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Exploring Reasons for Digitisation Not Percolating In To the Power Sector to the Extent Expected In India and Suggesting a Framework to Expedite the Same

[1] Pothala Koteswara Rao, [2] Dr. Vijayakumar Varadarajan

[1] DBA-Research Scholar.
[2] Supervisor/Mentor/Faculty-SSBM SWIZERLAND and UNSW AUSTRALIA.
Corresponding Author Email: [1] koteswara@ssbm.ch

***Abstract*— Energy is essential for human survival and development. So has become the digitalization. This paper lays out the research concept paper which intends to find out the reasons why the marriage between energy, in particular power, and the 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'.**

I. INTRODUCTION

It is said that "it is easier to change the people than to change the people" i.e., sometimes a new vision requires new people to create it. The contemporary connotations on "power for all" " save planet" " green power" " blue power" " sustainability" "ESG" " business analytics" " 3D-decarbonization, digitation and decentralization of power" gel well with contemporary era of digitization and yield positive effects only if the digitization is deployed to the extent possible in all relevant fields , including the power sector.

According to Livia Wiley , 2020[1][15][16] , "using digital technologies, a power plant could expect to significantly reduce its major costs–fuel costs by 28%, maintenance costs by 20%, and operations costs (by 19.5%)"

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, non-compliance and opaqueness in bits and pieces between all these areas. Digitization helps in brining consistency, alignment, transparency and compliance in place. It breaks the silos. Also it propagates 3D- decarburization, digitation and decentralization of power.[17]

Digitalization entails convergence and interaction between the physical and digital worlds comprising three layers viz., Data (Processed information/ perception / sensory layer), Analytics (actionable insights from models layer) and Connectivity (exchange of via communications networks, human to machine, machine to machine, human to human application layer). Digitization in power plants entails probes, sensors, measuring devices, smart devices like meters, actuators, deployment methods, SCADA, DAS, DCS, PCLs and real-time data processing.

A power plant continuously generates data with 10 V's- Volume, Variety, Veracity, Velocity, Value, Validity, Variability, Volatility, Vulnerability and Visualization.(George Firican,2017). Associated challenges involved in data capture, storage, and transmission, curation (reuse, preservation, value addition, retrieval, quality assurance, and discovery) also affect the speed of deployment.

There has been interplay between digitalization and energy for many years in process optimization, automation, predictive maintenance, and to improve worker health and safety, optimizing O&M costs, enhancing power plant efficiency, reducing MTTR (mean time to repair) and increasing MTBF (mean time between failures) , reducing forced outages and resulting downtime, and achieving 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 them and opens plethora of new avenues to accelerate the deployment of data analytics in power sector.

Despite this dire need of the hour, data analytics failed to penetrate power generation sector to the extent it ought to be. Ergo, the need for a holistic review of the reasons for the same arises.

Data analytics can be classified in to four categories based on applications:

- Monitoring and Diagnostics (both supervised and unsupervised) deals with observation and measurement of performance and facilitate corrective action if necessary
- Forecasting and Prediction (Supervised Data Analytics), For example to carry out the Reliability analysis RBD-reliability block diagram, FTA-fault tree analysis and Markov model can be used.(Hanumant Pandurang Jagtap. 2020)[2]
- Clustering descriptive (Unsupervised Data Analytics) Data from power plants could be structured (typical relational data), semi-structured (social media files, .xml files, web log files, unstructured (pdf files, video files, image files, audio files etc) (Hemant Kumar Gianey, 2017)[3][20]
- Prescriptive analytics (both supervised and unsupervised ML/AI) provides CAPA recommendations (corrective and preventive actions) with actionable insights guiding on future decisions and actions to be taken.

It is observed that , most articles, papers and publications focused on forecasting the generation of either wind or solar energy while examining the digitization data , considerable literature on gas fired power plants predictive analytics but very few on conventional coal fired plants. Solar and wind energy sources being heavily dependent on the weather conditions, reliable forecasting through data analytics yields reduced cost benefits and enhanced overall system stability contributing to sustainability.

With the more and more renewable power joining the grid, the conventional coal fired power plants which are supposed to run as 'base load' plants are forced to face fluctuations in their load schedules calling for more flexibility in their controls systems and agility in their operation processes.

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)[18][19] , non-availability of skilled and trained man power, aged man power, retiring experienced skill pool, mandatory stricter norms to adhere to emission controls asking for more capital infusion, mandatory guidelines to fire bio-mas co-firing in coal fired plants again requiring some operational regime changes and added fuel costs, never ending woes of achieving 100% ash utilization which again adds up to additional spending , ever increasing aspirations of work force for higher wages and salaries, not honoring PPA (power purchase agreements) by some of the buyers (few state governments), ever increasing coal supply prices in both domestic as well as international coals, non-availability of spares from OEMs on account of discontinued productions, 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) which is unable 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) through digitization of performance optimization is pulling on the other hand despite many utilities are struggling for working capital.

In this back ground the enthralling ethos of 'power for all' and minimizing the above omnipresent pathos across he sector is an uphill task. In order to increase resilience and bounce back to sustainable business operations, integration of various siloes in the power generation value chain is the need of the hour.

Digitization has an impeccable and innocuous role to play in power generation sector. It can facilitate seamless integration of decision siloes, bring in more transparency in the operations, enhance collaboration among various stake holders, reduce O&M costs, increase employee development and engagement, eliminate resource losses, incentivize lean management, optimize spares requirement, optimize maintenance activities and make them more cost effective, assure sustainability, overall enhance employee development an engagement with enhanced performance of people, plant and processes yielding more profits yet saving the planet. Digitization helps in providing better advanced process controller using evolutionary methods for optimization: PSO- Particle Swarm Optimization, BFPSO- Bacterial Foraging Particle Swarm Optimization, GA-Genetic Algorithm, BFO- Bacterial Foraging Optimization e and QFT- Question Formulation Technique based robust controller etc.(Xinghuo Yu, 2010)[4][21][22]

The 'euphoric GEAR power (green, efficient, affordable, and reliable power)' can only be realized by adopting relevant digitization in the power plant value chain.

Albeit such plethora of OFI –opportunities for improvement to lift the downward leaning profit curves in the northward direction through deployment of digitization, it has not picked up the speed to the extent expected in coal fired plants.

This opinion is corroborated by several articles written and published by many researchers, experts, consulting firms, institutions, OEMs. Though numerous causes for slow proliferation of digitization are enumerated, they are found not to be mutually exclusive and collectively exhaustive (MECE). Hence I intend to explore all the possible reasons for slow penetration of digitization in power sector and along with their relative significance. It is planned to carry out qualitative review of over 100 high-impact studies / articles to diagnose the reasons for nonproliferation of digitization, data analytics, AI and ML in the area of electricity generation and suggest a framework to alleviate these constraints.

1.1 Problem Statement

The research is taken up under the pretext that the hypothesis of "digitization has not percolated the power sector in India to the extent expected" is true. This fact is corroborated by PWC's Dr. Marcus Eul et al., 2019 whose report pronounces that only 2 percent of utilities in the

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EMEA region (Europe, the Middle East, and Africa) have adopted digitization extensively. Further World Bank Digital Adoption Index-DAI given for India is 0.51 against 0.87 of Singapore in the scale of 0-1 reinforces the fact that there is a long way to go in digitization.

Though several researchers have enumerated, as referred in the-literature review section, various reasons and challenges for non-adoption of digitization to the extent expected in power sector in India, the reasons are not mutually exclusive and collectively exhaustive (MECE) . I want to explore and collate all the reasons on the selected four pillars within the boundaries of Strategy (realigning business processes for product/service delivery), operational excellence (Operational excellence entailing realigning people, process and tools), IT-OT-ET convergence, ROI (short term and long term benefits).

Exploring the concrete exhaustive list of constraints within the boundaries as above is my primary research aim with a secondary aim to suggest a frame work to overcome these constraints and speed up digitization deployment in power sector. A pragmatic framework enabling faster deployment of digitization in power plants cannot be worked out without a deep dive into the associated constraints for the same.

1.2 Research Question

What are the salient reasons for digitization not picking up in power sector to the extent it is expected to be?

1.3 Research sub questions

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?

1.4 Objective of the Study

Based on the preliminary literature review a considerable gap is found in establishing the concrete exhaustive list of constraints that are blocking the agile[30] deployment of digitization in the power sector. Limited progress has been made on capturing mutually exclusive and collective exhaustive list of constraints according to their characteristics in a comprehensive manner.

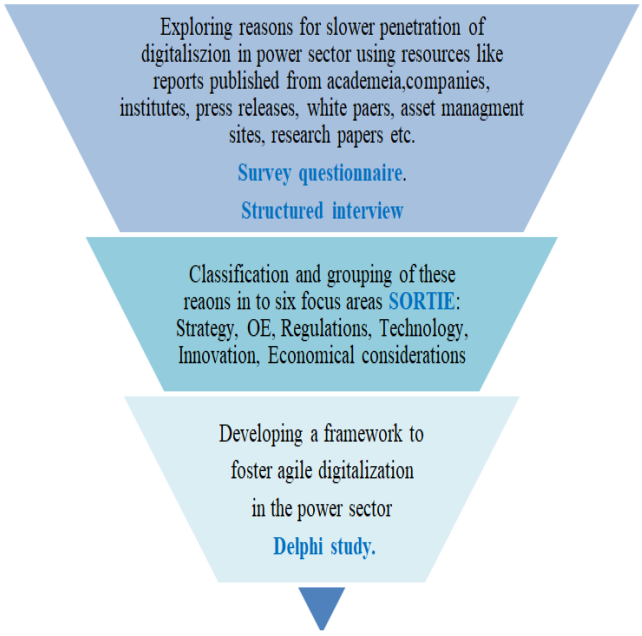
The objective of my study is to establish the reasons for digitization not picking up to the extent it is expected to be within the power plant in the ambit of four parameters- strategy, OE, IT/OT convergence and ROI.

Additionally a conceptual framework for managing the discovered constraints will be suggested.

1.5 Methods of data collection

I intend to adopt exploratory research method here. Delphi technique facilitating workshops with focused groups , structured interview of OEM/ IT enablers, and general survey questionnaire among professional working in the energy sector.

Research methodology converging on to specific topic from general broad area is depicted below.



II. PRELIMINARY LITERATURE REVIEW

2.1 Preliminary Literature Review Objectives

According to Dr. Marcus Eul and Folker Trepte, 2019[5], as mentioned in the 2019 Digital Operations study for energy from PwC's strategy consulting business, about 2 percent of utilities only in the EMEA region (Europe, the Middle East, and Africa) adopted considerable digitization while 45 percent lag behind.

Similar has been the experience in India, based on my preliminary focused interviews with industry leaders. Some support processes such as finance, administration, human resources, spares and service procurement, stores are digitized in some utilities while the core functions such as generation, transmission, distribution, coal procurement, ash utilization, trading, and sales are yet to gear up in adopting digitization.

World Bank the Digital Adoption Index-DAI entails three dimensions of the economy on a 0-1 scale:

- People (expanding opportunities and improving welfare) ,
- Government (enhancing accountability of effective service delivery) , and
- Business (increasing productivity and accelerating broad-based growth).

DAI for India 2016[5][31] is around 0.51 against advanced country like Singapore for example with a DAI of 0.87. This illustrates the fact that there is a long way to go for spread of digitization in India. Please refer table below for DAI values during 2014 and 2016[32].

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The Digital Adoption Index					
Country	Year	Digital Adoption Index DAI	Business Sub-index	People Sub-index	Government Sub-index
India	2014	0.442272395	0.430099308	0.160062328	0.736655533
India	2016	0.510771692	0.500528276	0.227437884	0.804348886
Country with highest DAI					
Country	Year	Digital Adoption Index DAI	Business Sub-index	People Sub-index	Government Sub-index
Singapore	2014	0.868270159	0.836006045	0.80476433	0.964040041
Singapore	2016	0.870592058	0.851721346	0.803051472	0.957003355

A maiden literature review shows that past studies are predominantly concentrated on understanding and modeling a limited number of constraints, for example financial constraints, policy impediments, capacity limitations (Gartner survey , 2018)[6][23], siloed and legacy data assets, human capabilities, companies trust in data, focus on value delivery (Fraser Beckwith , 2020)[7], legal and governance framework(Salam Ayman Abdeen, 2019)[8][25], capital investments, collaboration among departments (Trung Nguyen et al., 2020)[24] , technological, contractual, resource, spatial, and information constraints etc.

According to Manual et al., 2016[26] as mentioned by Salam Ayman Abdeen, 2019[9], the adoption of analytics to improve businesses presents some challenges. "The biggest challenge has nothing to do with data science or mathematics or data storage, it has to do with legal and governance framework"

As per Trung Nguyen et al., 2020[27], the technology's adoption needs investments and efforts at all levels of the organization, legal system and government. They also mentioned that 'nontechnical challenges also include collaboration between departments to deploy and operate the BD system effectively"

FEI Webcast Polling Results, 2017[10] say "Many organizations are still using manual process like spreadsheets, email, and in-person meetings to govern structural changes across enterprise systems." Oracle data management article mention that manual entries and interventions in data updating may creep in errors due to lack consistency of data among enterprise's transactional systems, data warehouses, BA & BI, and ERP , APM solutions. [14]

Report purposed for a joint G20 conference Berlin, Germany 2017[11] stated that "Advanced governance frameworks – building upon both existing public- and private-sector-led processes and new multi-stakeholder initiatives for the benefit of all – are necessary to effectively address the complexity of today's interlinked issues in successful Industry 4.0 development and deployment" Same report further mentions that "…digitalisation raises important policy challenges including privacy, security, consumer policy, competition, innovation, jobs and skills, among others"[13][28]

PwerGen Plus article on "Why we yet have to see the full value of digital power plant operations' clearly brings out 5 key factors that are limiting the digital deployment viz., emphasis on bringing perfection, focus on technology in place of value, ignoring user experience, lack of focus on change management, dearth of leadership commitment,

III. DISCUSSION AND CONCLUSION

3.1 Discussion

The primary research method for this study is exploratory literature review, Delphi technique facilitating workshops with focused groups, structured interview of OEM/ IT enablers, and general survey questionnaire among professional working in the energy sector and finally conceptual framework to enhance digitization deployment.

Constraint identification and classification through a structured approach on six attributes SORTIE-Strategy, OE, Regulation, Technology, Innovation and Economic considerations. From this research an exhaustive list of constraints that are show stoppers for faster digitization is developed. Further a comprehensive review of current industry practices and academic researches will help converge on the leading factors that are stalling agility in digitization. Finally, from the MECE[33] constraints a conceptual framework for accelerating the digitization will be outlined. This study and thesis is planned to be conducted and completed between Jan 2022 and Mar 2023.[12][29]

3.2 Conclusion

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 to accelerate 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.

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