Journal of Theoretical and Applied Information Technology
15th January 2017. Vol.95. No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

A PROTOTYPE TO DETECT AND EFFICIENTLY RECTIFY FAULTS IN A SMART POWER GRID USING AN INTELLIGENT KNOWLEDGE BASED INFORMATION SYSTEM

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ABSTRACT

Enhancement in distribution and management of electrical energy systems is one of the prominent and equally promising aspects to any sort of economical development in a country. Though the researches to further enhance the production, distribution and management of electrical power energy is vast, addressing the loss and wastage of power energy due to faults that exists in the distribution of the electrical power is too vital. Within the adaptive frame work, we would like to present an archetype of an Intelligent Knowledge Based Information System, based on an advanced level of smart power grid technology; in order to identify and rectify the faults resulted in electricity distribution system and management of electric power under the hood of smart grid technology. The system would help analyze the detection of faults in the equipments of the electrical distribution system, rectify the type of fault and will address it to the relevant technical specialists who would be ready to provide support in the field. The model would work on mining of text correspondences between the electrical engineers and technicians in the field, which would be changed into certain smart power grid fault rules. These rules, with the help of computer intelligence, will then be used to extract the attributes of faults such as the type of fault, the fault location, severity of fault, and other relevant coincidences to help rectify the fault healing process within the earliest time frame through nearest available supporting technical specialists. The system would also address the mobile based application support to enhance the time coping immediate support services and operations. The main objective of the prototype is to analyze the identified faults and rectify the power faults in an electrical smart power grid network to its best utilization within available technological resources, to consecutively elevate the supply and boost the power quality. The epitome would be designed in consultation with technical experts experienced in the power field and later be generated into an Intelligent Knowledge Based Information System to be tested through an existing power distribution and management company to measure its applicability, feasibility and sustainability.

Keywords: *Power Distribution Faults, Mobile Workforce Management System, Smart Power Grid Technology, Knowledge Management Systems, Intelligent Knowledge Based Information System*

1. INTRODUCTION & STATEMENT OF THE PROBLEM

While electrical power energy is well produced, managed and appropriately distributed in developing countries, its further enhancement to more precise utilization with detection and rectification of faults, plays a vital role in the development of a nation as well. Simultaneously, saving the energy in various aspects be it technical, economic or achievable is directly related to energy efficiency potential based on the methodologies and postulations influence [5]. Above that, in today's world, with the added importance of electrical

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

energy usage in the development of commercial or private infrastructure, with the need of constantly changing needs of the community, and to sustain the operational efficiency, management of electrical energy need to be at high priority [7]. Various indulging and affecting critical factors include power and energy saving, safety and security, mismanagement, faulty meters, wastage of power resources, timely and appropriate fault detection and rectification, outage restoration & restitution, customer satisfaction, integration of resources, leading to efficient electricity transmission, condensed customer costs, diminished operational and administration costs for power distribution companies. Well balanced and efficient methodologies through the best available technological innovations and applications, with the refined support of intelligent smart power grid technology could help improve and overcome problems in all these indulging factors. Today inclusive of the change on weather and climatic conditions, whereby the community suffers lots of outage alerts due to unexpected and unfortunate adversities, the smart grid technology can play a further vital role in the enhancement of the overall structure of the given standards. The fault diagnosis methods could be broadly classified into three aspects of qualitative, qualitative and process based evaluation [6]. This study will focus mainly on the process based evaluation of technical loses of electric power and an effective and efficient process to handle the fault detection in smart power grid environment.

With an overview of smart grid technologies that includes sophisticated sensing tools, organizing methods and incorporated communications into the electrical grid intelligent approaches to detect and rectify power grid faults plays a vital role in today's competitive world [3]. Considering these critical factors in general, we look into proposing a prototype towards developing a system for an Intelligent Knowledge Based Power Grid Information System whereby the power distribution and management companies could slickly enhance its operations, incorporated through enhanced, proficient service and support with the help of intelligent smart grid technological applications, to identify and rectify the detection of power equipment faults or failure leading to various related factors such as faults power mismanagement, challenges in identifying complex leakage faults and its associated technical faults. With the evidence that online fault detection and tolerance methods with least manual intrusion could provide great benefit in operability of the electrical energy systems [8]. The prototype would lead to solutions related to timely management of the fault detection and rectification of these failures through Mobile Based Intelligent Applications, ensuring a smooth and unequivocal flow of transition in the field. Hence our prototype Intelligent Knowledge Based Information System (IKBIS) would ultimately lead to a development of an effective Mobile Workforce Management Systems (MWMS) design, whereby the power management companies and relevant authorities could be alerted and notified on emergent power interruptions and equipment failures, enabling them to provide timely support and solution resulting in improved customer satisfaction and cost benefits. We believe that any type of encumbrance to well-organized and desired flow of the power energy would directly or indirectly reflect with heavy and hefty penalties to the whole community such as financial loss, time loss, food and other energy loss, mismanagement of schedules and the most critical being the relevant loss in medical and life emergencies, in general affecting the entire communities life style.

The prototype would provide alternate solutions through computer based query language, to the cases where consecutive analysis of fault detection could be easily tracked and addressed to relevant authorized conduits for further execution and follow ups. The use of IKBIS to create, store and retrieve relevant data will be addressed as a core factor of this prototype. Various new developments in the power grid field along with the latest computer intelligence systems will be addressed. Issues such as the detection of fault in rural remote areas could also be managed with the self-sustainable magneto electric sensors, unlike traditional sensors, does not use the power cords or other signal indicators, and could be conveniently used for efficient fault detection [9]. With the operation of smart grid intelligent electronic devices for scrutinizing, managing, and fortification, supported by high alacrity broadband communications, the optimal fault location solutions will become the norm in the future grids, both at the transmission and distribution levels [3]. The capability to generate fault location results efficiently, reliably, and with high level of confidence would be the core smart grid constraint [3]. With this technological advancement in view, the system would also be optimized with an aim to help the Electricity Distribution Companies to effectively and efficiently manage analyze, identify,

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

rectify the power grid faults with minimal costs as compared to the traditional mode of evaluation. The flexibility to switch to distributed power generation through usage of various resources with its efficacy factors behind the power transmission load adjustments would also be seen forward.

The rationale to develop the research has been initiated with the fact that in spite of the technology at its peak with the resources available, it is seen that still the loss of energy has yet not been satisfactorily addressed by most of the power generation and distribution companies. This loss of energy occurred are due to the unfortunate mismanagement of the distributed energy sources such as delayed detection of faults and/or delayed expert responses to the faults. Simultaneously, the cost of solutions be it the technology or from the point of human aspects, to address these issues is also an important factor that negotiates the power distribution and management companies to step behind the scenes. Our proposed solution using the MWMS, in comparison, would be a feasible and cost effective solution, to efficiently and successfully handle the issues.

2. PROPOSAL PLAN

A smart grid being an arrangement of electro ostensible, communication and intelligent informatics technologies, the integration allows development of new fault spot technologies based on transient methods to efficiently locate the power faults with further reliability to prevent possible faults [10]. Being known that a smart power grid functions by activating the computerized intelligent features of an electrical power grid system, the benefit being to manage and utilize the power distribution loads as per the needs of the consumer, provide maximum automation during an outrage event and improve communication between the service providers and the consumer. Simultaneously, it also lowers the human intervention thereby reducing the cost, increased efficiency of power supply and related factors. Though the era of smart grid power technology is not too old, there had been various researches on the smart grid technology and its related consequences as well negative impacts, most importantly the techniques to efficiently handle its optimization and management [11].

We propose a prototype that integrates the technology of Knowledge Management System (KMS) with the established theoretical base of smart grid technology to identify, archive, manage, and disseminate the needed information to the right power grid workforce, through MWMS, at the right time. To achieve these tasks, the system analyses the power grid factors under various criteria using a range of smart grid components such as intelligent power appliances, smart power meters, smart substations, with smart distribution and smart generation capabilities. Our prototype would work on different parameters of the major power grid equipments, collect information of fault detections based on the specifications of the equipment. These fault detection parameters and its possible outcomes would be stored in a secured database which on query will be transferred to the nearest available specialized workforce to effectively tackle the fault problem. The proposed system would also address the threats affecting the security of a smart grid technology, which could exist as a consequence of sophisticated intrusion and imperceptible faults [12].

Upon detection of a fault in the electrical systems, the power grid equipments designed to rectify the faults starts functioning through providing relevant signals such as beeps, alarms, flash lights at the central control center of the power distribution and Management Company, notifying the existence of fault, as well the area and the equipment where the fault occurred. Traditionally, on such alert and notifications usually the power company calls and finds the workforce spending valuable time in just identifying the nearest workforce available around the faulty area. Consecutively, the identified workforce when it reaches the faulty area, equipment, they may not have the required tools necessary to rectify the fault, thereby leading to shutdown the power system in that area connected to that faulty equipment till it gets repaired or replaced or rectified, leading to wastage of time and resources. Therefore intelligent technologies need to be incorporated to address such issues effectively and efficiently, in comparison to the conventional techniques of fault findings, detection and rectification. Our prototype is designed to help increase the efficiency of fault addressing, reduce the rectification time simultaneously reducing the overall occurred cost, by identifying the type of fault in the equipment and identifying the nearest expert workforce alerting them on the type of fault in the detected equipment, helping the team to attend the incident inviting prior safety measures and possible rectification tools. The prototype would also take care of more complicated problems

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

too, occurred in terms of multi fault analysis and indications triggered by severe factors such as lightning strike, heavy rain and winds, fire and storm, floods, severe accidents, etc. whereby multiple fault signals at the control center would be crucially addressed.

3. INTELLIGENT KNOWLEDGE BASED INFORMATION SYSTEM (IKBIS)

A human brain could store millions or billions of sets of sophisticated knowledge and could deliver it at the right time and in the right situation [17]. But at certain stages as per its behavior, with lots of complex sets of information, it is obvious that a human brain could slip off due to confusion, stress or tension that could lead to unfortunate disaster ending up with tremendous loss too. Also there is a limit in which human brain could respond to various vastly addressed multiple situations, affecting the lapse of time and loss of accuracy. To overcome the problem of human error, time lapse, confused states, derivation of raw data into processed ones, and with an advantage to have fast access as well distribution of enormous quantity of processed data, in line with the requirement, a need of computational methods to emulate intelligence with logical reasoning, the need of artificial intelligence systems has been evident [2]. With the consideration in this regard, we propose to develop an intelligent expert information system, which would incorporate the intelligent capabilities of artificial intelligence research with the key concepts of knowledge based systems to store, process and retrieve the data, to be specified as Intelligent Knowledge Based Information System (IKBIS). IKBIS is basically an intelligent expert system designed basically to act like a human brain with sets of knowledge stored in its database hood. Evident that the expert systems which is a combination of knowledge based systems and artificial intelligence, used to make decisions in all sectors of business, science, engineering and other fields, to assess the field experts with situational assessment and long term plans [13], our IKBIS would make use of the expert system concepts by extracting the relevant knowledge from the human experts to derive formal representations, with a purpose to respond quickly to the experts and technicians, which traditionally would be too thorny, in the field. Though it cannot compete the human brain in terms of certain on the spot instincts, it simultaneously leads to an advantage of faster and quick processing and response factors as compared to human brain. Hence speed and accuracy is well addressed through IKBIS.

With the benefit over information quality, accuracy and error free effective communication compared to manual and miscalculated flat and verbal practices, our prototype would be designed with an aim to assign the right task to the right workforce equipped with the right resource and materials. The proposed model will capture, store and disseminate the knowledge to and from the database, created through relevant data gained and filtered from experts and technical workforce in the field. Both explicit and tacit knowledge need to be addressed though it is too complicated to capture and store tacit knowledge in the form of reliable data with the support of experts in the field. Tacit knowledge as it is too hard to be traced and code, and it being the complicated one to capture then exploit too, still is the main source to a key form of knowledge [1].

We are planning to incorporate the expertise of the team/workforce instructions and solutions to known problems in suitable defined database codes, which would help support the tacit knowledge to be recorded. A query language would be used to intercede with the database from which relevant queries from the workforce would be answered. The workforce would communicate and interact through mobile based application.

Technically, our proposed system would thus work on semantic web technology with linked data. It is an approach to link interrelated data between systems or entities widely available on the net. Through our system, it would equally share the mobile based platforms to share and disseminate relevant linked data for efficient services in the sector of smart power grid. The advantage of semantic web based technology with linked data being that, unlike traditional web based technology, the machines could also directly or indirectly proficiently read the contents in web pages for further processing of data [19].

4. MOBILE WORKFORCE MANAGEMENT SYSTEMS (MWMS)

With an added advantage of mobile management systems to keep track of users, data, locations, rapid extraction of reliable data anywhere anytime, allowing the controlling or management team to take effective decisions, as the information is available at the right time [14]. A Mobile

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Workforce Management System (MWMS), based on the structure of a mobile management system, would thus interconnect and help the workforce to effectively and efficiently communicate with each other as the hand held device is obviously considered as one of the key communication components and vastly available with any field workforce. The most advanced and instantaneous real time decision making process could be enabled through such system for an effective management of the given problem. The increasing use of intelligent tools is due to the fact that conventional techniques are not always able to achieve high accuracy rates of fault identification [4].

A MWMS will be useful for any workforce to interact, with their team members, subordinates and senior managers and update them with the relevant job statuses. It will thereby unify the entire team of the power company leading to provide best solutions for a given problematic situation. The real time MWMS will enable enhanced workforce team productivity, enhanced safety procedures, improved timely solutions, abridged travel distances in turn abridged fuel and effort consumptions, enhanced customer satisfaction, reduced occurring costs for the power company and in turn reflected reduced costs for the consumers too, effective return on investments, ascended profits. Again the costs when discussed in this regard, also need to consider the fact that the monetary expenses in comparison to social and environmental benefits is almost none or in other words the expenses dripped over the intelligent smart grid project in comparison to the benefits with the electricity system needed for the society [18].

5. OUR METHODOLOGY

As seen in Figure 1, the main structure of the IKBIS consists of the database, power control center, technical experts and the technical work force equipped with hand held mobile devices in which the interference engine would be a mobile application interface. IKBIS would be equipped with developed with an intelligent and expert MWMS application developed for the hand held device that in turn would be connected to a database designated as a backend support. The entire IKBIS would be connected through the power control center, workforce teams, experienced and technical experts on the smart grid. On an alarming situation, occurred due to power faults, the control center would intimate the entire workforces through the MWMS application. Along with its latitude and longitude coordinates, the control center will either pass over a geographical map with location of the fault to the workforces. On receipt of such contingency intimation all the nearest workforce group leaders will in turn respond with their adjacent availability, to the control center. The control center will immediately instruct/assign the closest available workforce to move to the fault location. Simultaneously the control center as well the workforce teams, through a standard query language, will be able to access the IKBIS database for the identified fault analysis and its possible solution/s. With the analyzed solution, a part of the workforce team could move ahead to the faulty location and the other part of the team would go towards collecting the needed resources and materials to rectify the fault. Once a fault is rectified and sorted, the workforce team will update the control center with complete status of the incident and resulted outcome/solutions which in turn will be referred back to relevant experts to ensure the rectified data availability and its consistency in the IKBIS database. Further future related work on assets and workforce management integrated with the IKBIS will enable help identify the resources and materials availability on various locations, workforce commitments, involvements, availability and priority factors, scheduling and tracking workforce assignments and jobs, travel guides/maps to reduce distances to the faulty power grid locations.

The database of IKBIS would be structured on various entities and its properties such as the equipment code, equipment name, price, brand, life expectancy period or age, height, length and its associated indication of fault analysis, possible reasons of fault analysis and relevant outcomes. As depicted in Figure 3, once the control center finds a faulty alarm or indication, it will pass over messages to all the relevant workforce teams and identify the nearest team close to the faulty location. During and after the process of finding the right workforce team, who also in turn would simultaneously search in the database through specific query for a possible solution to the alarming indication of the situation. The database on query will produce the results indicating the possible solution/s to the alarming/faulty situation. The workforce team can then move towards the site for rectification of the fault. Various equipments such as Feeder Transformer, Feeder Pillar, High Voltage Overhead Lines, High Voltage & Low Voltage Underground Cables and its fault detection

Journal of Theoretical and Applied Information Technology
15th January 2017. Vol.95. No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

and simultaneous analysis will be considered in the project.

Our methodology incorporates the use of Information Technology (IT) sources in the form of programming software used for the development of MWMS application. This application would run in parallel on IT based supportive devices such as the tablets, laptops, mobile phones, personal computers over a network of extensively used IT appliances.

5.1. High Level Architecture of the Proposed IKBIS

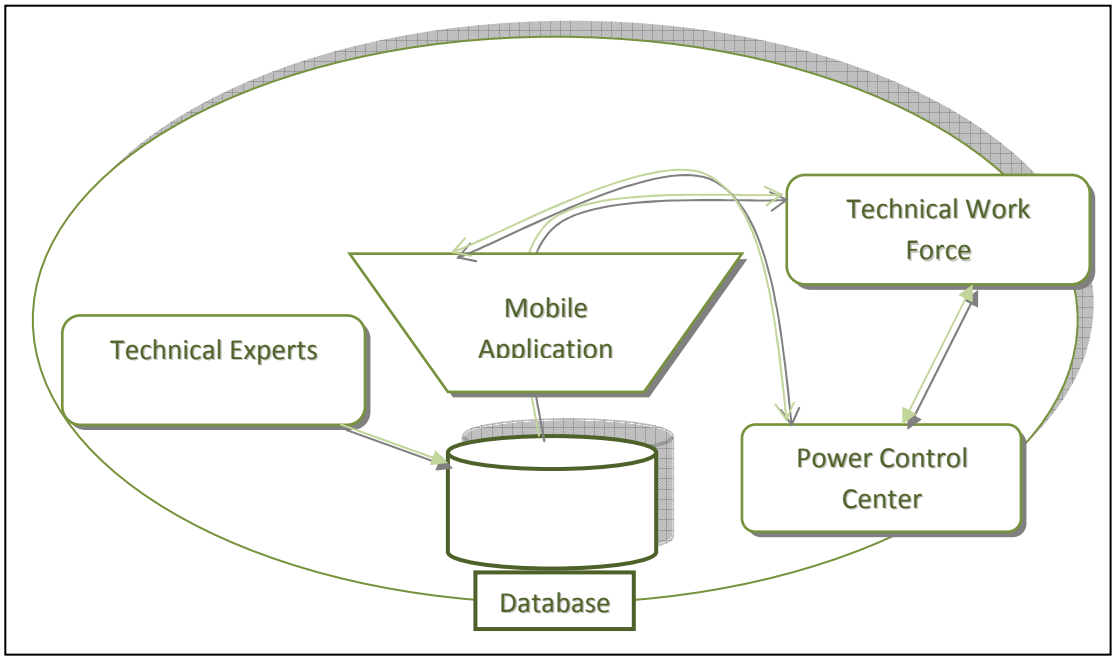

Figure 1. High Level Architecture of the Proposed IKBIS

A later development of Workforce Asset Management System(WAMS) is targeted to be incorporated with this system to keep track of all the assets such as transformers, feeder pillars, cables, sensors, High voltage and low voltage power cables, and other relevant electrical and electronic gadgets used with smart power grids. With a view on return on investments, it is seen from the prospective of more sociological and environmental impact rather than just monetary impacts, where negotiation or loss of monetary impact is not a major constraint in comparison to human lives or values. Still if seen from a different angle, the returns on investment from such platforms are much higher than what is expected, on a long run.

Though evident from various researches that official application of mobile computing into the field is just as meager as to say just around 15%, due to unfortunate barriers in the field [20].

This indicates that the barriers could relate to lack of information to the field technicians in the form of location, geographical constraints, technical data, references, assets, and other relevant information needed on customer's archives [20].

Our proposed system overcomes such barriers by having additional access to the technicians on all such facts needed to provide an efficient service in the field. The field technicians or technical workforce will have access to most of the back office information such as the geographical locations of the fault occurred, power equipment locations, online support from control center experts, online technical details of the smart power grid equipments. Other barrier factors to be addressed and considered are the strong telecommunications signals to access the web server, such as Wi-Fi even in remote areas or out of coverage areas, in which case a system to deliver relevant messages as soon as the telecommunication coverage is over line, could be enabled.

Journal of Theoretical and Applied Information Technology
15th January 2017. Vol.95. No.1

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

5.2. Technical Aspects of IKBIS

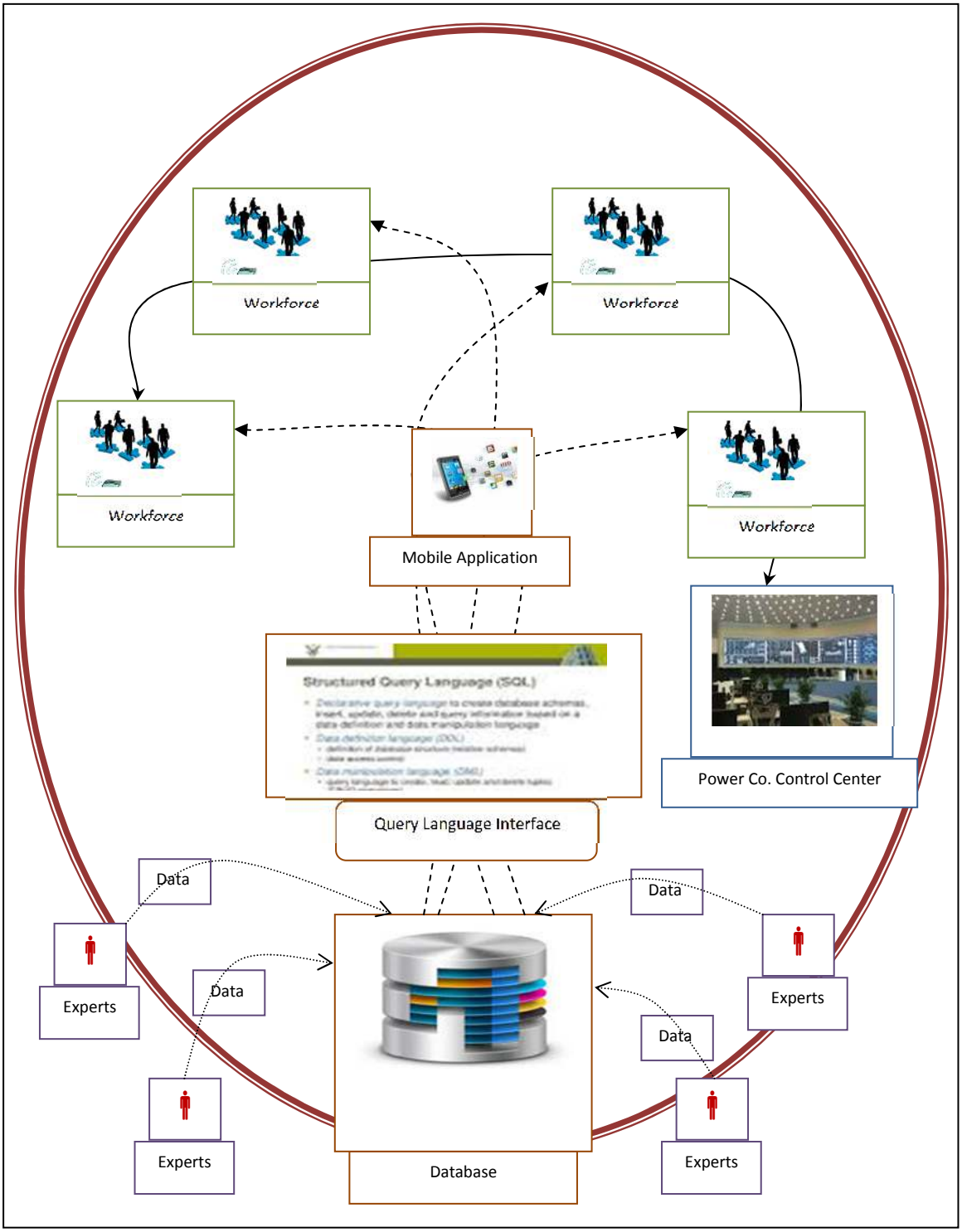

Figure 2. Technical Aspects of IKBIS

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

As depicted in Figure 2, the technical workforce teams should be online with the control center, the database and the semantic web enabled interface to detect and rectify the faults, such barriers that could lead to the system failure has to be considered and overcome in due processes. To enable a successful system, it is mandatory that the technical workforce would also have latest trends of extreme quality hand held devices that would not interrupt them in other forms such as low screen resolution, brightness, glare issues, battery charges, and lack of other high end features of electronic hand held devices.

With the fact that most experienced, dependable and efficient senior workers being at their retirement age, with a logic that they have not been indulged much with the technology based tools and equipments, but simultaneously occupying key useful knowledge and skills gained from their high end practice in the field [21], we suggest that implementation of IKBIS at an early stage would be highly recommendable as the key tacit knowledge gained by majority of these highly experienced and skilled senior experts before the stage of their retirement could be extracted to be stored in the IKBIS database, which could then be used as key trademarks for future fault detection, analysis and rectifications. As seen in Figure 2, the experts are hugely involved to feed in the relevant data to the IKBIS database all related to the fault detection and rectification of the smart power grid tools and equipments.

Figure 4 depicts an intended sample entity relationships model to a physical notation of the database with assumptions of IKBIS in use.

As mentioned in our proposed plan, the proposed IKBIS is also a targeted IT based Knowledge Management System (KMS) that would, using appropriate software's, make use of the relevant development of an IT application to efficiently store, manage and retrieve the data required to execute the operation.

The limitations are based on the assumptions that the power distribution and management company would be ready to invest in the software, hardware, people management and other occurring costs towards successful development and implementation of the mentioned MWMS and IKBIS. The company would consider the fact that the investment on the implementation of such system is much profitable, in comparison to the loss of energy, values and resources over a long run, widely benefiting the economy and community with higher social compensations too.

Journal of Theoretical and Applied Information Technology
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ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

5.3. Low Level Architecture of the Proposed IKBIS

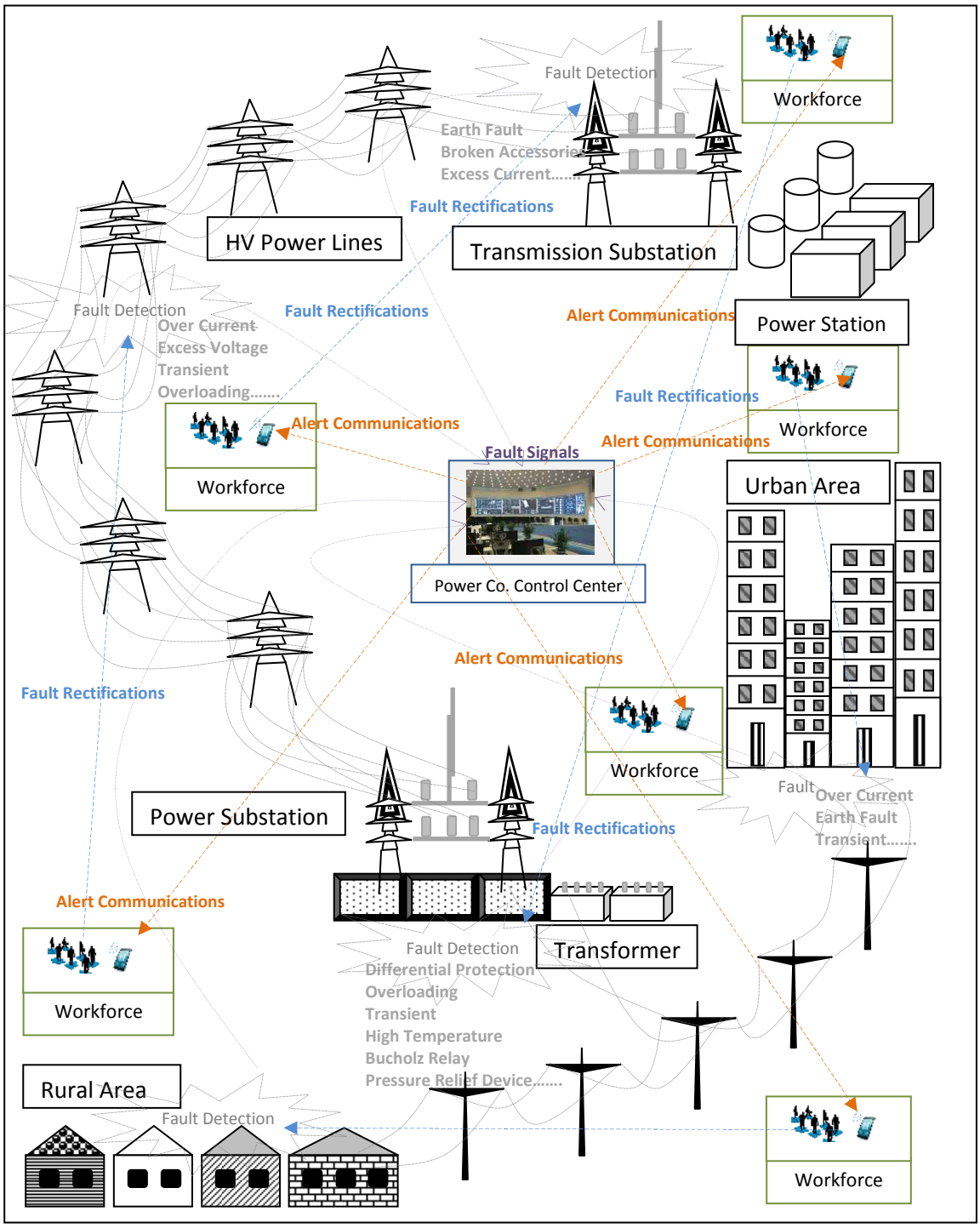

Figure 3. Low Level Architecture of the Proposed IKBIS

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ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

5.4. Entity Relationships Physical Notation

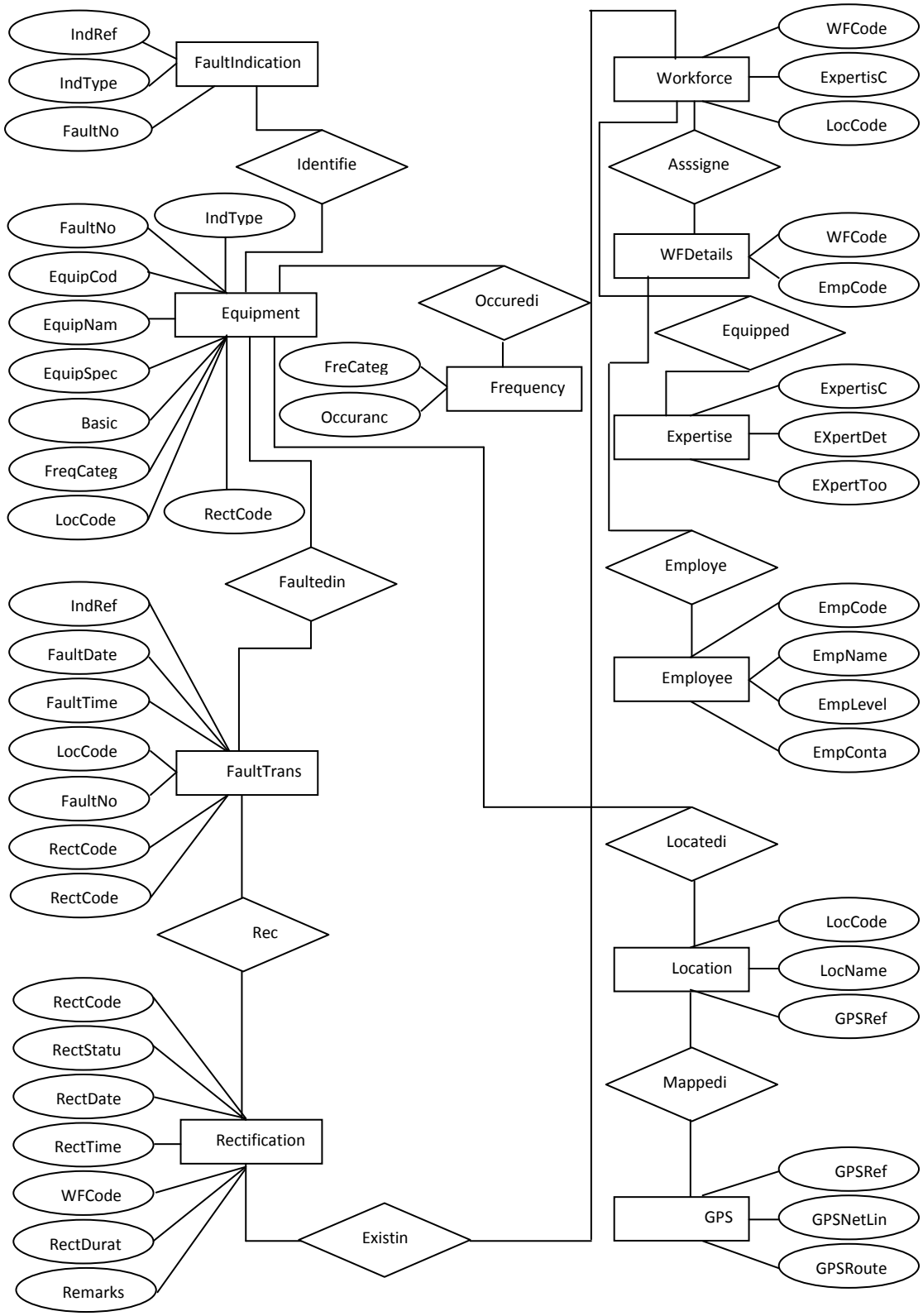

Figure 4. Entity Relationships Physical Notation

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

6. THE SPARQL QUERY LANGUAGE INTERFACE, ELEMENTS AND STRUCTURE

Since our system IKBIS follows the development of an intelligent expert system based on the structure of a knowledge management system, our data would be stored in descriptive collaborative format that need to be retrieved and manipulated using a Resource Descriptive Format (RDF), we propose to use an ontology based approach, using SPARQL, a query language protocol recommended for such developments [15]. The purpose of using this format is to have a very formal language which would help us to extract answers of meaning driven questions or in other words this format would help us translate or convert our meaning driven questions into sensible query able answers and outputs. The query would allow accessing the data stored in the format of subjective object. It therefore allows interacting with the subjective object through a database known as RDF store [16]. After adding the semantics to the RDF database, in order it to extract and or query relevant data, the triples of the database can be used using SPARQL. Similar to the query language statements used with traditional Structured Query Language (SQL), the data from the database set can be accessed using SPARQL, via statements like SELECT with optional conditional clauses such as WHERE to access relevant data in the form of graph pattern. These patterns consist of a subject, predicate and object triple to fit a corresponding match with the needed data. Variable names in this query language are usually prefixed with a sign of question mark (?) to match a nodule.

The basic generic format of the SPARQL language consists of a prefixes, result sets, data sets, triple pattern and modifiers. For example if we have a rdf database called equipment, referring to a web link such as <http://www.smartpowergridequipment.com/equipments>, by using the prefix equipment we can have the structure of the SPARQL language query as:

```
PREFIX
equipment: <http://www.smartpowergridequipment.com/equipments>
FROM
<http://www.smartpowergridequipment.com/equipmentdata/equipments.rdf>
SELECT ?ecode WHERE
{
?equipcode equipment:equipcode ?ecode.
}
ORDER BY ?ecode
```

Similarly the usage of CREATE, INSERT and UPDATE could be implemented as required by the technical dataset extract experts.

7. OUR METHODOLOGY IN TECHNICAL ASPECTS

In order to work out better with the SPARQL query language let's consider a triple data containing a variety of power grid equipments and their classifications, as seen in table1.

The given data consists of various types of power grid equipments such as transformers, feeder pillars, high voltage power lines, high voltage underground cables and low voltage underground cables. The subject represents a resource locator for equipments, predicate is the sheet index derived from the ontology of previously defined power grid equipments and finally the objects represents literal string values of equipments category.

If we need to write an SPARQL query to identify all the equipments from within the given data set, the statements would be:

```
PREFIX
equipment: <http://www.smartpowergridequipment.com/equipments>
SELECT * WHERE
{
?equipname equipment:sheetindex ?sheetindex
}
```

One of the key advantages of SPARQL is that it can also produce the outputs in XML format too. Refer the sample below as a result of the above query statement.

```
<?xml version="1.0" ?>
<sparql
xmlns="http://www.w3.org/2005/sparql-results#"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
<head>
<variable name="equipname"/>
<variable name="sheetindex"/>
</head>
<results>
<result>
<binding name="equipname">
```

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

```
<uri>http://www.smartpowergridequipment.com/equipments#transformer</uri>
</binding>
<binding name="sheetindex">
<literal> Powertrans</literal>
</binding>
</result>
<result>
<binding name="equipname">
<uri>http://www.smartpowergridequipment.com/equipments#feedpillar</uri>
</binding>
<binding name="sheetindex">
<literal>Feederpillar</literal>
</binding>
</result>
<result>
<binding name="equipname">
<uri>http://www.smartpowergridequipment.com/equipments#hvplines</uri>
</binding>
<binding name="sheetindex">
<literal>HighvoltOhl</literal>
</binding>
</result>
<result>
<binding name="equipname">
<uri>http://www.smartpowergridequipment.com/equipments#uhvcables</uri>
</binding>
<binding name="sheetindex">
<literal>Cables</literal>
</binding>
</result>
<result>
<binding name="equipname">
<uri>http://www.smartpowergridequipment.com/equipments#ulvcables</uri>
</binding>
<binding name="sheetindex">
<literal>Cables</literal>
</binding>
</result>
</results>
</sparql>
```

Another SPARQL query statement to identify the Cables sheetindex would be:

```
PREFIX equipment: <http://www.smartpowergridequipment.com/equipments
SELECT * WHERE
{
?equipname equipment:sheetindex "Cables"
}
```

On execution we would have the following XML output:

```
<?xml version="1.0" ?>
<sparql xmlns="http://www.w3.org/2005/sparql-results#"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
<head>
<variable name="equipname"/>
</head>
<results>
<result>
<binding name="equipname">
<uri>
http://www.smartpowergridequipment.com/equipments#uhvcables </uri>
</binding>
</result>
<result>
<binding name="equipname">
<uri>
http://www.smartpowergridequipment.com/equipments#ulvcables </uri>
</binding>
</result>
</results>
</sparql>
```

Since in the above query statement, we have replaced the “?sheetindex” variable from our WHERE clause, our two matching patterns, uhvcables and ulvcables, in the triple with the literal value “Cables” would be selected as they relate to the “Cables” sheetindex. Thus our query being more specific in this regard.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Table 1. Triple Data Containing a Variety of Power Grid Equipments

Subject	Predicate	Object
http://www.smartpowergridequipment.com/equipments#transformer	http://www.smartpowergridequipment.com/equipments#sheetindex	Powertrans
http://www.smartpowergridequipment.com/equipments#feedpillar	http://www.smartpowergridequipment.com/equipments#sheetindex	Feederpillar
http://www.smartpowergridequipment.com/equipments#hvplines	http://www.smartpowergridequipment.com/equipments#sheetindex	HighvoltOhl
http://www.smartpowergridequipment.com/equipments#uhvcables	http://www.smartpowergridequipment.com/equipments#sheetindex	Cables
http://www.smartpowergridequipment.com/equipments#ulvcables	http://www.smartpowergridequipment.com/equipments#sheetindex	Cables

8. CONCLUSION

The research has been carefully planned and developed in multiple discussions and overview with technical experts active in the field, on identifying the existing problems that arises in managing the fault detections in a smart grid. The discussion had been widely focused on the issues related to the current traditional strategies used to address various faults in a smart grid, leading to cause delays in identifying those faults. With articulated understanding that the power management companies lack sufficient technological and innovative applications and implementations to address these issues, we propose to provide a feasible and effective solution to address these faults using the mentioned MWMS integrated with IKBIS. In order to implement the proposed solution, the power management and distribution company need to work out their viability on running assets such as hardware and software system setup, employees training and professional development, along with other relevant equipments needed in the execution of the research. We believe that the research will significantly contribute towards an effective development to efficiently address all the fault detection issues, currently existing in the management of a smart power grid technology.

From the technical point of view, since it is too vital to trace and extract the tacit knowledge from senior experts, we suggest that implementation of IKBIS at an early stage would be highly recommendable as the key tacit knowledge gained by majority of these highly experienced and skilled senior experts before the stage of their retirement could be extracted to be stored in the IKBIS database, which could then be used as key trademarks for future fault detection, analysis and rectifications. Secondly an additional development of Workforce Asset Management System(WAMS) is targeted to be incorporated with this system to keep track of all the assets such as transformers, feeder pillars, cables, sensors, High voltage and low voltage power cables, and other relevant electrical and electronic gadgets used with smart power grids. With a view on return on investments, it is seen from the prospective of more social and environmental impact rather than just monetary impacts in the benefit of the community, where negotiation or loss of monetary impact is not a major constraint in comparison to social benefits. Still if seen from a different angle, the returns on investment, from monetary point of view, from such platforms are much higher than what is expected, on a long run.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

REFERENCES

[1] Kiku Jones, Lori N. K. Leonard, From Tacit Knowledge to Organizational Knowledge for Successful KM, Springer Science+Business Media, LLC 2009
[2] Oxford University Press, Janak Shastri, Review: Benefits and Risks of Knowledge Based Systems, 1989
[3] Mladen Kezunovic, Smart Fault Location for Smart Grids, 2011
[4] Ivan N. da Silva, Carlos G. Gonzales, Rogério A. Flauzino, Paulo G. da Silva Junior, Ricardo A. S. Fernandes, Erasmo S. Neto, Danilo H. Spatti and José A. C. Ulson, Intelligent Systems for the Detection of Internal Faults in Power Transmission Transformers, 2012
[5] Maggie Molina and Neal Elliott, Energy Efficiency Potential in Ohio, 2015
[6] Venkat Venkatasubramanian, Raghunathan Rengaswamy, Kewen Yinc, Surya N. Kavuri, A review of process fault detection and diagnosis, 2003
[7]http://www.albireoenergy.com/fault-detectiondiagnostics.html
[8] Y. Wang, X. Lin, M. Pedram, N. Chang, Online fault detection and fault tolerance in electrical energy storage systems, 2014
[9] Derek Or Siu-wing, Detection of electrical faults in hard-to-access locations, 2014
[10] S. Gudzius, L. A. Markevicius, A. Morkvenas, Characteristics of Fault Detection System for Smart Grid Distribution Network, 2011
[11] Sanket Raval, Parth Suthar, Fault Detection Method for Smart Grid, 2014
[12] Qian He, Rick S. Blum, Smart Grid Fault Detection Using Locally Optimum Unknown or Estimated Direction Hypothesis Test, 2011
[13] Szakwani, Expert System and Knowledge Based Systems, 2007
[14]http://usresources.com/resource-articles/cloud-service-articles/mobile-device-management/
[15]https://en.wikipedia.org/wiki/SPARQL
[16]https://en.wikipedia.org/wiki/Triplestore
[17]http://www.telegraph.co.uk/news/science/science-news/12114150/Human-brain-can-store-4.7-billion-books-ten-times-more-than-originally-thought.html
[18]http://ses.jrc.ec.europa.eu/smart-grid-cost-benefit-analysis
[19] https://en.wikipedia.org/wiki/Semantic_Web
[20] Teresa Hansen, Mobile Computing Moves Beyond Dispatching and Scheduling, 2000
[21] Oracle Whitepaper at Oracle Utilities, Mobile Workforce Management and the Aging Utility Workforce, 2010
[22] Vatcharaphun Rajsiria, Jean-Pierre Lorréa, Fréderick Bénabenb, Hervé Pingaudb, Knowledge-based system for collaborative process specification, 2009