-based convergence.

Three rounds, which would typically take four months, often suffice (Stone Fish & Busby, 2005). A Delphi Survey is a series of questionnaires that allow experts to develop ideas about potential future developments around an issue. The questionnaires are developed throughout the process in relation to the responses given by participants in the previous rounds.

The size of a Delphi panel may be as small as three members (3) and as large as eighty (80). It is important to select people who are knowledgeable in the field of study and are willing to commit themselves to multiple rounds of questions or interactions on the same topic.

Steps in Delphi

Step 1: Choose a Facilitator.

Step 2: Identify the subject matter experts.

Step 3: Define the Problem

Step 4: Develop Round One Questions

Step 5: Send Out and Analyze Round-one Questionnaire.

Step 6: Based on the round1 feedback, develop round 2 questionnaires

Step 7: Send Out and Analyze Round-two Questionnaire & iterate thrice.

#### Schedule-subtasks

A.	Survey questionnaire	1 Month
	<ul style="list-style-type: none"> <li>DBA DA students, industry experts, vendors, end users</li> </ul>	
B	Structured interview	1 Month
	<ul style="list-style-type: none"> <li>SMES, OEMS, IT heads</li> <li>Based on findings and MECE list of challenges from the above two steps, develop first level of questionnaire for framework in Delphi.</li> </ul>	
C	DELPHI for Framework	3 Months
	<ul style="list-style-type: none"> <li>Selection of SMEs</li> <li>Selection of Facilitator</li> <li>Delphi first round of questions</li> <li>Second and third round of questionnaire</li> <li>Findings and actionable insights</li> </ul>	

#### Practical Considerations

There exist, possibly, some potential obstacles like availability of time by SMEs and respondents, limitations and ethical or practical issues like biases, conflict of interests and competition among vendors. Due care and prudence will be exercised to minimize these effects.

#### IV. IMPLICATIONS AND CONTRIBUTIONS TO KNOWLEDGE

The proposed project is important and it will contribute to new knowledge. The new findings will pave a path to accelerate the digitalisation in power sector.

##### Practical Implications

In order to alleviate an ivory tower, care will be exercised in research to include SMEs, OEMs, industry specialists, domain specialists, power plant professionals, and academicians in the interactions, interviews, and surveys obtaining more ground realities and providing pragmatic framework with actionable insights.

##### Theoretical Implications

The research work would help strengthen the novel business models overcoming current challenges and would create a basis for further research. A framework also will be developed which would help in accelerating the digital deployment in the power sector.

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