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Energy conservation in India: a TQM approach

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Abstract

Operations in energy generation, transmission, distribution and consumption are independent in India and operates in isolation in the absence of Total Quality Management (TQM) system leading to gaps between the operations. These gaps make the whole system less efficient because of voids in the quality control systems when we take a bird's eye view at the macro level. It cannot be seen in isolation and needs to be addressed at the macro level. Integrating the Quality Control Systems (QCS) in each operation by TQM will strengthen each QCS that will bring more clarity and better control. Energy Conservation will also have a positive impact on environment and that increases the number of stake holders when we talk about an integrated Quality Management System (QMS). This paper discusses the importance and needs for TQM in Indian energy conservation.

Keywords: Energy Conservation, Commercial Building, Total Quality Management, Demand Side Management

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1. Introduction

When the world's first energy crisis was experienced in early 1970s Demand Side Management (DSM) was coined to be the solution to overcome the energy shortage (2). DSM was thought to be a bi-directional action oriented solution (37). Organisations were expected to be proactive in their approaches to facilitate the technology to excel for the highest possible efficacy. Then came 2007 when it was

realized that there is a third element to DSM and that is the human beings which brings sustainability to DSM (3). Quality management plays a major role in energy management (7). Quality management in energy conservation is thought to be an isolated localized requirements. Total Quality Management (TQM) is perceived to be applicable to only in manufacturing (30). India has come a long way in energy conservation since 2000. Energy Conservation Act 2001, Electricity Act 2003 and Energy Conservation Building Code (ECBC) 2017 are in operations since then to boost the energy conservation activities in India. Quality management is working in isolation in segments like generation, transmission, distribution and consumption. When the energy is required to be carried from generation to consumption then quality management in isolation creates many voids to make the whole system inefficient. The thumb rule followed in India is that saving one unit at the consumer end is like saving two units at the generating point (8). This huge loss is the testimony to the need for TQM in order to bridge the gaps between the segments for improving the overall efficiency of the whole operations from generation to consumption. The objective of this article is to discuss the need of TQM application in energy conservation in India.

2. Literature Review

A detailed literature review is done to understand the concept of Total Quality Management in Energy Conservation application for identifying the gap in the operations with cradle to grave approach. The literature review is explained in some appropriately titled sub-headings.

2.1. Total Quality Management

Total Quality Management (TQM) is defined as a management approach with complete focus on customers (10). It enables the development of products and services which meet the needs and exceed the expectations of customers. This is executed by creating an integrated system that is process centric, has total employee involvement and is completely customer focused (4). The entire organization needs to function as a single unit in the pursuit of excellence in order to correctly perform on TQM methods (1). Attaining this is accomplished with a sharp-focus on the eight principles of TQM. These are Customer First, Employee Ownership, Process-Based, System Integration, Strategic and Systematic Approach, Data Driven, Communication, and Constant Improvement as shown in Figure 1.

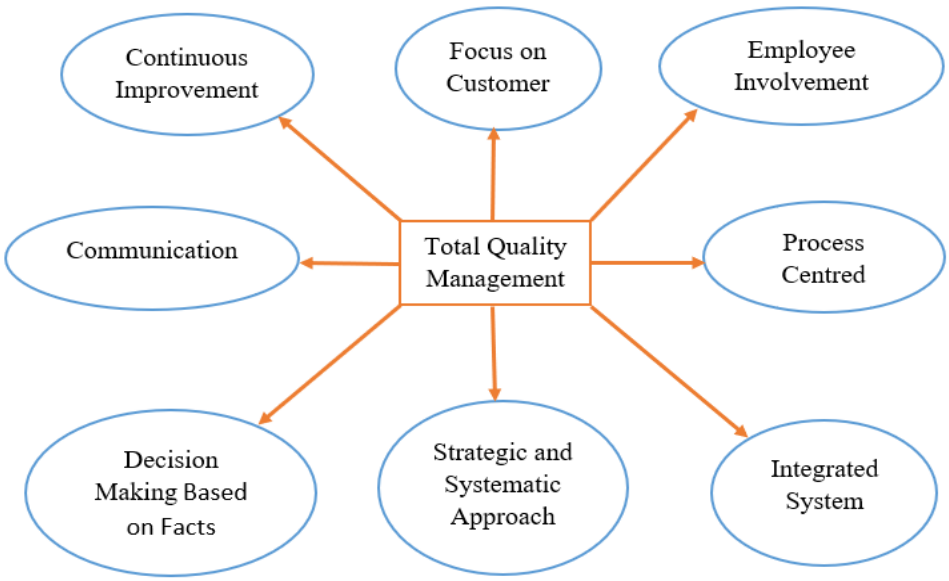

Figure 1: Principles of TQM

Source: Compiled by the Author

Study in Bangladesh Power Development Board (BPDB) suggested the need of implementing TQM to address the inefficiencies in operation to minimise the operational losses. (8). Total Productive Energy Management (TPEM) is an approach that calls for the participation of all members of any facility to take part in energy conservation activities by taking the ownership for the efficient management of energy (22). Commitment of top management, incentives to employees and continual learning through training are the means of implementing such an approach in any organizations. This approach will not only help in creating the awareness and vow to energy conservation at all levels but also translate into saving money and protecting the environment (28). Study suggest the need to implement TQM in electricity sector in industrialised nation like Brazil for making the operations efficient and customer centric (39).

2.2. Indian Energy Scenario

Energy demand in India had been growing steadily since 1960s and it is expected to grow in the same trajectory even after the Covid-19 situation is over as shown in Figure 2 (17). The steady growth in energy demand is met by increasing the generation through enhanced generating capacity and technological excellence for improved efficacy. Figure 2 illustrate the fact of doubling the energy demand from 2019 to 2040 if the expected growth and development remains at pre-Covid 19 stage.

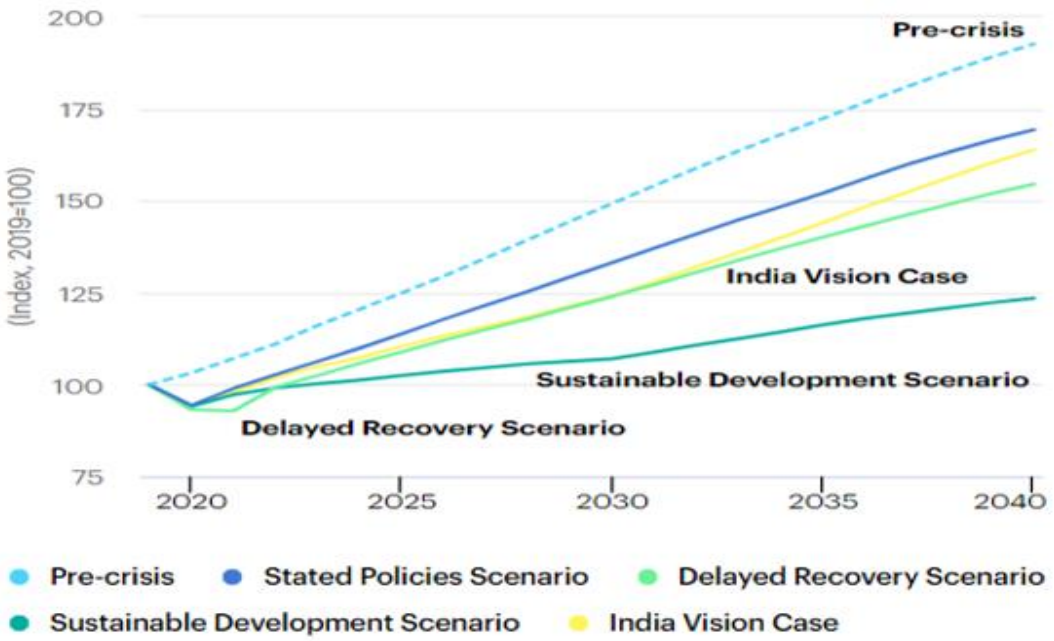

Figure 2: Expected Growth in Energy Demand in India

Source: India Energy Outlook, 2021Report

Primary source to meet the growing energy demand in India remains the fossil fuel. Coal and Oil continue to meet the major demand while the discovery of new fossil fuel reserve in the world continue to shrink (17). Figure 3 gives the break-up of the fossil and non-fossil fuel contribution to meet the Indian energy demand.

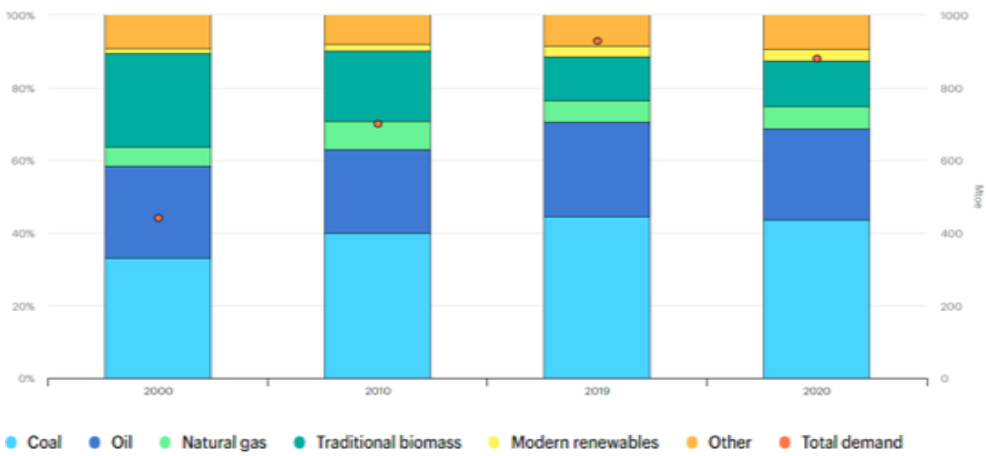

Figure 3: Total primary energy demand in India, 2000-2020

Source: India Energy Outlook, 2021Report

2.3. Energy Conservation initiative in Indian

Structured initiative for energy conservation in India goes back in 2000 when then the president of India Dr. APJ Abdul Kalam gave "Energy independence by 2020" as energy vision of the country (3). The Government under the leadership of Mr. AB Vajpayee passed "Energy Conservation Act 2001 (EC 2001)" and revamped the State Electricity Boards to operate as profit center through corporate like structures by passing revised "Electricity Act 2003 (EA 2003)" (32). Major energy consuming industries were identified as "Designated Consumers (DC)" and "Bureau of Energy Efficiency (BEE)" was created to drive the revised energy policy towards the new initiative called "Energy Conservation". "Energy Conservation Building Code (ECBC)" was further introduced to bring the building sectors under the umbrella of energy conservation act (3).

Quality management in generation, transmission, distribution, billing, and consumption remained in isolation in the revised plan. Quality is seen and managed at micro level while the need of the hour is to look at macro level with a holistic view instead of periscopic view (19). This will help in bridging the gaps between different segments of operation to transfer energy from generation to consumption which will lead to better energy management and enhanced operational efficacy (28).

2.4. Energy Conservation Measures Implementation Opportunity in Indian

An Energy Efficiency Project (EEP) involves a number of Energy Conservation Measures (ECM) that will lead to a more efficient energy consumption at the consumer's end (15). Study shows only 3% of the industrial establishments have

executed energy efficiency projects for energy conservation within their area of operation (IEA, 2021). There is a dearth of literature on energy conservation projects in India at the backdrop of TQM (31). Twenty percent of the organisations think extended time and extensive efforts are required to implement any EEP successfully (6). Study also suggests that 23% of employees in any organisation believe that there is an opportunity for energy conservation in lighting which is common in any premise (14). Energy conservation initiatives in India have come a long way and much more needs to be done to make it a way of life so that the energy conservation become sustainable. One of the prominent need is to formulate a TQM covering from energy generation to energy consumption at a macro level from the bird's eye perspective.

2.5. Government Policy and Regulation

The Indian Government has passed EC 2001 to kick start the energy conservation activities in India. State Electricity Boards (SEB) were revamped and restructured under EA 2003 to operate as corporates with better transparency and accountability in the operations. ECBC was revised several times and fine-tuned to match the requirements of Indian building sector involving central government, state governments and urban local bodies for bringing a revolution called "Green Building". ECBC 2017 is in implementation since 2018 and both the central government and state governments have launched many energy conservation and green building programs to give the momentum to energy conservation (13). Policies, regulations and several programs are in place while the authorities continue to explore opportunities to close the gaps. TQM is one such gap that needs to be addressed with modified quality management policy in order to minimize the losses due to the absence of a composite quality management system (9).

2.6. Awareness of TQM in Energy Conservation

There is a need for awareness creation first to unlearn and then relearn when we talk about TQM in energy conservation in India. General perception of the people about TQM is that it is something related only to manufacturing (15). The survey findings in one study on quality management in an Indian manufacturing organisation indicated that Indian organizations are well aware of TQM practices, but implementation level is not at par with the awareness level (24). Figure 4 illustrates the familiarity with TQM Principles while Figure 5 highlights the difference between awareness and relevance of various quality management systems (15).

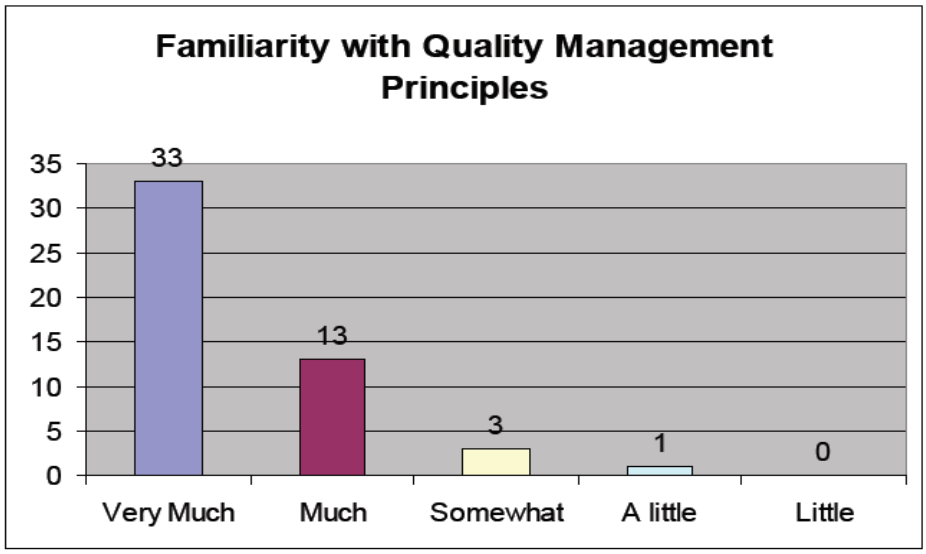

Figure 4: Familiarity with TQM Principles

Source: Khanna et al. 2010

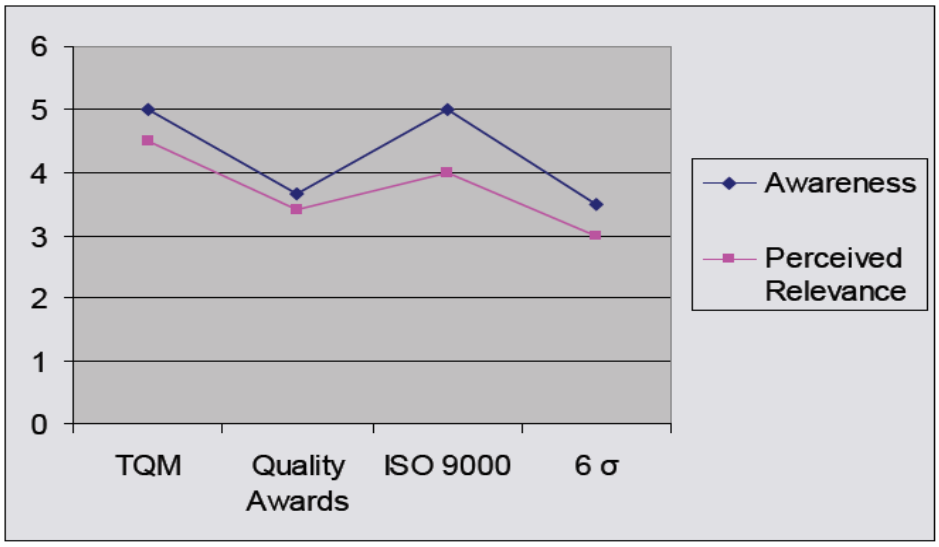

Figure 5: Awareness and Relevance of Quality Management Systems

Source: Khanna et al. 2010

3. Methodology and Approach

The methodology and approach of TQM in energy conservation at a macro level is similar to any quality management approach, but only difference is that it will cover right from energy generation to energy consumption while the others are localized approach like only for generation or transmission or consumption etc. (26). M M Kablan proposed a five phases TQM approach for his energy conservation project in Jordanian industrial sector with the model termed as "Kablan's 5 Steps Close Loop TQM Model" as shown in Figure 6.

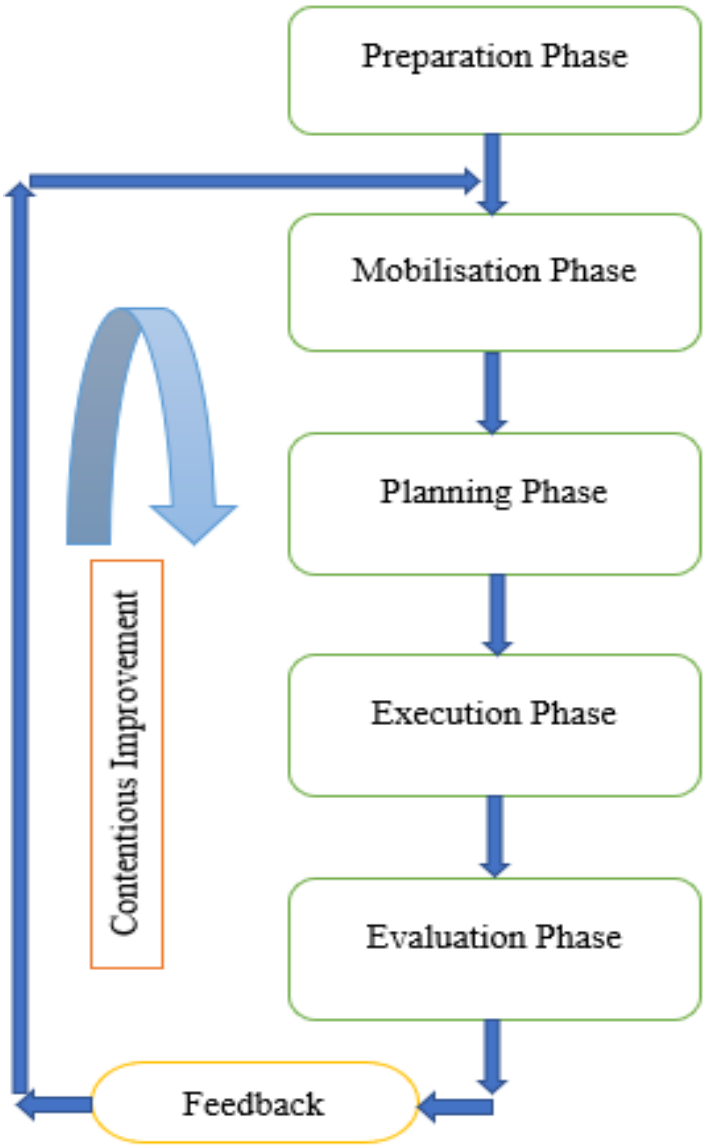

Figure 6: Kablan's 5 Phases Close Loop TQM Model

Source: M.M. Kablan, 2003

The key stakeholders in Indian power sector is shown in Figure 7. Today the sources of fossil fuel for Indian power plants are not limited to Indian resources but major part of it is imported from different countries (32). Even if we consider from generation to distribution then also there are many entities in this chain of events. Each entity operates within its perepharies and with own quality management systems. Therefore, the stake holders in this chain of events are expected to follow more than one quality

management systems. If the quality management systems operate in isolation within each stakeholder's periphery then chances of gap between the stakeholder's operation will be more leading to drop in operational efficiency causing energy losses (33).

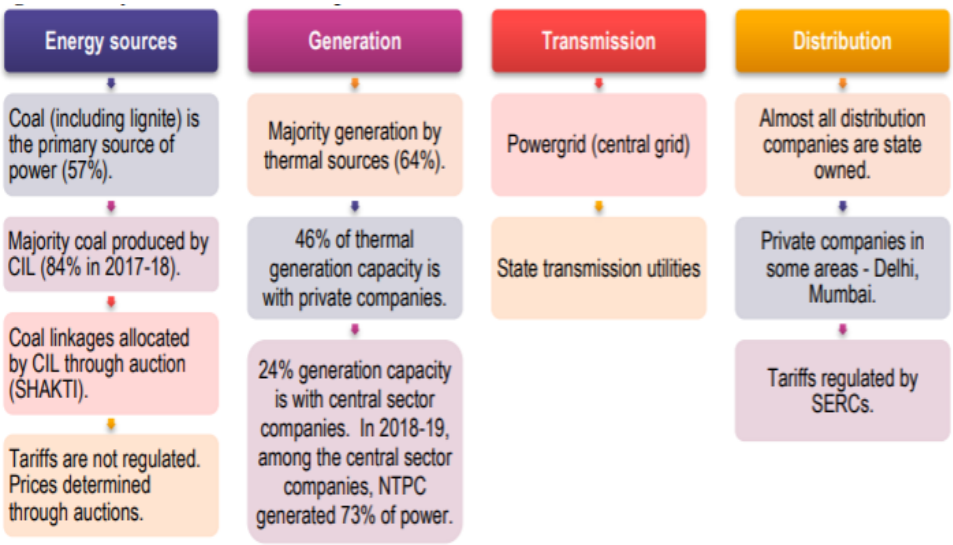

Figure 7: Key Stake Holders in Indian Power Sector

Source: Prachee Mishra, 2019

The basic structure of a TQM should have policy, planning, implementation, monitoring, checking, and feedback to make it a close loop system with continuous improvement mechanism as shown in Figure 8. (4). There is a need to formulate a composite quality management policy to cover all stakeholders under one umbrella through a Total Quality Management system.

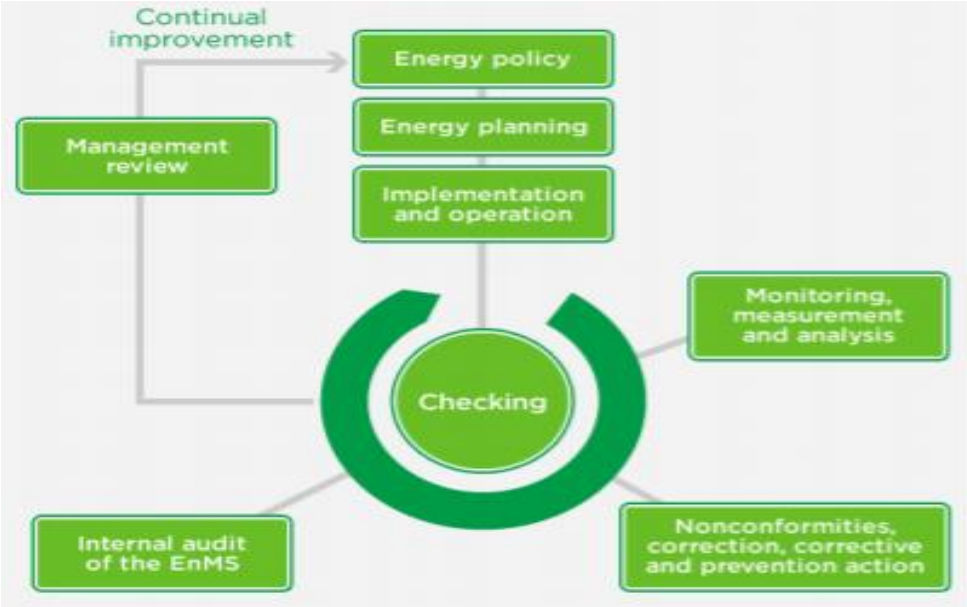

Figure 8: Basic Structure of Energy Management System

Source: Joshi et al., 2016

Each operation is unique and require its own approach, but the core elements of TQM can guide each decision for its implementation. Implementation of TQM is something that needs to be applied to the present structure of the organization and it will vary from operation to operation (35).

4. Recommendations

TQM in energy conservation has two sides. One is the energy supply side while the other is the by-products because of energy conservation. Supply side covers all operations starting from the mines / rigs, from where the fossil fuel is extracted from mother earth, to the last equipment using the energy at the consumer's end. Because of energy conservation there will be positive effects on carbon emission, global warming and environmental impacts. Fossil fuel, be it coal, oil or natural gas, is extracted both

by the government and private organisations having their own respective Quality Management Systems (QMS). Similarly electrical power is generated in thermal power plants using fossil fuel or any other alternative fuel/s both by the government and private organisations having their respective QMS. Electrical power is evacuated from all power plants, be it thermal, hydro, solar or wind, and distributed amongst the consumers using state operated power grid having their won QMS. The power transmission and distribution system is illustrated in Figure 9. All these QMS at various levels are not the same. Therefore, bringing all these QMS under one umbrella calls for an integrated TQM policy driven by a central nodal agency like Central Electricity Authority (CEA) at the behest of the government of India. TQM at this national level will help in smooth integration of all QMS in operation at different organisations level which will help in bridging the gaps between the operations at different organisations level. Since energy conservation is not in isolation of energy supply, it will also govern the energy conservation as well under such TQM.

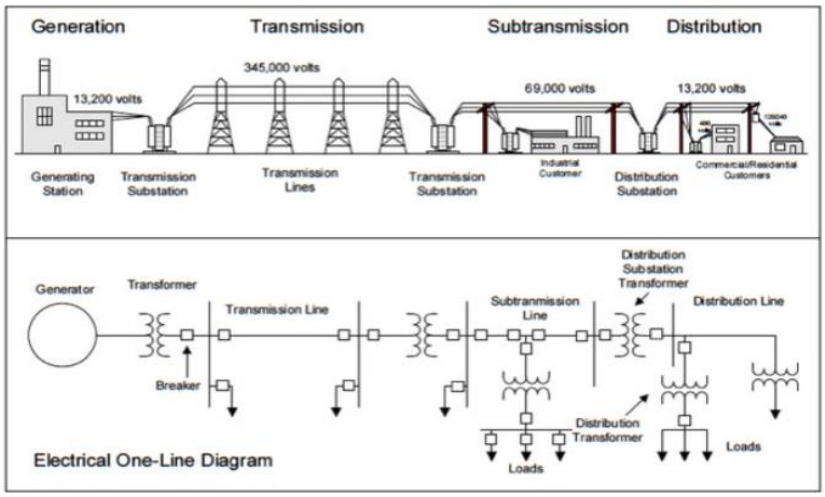

Figure 9: Single Line Power Distribution Diagram

Source: J. Keller and B. Kroposki, (2010)

A systematic PDCA approach (Plan-Do-Check and Act) can lead to continuous energy efficiency improvement under such TQM. Organizations with an existing QMS can easily integrate with other QMS (18). Buildings in Europe consume about 40 % of the energy which translates into about 36 % of the CO2 emissions (1). The reduction of energy consumption in building sector alone is one of the most important factors for reducing environmental impact. A TQM will integrate all QMS practiced in other industries to make a bigger impact on environment. Generally speaking the scholarly literature suggests that Quality Assurance (QA) and Quality Control (QC) associated with the quality management paradigm facilitate the adoption of environmental and social practices associated with corporate environmental management policy as shown in Figure 10 (10).

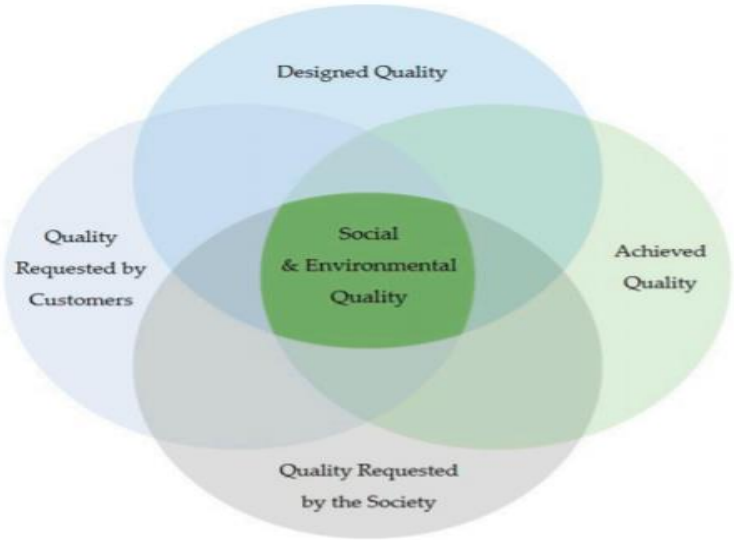

Figure 10: Social and Environmental aspect of QMS

Source: Erlantz Allur et al., 2018

5. Conclusion

Total Quality Management ensures the demand of both internal and external customers in this changing nature of business operations. Top management's commitment, determination and direction is required to ensure the conducive atmosphere for improvement of organisational environment to create a TQM culture. It also calls for a well-developed Quality Management System (QMS) which clearly defines managerial processes and describes how they are to be integrated with all internal and external customers, suppliers and related service providers or in other words all the stake holders. Participative management will make the system more proactive compared to control management. Middle management, lower management and the general employees need to align with the vision and mission of the top management. An effective implementation of TQM in energy conservation application from generation to consumption will help in plugging the gaps between operations which will lead to increased efficiency, better utilization of energy, reduction of carbon emission and global warming.

REFERENCES

[1]. Agris Kamenders, Kristaps Kass, Edite Biseniece, Laine Lupkina, Janis Bazbauers (2018); Quality management in energy performance contracting projects; International Scientific Conference "Environmental and Climate Technologies", CONECT 2018; ScienceDirect, Energy Procedia 147 (2018) 636–640

[2]. Ali SS, Tyagi R, Ragini, (2019); Energy conservation project funding in commercial building: an expenditure or investment? International Journal of Power Electronics and Drive System (IJPEDS), Vol. 10, No. 1, March 2019, pp. 504~513 ISSN: 2088-8694, DOI: 10.11591/ijpeds.v10.i1.pp504-513.

[3]. Ali SS, Tyagi R, (2020); Conserving Energy through Energy Management by the Facility Managers in India. Global Journal of Researches in Engineering: J General Engineering, Volume 19 Issue 3 Version 1.0 Year 2020, https://globaljournals.org/GJRE_Volume19/3-Conserving-Energy-through-Energy.pdf

[4]. Alok Joshi, Suvek Venugopal; Energy Management System in India; International Research Journal of Engineering and Technology (IRJET), Nov. 2016, Volume 3, Issue 1

[5]. Bilal AA, Mohsen MS, (1999); Energy analysis of Jordan's residential sector. Energy 1999;24:823–31.

[6]. Bureau of Energy Efficiency (2016); "Energy Conservation Building Code 2016. Bureau of Energy Efficiency"; Ministry of Power, Govt. of India; https://beeindia.gov.in/sites/default/files/ECBC%202016_Draft_V8.pdf

[7]. Caroline Wilsona, Melissa R. Marselleb (2016); "Insights from psychology about the design and implementation of energy interventions using the Behaviour Change Wheel"; Elsevier, Energy Research & Social Science 19 (2016) 177–191

[8]. D. van Dorena, M. Giezenb, P.P.J. Driessena, H.A.C. Runhaara (2016); "Scaling-up energy conservation initiatives: Barriers and local strategies"; Elsevier, Sustainable Cities and Society 26 (2016) 227–239
[9]. Elie Azar, Hamad Al Ansari (2017); "Framework to investigate energy conservation motivation and actions of building occupants: The case of a green campus in Abu Dhabi, UAE"; Elsevier, Applied Energy 190 (2017) 563–573,
[10]. Erlantz Allur, Iñaki Heras-Saizarbitoria, Olivier Boiral and Francesco Testa (2018); Quality and Environmental Management Linkage: A Review of the Literature; Sustainability 2018, 10, 4311; doi:10.3390/su10114311
[11]. G. Thondhlana, H.W. Kua (2016); "Promoting household energy conservation in low-income households through tailored interventions in Grahamstown, South Africa"; Elsevier, Journal of Cleaner Production 131 (2016) 327e340,
[12]. Godwin GU, (2000); Using analytic hierarchy process to analyze the information technology outstanding decision. Industrial Management and Data Systems 2000;100(9):421–9.
[13]. Govt. of India (2015); "Energy Efficiency and Behaviour in India. Energy Efficiency and Behaviour in India" https://www.iea.org/media/workshops/2015/eeuevents/behave1103/S2India.pdf
[14]. Government of India, Ministry of Power, Central Electricity Authority (2017); "Report - Government of India, Ministry of Power, Central Electricity Authority"; Government Of India, Ministry of Power, Central Electricity Authority, New Delhi, Power Sector Jan-2017. http://www.cea.nic.in/reports/monthly/executivesummary/2017/exe_summary-01.pdf
[15]. Harjeev Kumar Khanna, S C Laroiya, D. D. Sharma; Quality Management in Indian Manufacturing Organizations: Some Observations and Results from a Pilot Survey. Brazilian Journal of Operations & Production Management. Volume 7, Number 1, 2010, pp. 141-162
[16]. Hille S. L (2016); "The Myth of the Unscrupulous Energy User's Dilemma: Evidence from Switzerland"; Institute for Economy and the Environment, University of St. Gallen, Switzerland, Journal of Consumer Policy (2016) 39:327–347, India Energy Outlook, 2021Report, Feb. 2021, IEA
[17]. Ivana Krstic, Mirjana Stamenic, Aleksandar Nikolic (2015); Integration Of Energy Management In The Existing Quality Management System; https://www.researchgate.net/publication/283007424; Conference Paper.
[18]. J. Keller and B. Kroposki, (2010); Understanding Fault Characteristics of Inverter-Based Distributed Energy Resources; Technical Report NREL/TP-550-46698 January 2010; National Renewable Energy Laboratory, USA.
[19]. Jaber JO. Future energy consumption and greenhouse gas emissions in Jordanian industries. Applied Energy 2002;71:15–30.
[20]. Jaber JO, Probert SD. Purchased energy consumptions in Jordan's commercial and public-service sector. Applied Energy 2002;71:31–43.
[21]. Julien Walzberg, Thomas Dandres, Nicolas Merveille, Mohamed Cheriet, Réjean Samson (2019); "Assessing behavioural change with agent-based life cycle assessment: Application to smart homes"; Renewable and Sustainable Energy Reviews, Volume 111, September 2019, Pages 365-376,
[22]. Kaiyu Sun Tianzhen Hong (2017); "A Framework for Quantifying the Impact of Occupant Behaviour on Energy Savings of Energy Conservation Measures"; Energy and buildings,
[23]. Kiss B (2013); "Building Energy Efficiency Policy, learning and technology change efficiency"; Building Energy Policy, learning and technology change Efficiency, The International Institute for Industrial Environmental Economics, Published in 2013 by IIIEE, Lund University
[24]. Lauren Ross and Ariel Drehobl (2018); "Energy efficiency through tenant engagement: A Pilot Behavioural Program for Multifamily Buildings"; American Council for an Energy-Efficient Economy, 529 14th Street NW, Suite 600, Washington, DC 20045,
[25]. M.M. Kablan; Energy conservation projects implementation at Jordan's industrial sector: a total quality management approach; Energy 28 (2003) 1533–1543
[26]. Ministry of Energy and Mineral Resources. Survey of energy consumption in the industrial sector, final report. Amman, Jordan: MEMR; 1998.
[27]. Mohammad S. Al-Homoud; Total Productive Energy Management; Energy Engineering 97(5):21-38 • August 2000; DOI: 10.1092/253E-NC28-F85N-CRCR
[28]. National Energy Research Center, Amman, Jordan: www.nerc.gov.jo (7 July 2002).
[29]. Oakland JS (2000); Total quality Management (TQM), 2nd ed. Oxford: Butterworth-Heinemann, 2000.
[30]. Podgornik A, B. Sucic & B. Blazic (2016); "Effects of customised consumption feedback on energy efficient behaviour in low income household"; Journal of cleaner production (2016) , DOI - 10.1016/j.Jelepro.2016.02.09, JCLP 6693.
[31]. Prachee Mishra; Overview of the power sector; Sept. 2019.
[32]. Ravindra N. Chikhale (2018); "A Comparative Study : Impact of Different Artificial Light Sources on Human Bein"; . Science and technology, Volume 4 | Issue 2 | Print ISSN: 2395-6011

[33]. Rayyan LA, Tahboub K. Total quality management (TQM), and the success opportunity of 'ISO 9000' in Jordan. Master thesis at the Industrial Engineering Department, Jordan University; Amman, Jordan; 1995.
[34]. Sam C. Staddon , Chandrika Cycil , Murray Goulden , Caroline Leygue , Alexa Spence (2018); "Intervening to change behaviour & save energy in the work place : A systematic review of available evidence"; Science Direct, Energy Research & Social Science, Volume 17, July 2016, Pages 30-51. http://www.sciencedirect.com/science/article/pii/S2214629616300627
[35]. Stam A, Kula M, (1991); Selecting a flexible manufacturing system using multiple criteria analysis. International Journal of Production Research 1991;29(4):803–20.
[36]. Stephanie N. Timma, Brian M. Dealb (2016); "Effective or ephemeral? The role of energy information dashboards in changing occupant energy behaviors"; Elsevier, Energy Research & Social Science 19 (2016) 11–20,
[37]. Sutherland R. J (2016); "No Cost Efforts to Reduce Carbon Emissions in the U.S.: An Economic Perspective"; International Association for Energy Economics, The Energy Journal, Vol. 21, No. 3 (2000), pp. 89-112.
[38]. Total Quality Management: The Case of an Electricity Distribution Company. Brazilian Journal of Operations & Production Management 16 (2019), pp 53-65
[39]. Wang J, M. Biviji & W. M. Wang (2011); "Case Studies of Smart Grid Demand Response Programs in North America"; Innovative Smart Grid Technologies (ISGT), 2011 IEEE PES, DOI: 10.1109/ISGT.2011.5759162, INSPEC Accession Number: 11973000.