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Development of a Set of Futuristic Guidelines for Technical Assets Management

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Abstract

The paper presents a concept of sector specific guidance generation for engineers and technical solution seekers in field of power assets management. The developed guidance seeks to make solution hunting process more guided, systematic and innovative. It takes scenario of smart grid technologies implementation and discusses the possible utilization of smart grid technologies' potential for power asset management. For generating the innovative and systematic guidance framework, the research utilizes the inventive knowledgebase of Theory of Inventive Problem Solving (TRIZ). Using TRIZ researchers' works, it develops a methodology to generate sector specific guidance from TRIZ inventive knowledgebase. Using the developed guidance methodology, this paper generates a guidance framework for solution seekers in field of asset management.

.**Keywords:** *Technical assets management, TRIZ, innovation, Systematic guidance*

1. Introduction

Electricity and electrical engineering systems are crucial for today's world whether it is in commercial, industrial or social sectors. In today's tight competition holding markets, increasing demand for electricity and issues in fulfilling this increasing demand, optimization for technical systems is sought more than ever before. Topics focusing efficient systems, optimized usage of resources and management of energy are getting importance in purview of critical market. To be a success in the competition, key rule of competitors around the globe have been acquiring the great assets [1]. However, after years and years of investment in technical infrastructures and energy market related technologies, much more is needed to win share from today's fierce competitive business market. The years of developing mature markets today need to get best out of their great assets by best management and planning. Only having the great assets isn't sufficient [1]. Research literature presents a lot of work related to asset management of electrical systems, yet things are needed to be improved. Over the past years, rapid developments have been achieved in fields of telecommunications, data communications, information management, actuarial sciences and forecasting. Just like a lot of related technological domains, these developments are reshaping the field of technical asset management as well. New developments are continuously sought in field of asset management to make use of recent technological development and generate best opportunities for optimized use of resources and assets [2], [3], and [4].
Smart grids and related technologies are among those key technological developments, which are passionately worked by researchers in the recent years. To cater ever arising electricity system issues like aging equipment, difference in peak and off peak load hours, multiple electricity generation points, multiple nature of electricity generation, losses in transmission, congestion of networks and management of electricity supply, networks are moving towards more mature and high-tech technologies like "smart grids" [2], [3], [4], and [5].

2. Research Approach and Methodology

This research mainly explores the issues of increasing complexity in finding new improved solution for already developed and mature technological systems. It introduces an approach of bringing systematic guidance frameworks for engineers and project workers, working in a specific sector. These guidance frameworks will make solution hunting process more systematic, more effective and innovative at the same time. For the purpose, the research takes into account the "Theory of Inventive Problem Solving (TRIZ)" in providing generic level conceptual guidance for power asset management in terms of smart grid technologies. For analysis purpose, the research derives the key parameters to be considered in an efficient and effective smart grid system. Then it generates a list of asset management related key parameters in smart grid technologies. Furthermore it relates the derived key parameters with TRIZ database for deducing the related inventive principles and expected future transitions. The documentation keeps track of compiling all important parameters and related innovative principles and development gaps for future improvement to generate

a sector specific guidance framework. Such a guidance concept will keep engineers more focused and help them to reach breakthrough solutions while following the basic innovation rules. Tools and solution search methods of TRIZ i.e. 'Trends of Engineering System Evolution' (TESE) for future transitional gaps and recommendations, S-Curve for key parameters of value and Inventive Principles for breakthrough solutions are used for analysis and formulation of guidance framework [7], [8], and [9].

The derived guidelines are summarized in a tabular form. Furthermore, to use the developed guidance framework a methodology chart is presented to support solution seekers. The main analysis follows a methodological chart derived from TRIZ researchers' works as shown in **Fig 1**.

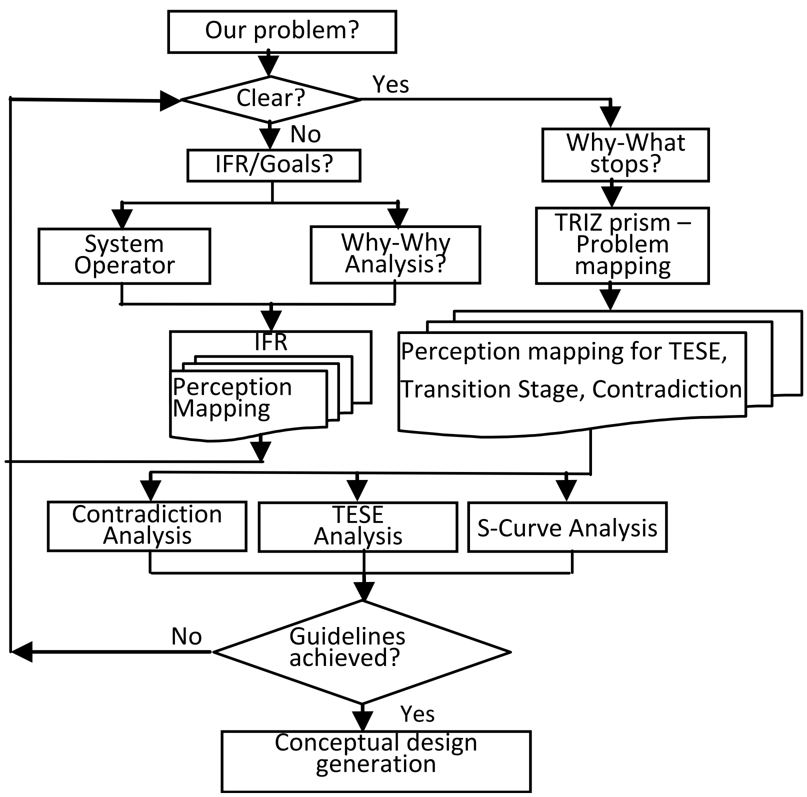

Fig 1. Flow chart for methodology of derivation of guidelines and recommendations

3. Guidelines for Solutions in Management of Technical Assets

The methodological chart presented in **Fig 1** generates the proposed sector specific guidance from TRIZ knowledgebase. To derive the guidance framework for asset management in smart grid era, case-study specific steps are presented in **Fig 2.**

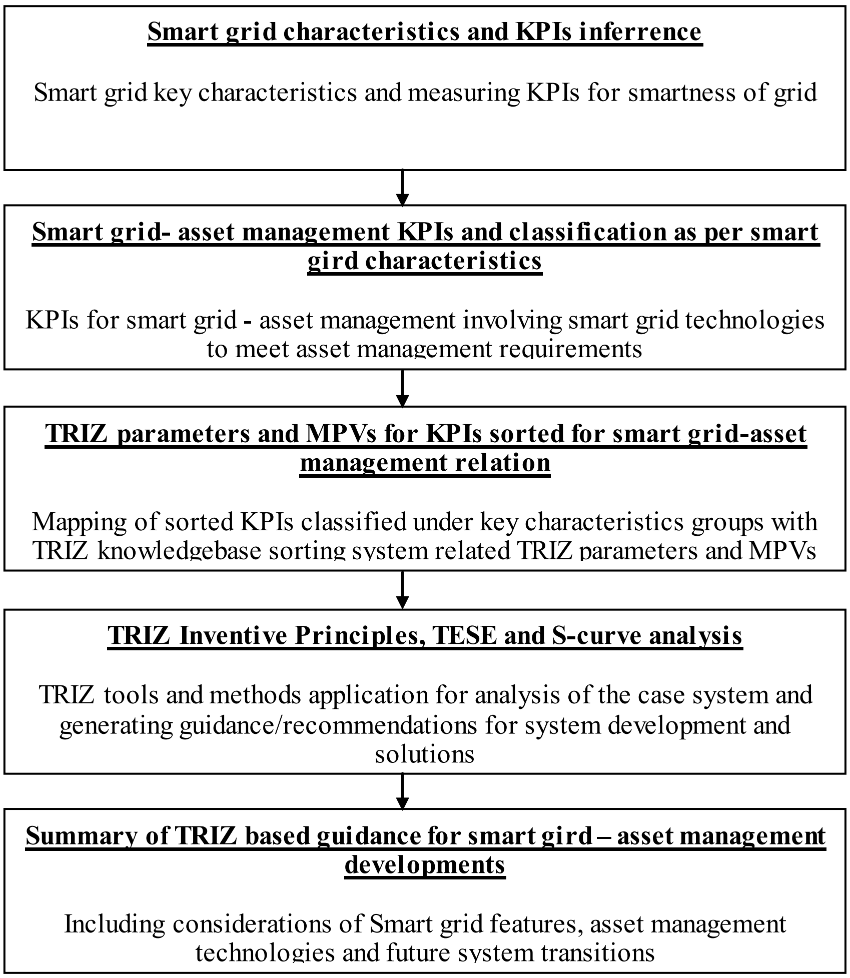

Fig 2. Analysis steps for asset management guidance generation

Following the methodological steps, the derived guidelines are compiled in a tabular form (Tables 1 and Table 3). The developed guidance/framework can be consulted for seeking the conceptual directions of future moves, while seeking innovative solutions for problems occurring in path of smart grid-asset management related developments. These guidance results are derived from application of different TRIZ tools and cross linking TRIZ based research works. [7], [8], [9], [10], [11], [12], and [14]. The parameters for smartness of a grid and management of assets are derived from cross linking the state of the art research work from literature [1], [3], [4], [16], [17] and [18].

Table 1 compiles the derived characteristics and KPIs for smartness of a grid, and further derivation of asset management related key components in smart grids. It maps and deduces all possible inventive principles from TRIZ inventive knowledgebase, which are to be considered by solution seekers.

Table 1: Smartness of a grid, asset management components and TRIZ inventive principles

Key Characteristics of Smart Grid	**TRIZ parameters for KPIs of asset management in Smart grid**	**Related Inventive Principles of TRIZ**
Enable active participation by consumers	• Amount of information/data • Customer feedback • Communication flow • Interface	2, 3, 6, 7, 10, 13, 24, 25, 28, 35, 37.
Accommodate all generation and storage options	• Adaptability/ Versatility • Control complexity • Size (dynamic) • Interface • Compatibility/Connect-ability	1, 2, 3, 4, 7, 10, 13, 15, 17, 24, 25, 28, 29, 35, 37
Enable new products, services, and markets	• Ease of operation/ Convenience • Interface • Adaptability/versatility • Control complexity • System complexity	1, 2, 3, 4, 5, 10, 13, 15, 17, 24, 25, 28, 29, 32, 35, 37
Provide power quality for the digital economy	• Stability • Accuracy • Compatibility/Connectability • Control complexity • Security	1, 2, 3, 4, 7, 10, 13, 15, 19, 24, 25, 28, 35, 37
Optimize asset utilization and operate efficiently	• Adaptability/Versatility • Extent of automation • Ability to detect/measure • Accuracy • Control complexity • System complexity • Speed	1, 2, 3, 4, 10, 13, 15, 17, 24, 25, 28, 29, 35, 37
Anticipate & respond to system disturbances (self-heal)	• Loss of information/data • Amount of information/data • Production risk • Supply risk • Support risk • Customer feedback • Communication flow • Control complexity • Speed • Accuracy • Ability to detect/measure • Harmful effects generated by system	1, 2, 3, 4, 6, 7, 10, 13, 15, 17, 24, 25, 28, 35, 37

	• Security • Interface • System complexity • Harmful effects on system	
Operate resiliently against attack and natural disaster	• Reliability/Robustness • Accuracy • Amount of information/data • Communication flow • Control complexity • Stability • Speed • Ability to detect/measure • Harmful effects generated by system • Security	1, 2, 3, 4, 5, 6, 10, 13, 15, 17, 19, 24, 25, 28, 35, 37

Where the inventive principles listing is summarized in single tabular form (Table 2) for reference of the work (Mann D., 2002).

Table 2: 40 - TRIZ Inventive Principles

Principle 1 – Segmentation	Principle 21 – Skipping
Principle 2 - Taking out	Principle 22 - Blessing in disguise
Principle 3 - Local quality	Principle 23 – Feedback
Principle 4 – Asymmetry	Principle 24 – Intermediary
Principle 5 – Merging	Principle 25 - Self-service
Principle 6 – Universality	Principle 26 – Copying
Principle 7 - Nested doll	Principle 27 - Cheap short-living objects
Principle 8 - Anti-weight	Principle 28 - Mechanics substitution
Principle 9 - Preliminary anti-action	Principle 29 - Pneumatics and hydraulics
Principle 10 - Preliminary action	Principle 30 - Flexible shells and thin films
Principle 11 - Beforehand cushioning	Principle 31 - Porous materials
Principle 12 – Equipotentiality	Principle 32 - Color changes
Principle 13 - The other way round	Principle 33 – Homogeneity
Principle 14 - Spheroidality – Curvature	Principle 34 - Discarding and recovering
Principle 15 – Dynamics	Principle 35 - Parameter changes
Principle 16 - Partial or excessive action	Principle 36 - Phase transitions
Principle 17 - Another dimension	Principle 37 - Thermal expansion
Principle 18 - Mechanical vibration	Principle 38 - Strong oxidants
Principle 19 - Periodic action	Principle 39 - Inert atmosphere
Principle 20 - Continuity of useful action	Principle 40 - Composite materials

Table 3 co-relates the smartness of a grid and asset management related key components with TRIZ trends for engineering system evolution and life cycle transition S Curve based recommendations. This supports solution and improvement seekers for finding possible gaps and transition to more developed state of a system.

Table 3: Asset management parameters related TRIZ knowledgebase derived recommendations

TRIZ parameters for KPIs of asset management in Smart grid	**Related TRIZ based system transition trends**	**TRIZ based S-curve Recommendations**
• Amount of information/data • Customer feedback • Communication flow • Interface	Trend of transition to super-system + completeness + coordination	- Optimization is the principle method for improving the system - Adapt ES to new applications - Use of resources specially adapted to the ES from super-system is possible(look for potential resources in super-system - Moderate changes should be introduced to the system design and design of system components (without changing their principles of operation) - It is possible to focus on compromises and solutions aimed at limiting disadvantages, without eliminating entirely. - Can assume the existence of ES specialized resources - Adding components can be as useful as trimming for improvement
• Adaptability/ Versatility • Control complexity • Size (dynamic) • Interface • Compatibility/Connect-ability	Trend of transition to super-system + Control + Dynamization	
• Ease of operation/ Convenience • Interface • Adaptability/versatility • Control complexity • System complexity	Trend of completeness + dynamization	
• Stability • Accuracy • Compatibility/Connectability • Control complexity • Security	Trend of coordination + flow enhancement+control	
• Adaptability/Versatility • Extent of automation • Ability to detect/measure • Accuracy • Control complexity • System complexity • Speed	Trend of trimming + coordination+ completeness	
• Loss of information/data • Amount of information/data • Production risk • Supply risk • Support risk • Customer feedback • Communication flow • Control complexity • Speed • Accuracy • Ability to detect/measure • Harmful effects generated by system • Security • Interface	Trend of control + flow enhancement + coordination + completeness	
• Reliability/Robustness • Accuracy • Amount of information/data • Communication flow • Control complexity • Stability • Speed • Ability to detect/measure • Harmful effects generated by	Trend of control + coordination+ dynamization+ completeness	

To help engineers in using the derived guidelines, a stepwise methodology is also presented to use the tabular guidance framework. The stepwise methodology helps in making the process more systematic and focused for solution seekers. This guided solution hunting reduces the complexity of the process and helps in using innovative principles derived from TRIZ knowledgebase for asset management related developments. The methodology is depicted in **Fig 3.**

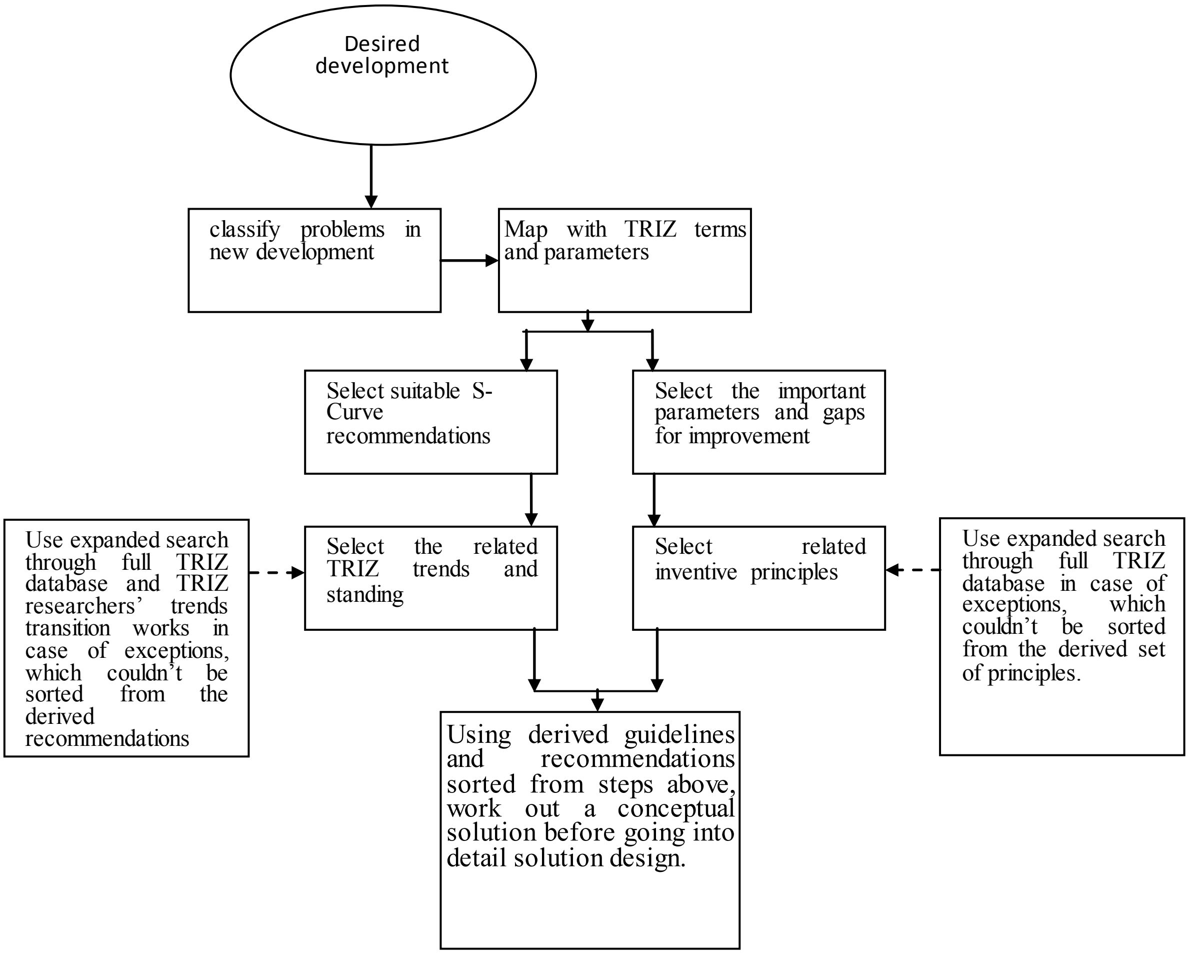

Fig. 3. Methodology chart for seeking new development related solution.

4. Summary

The paper presents a concept of guiding engineering solution seekers with innovative guidance and systematic solution hunting approach. Using capabilities and potential of TRIZ, the research shows a methodology to derive guidelines from TRIZ knowledgebase for the management of technical assets. Hence the approach makes the usage and application of TRIZ easier, more focused and more practical for management of technical assets. The solution seekers may consult the derived guidelines and recommendations for finding the potential gaps in the addressed engineering system. The solution seekers then may use the inventive problem related principles along with the recommended steps for possible improvements which are summarized in the generic framework, derived for asset management.

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