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3.3.2 Number of books and chapters in edited volumes/books published and papers published in national/ international conference proceedings per teacher during last five year

Sl. No.	Name of the teacher	Title of the book/chapters published	Title of the paper	Title of the proceedings of the conference	Name of the conference	National / International	Year of publication	ISBN number of the proceeding	Affiliating Institute at the time of publication	Name of the publisher
1	Korra Srinivas,Dr.joseph Prakash Mosiganti		Rural Banking Based Cloud Computing Analysis		International Conference On Research In Management,Engineering Science and Technology	International	Feb-18		Visvesvaraya College Of engineering and technology Analysis	IJRDST
2	Korra Srinivas,Dr.joseph Prakash Mosiganti		Cloud Technology Applications On rural Banking		International Conference on Recent Advancement in Computer Science Technology	International	Apr-18		Dhanekula institute of engineering and technology	IJIEMR
3	Korra Srinivas,Dr.joseph Prakash Mosiganti		Analysis of Rural Networks Based Cloud Computing		International Conference on Emerging Trends on Engineering Science,Technology and Management	International	Nov-18		Aditya Institute of Technology and Management	IJARST

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4	Dr.Y V Balarama Krishna Rao		Implementation of ANN Trained Voltage Control Scheme for Grid islanded DG sytem		International Conference on Advances in Smart Sensor,Signal Processing and Communication Technology	International	19-20 ,March 2021	1921 (2021) 012057 doi:10.1088/ 1742-6596/1921/1 /012057	Scient Institute of Technology	IOP
5	Dr.Y V Balarama Krishna Rao		Optimal Solution of Economic Load Dispatch Using Teaching Learning Algorithm		International Conference on Artificial Intelligence and Smart Systems	International	25-27,March 2021	978-1-7281-9538-4	Scient Institute of Technology	IEEE
6	Dr.Y V Balarama Krishna Rao		A Solution to Economic Load Dispatch using Ant colony Search based-Teaching Learning Optimization		International Conference on Emerging Trends in Industry 4.0	International	19-21,May 2021	978-1-6654-4663-1	Scient Institute of Technology	IEEE

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7	Dr. G. Anil Kumar		Internet of Things based Data Security Management using Three Level Cyber Security Policies		International Conference on Advances in Computing, Communication and Applied Informatics	International	28-29 January 2022	978-1-6654-9529-5	Scient Institute of Technology	IEEE
8	Shaik Mohammed Shafiulla		Security Enhancements for Software Defined Network	International Conference on Recent Challenges in Engineering, Science and Management	International Conference on Recent Challenges in Engineering,Science and Management	International	4th June 2022		Scient Institute of Technology	ICRCESM
9	Dr.G.Anil Kumar	An impact of Robust Industry 4.0 strategy onsupply chain management				International	2022	978-3-11-077149-7	Scient Institute of Technology	De Gruyter

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1. **Name of the teacher**: KORRA SRINIVAS, DR. JOSEPH PRAKASH MOSIGANTI

Title of the Paper: RURAL BANKING BASED CLOUD COMPUTUING ANALYSIS

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INTERNATIONAL CONFERENCE ON RESEARCH IN MANGEMENT, ENGINEERING SCIENCE & TECHNOLOGY
VISVESVARAYA COLLEGE OF ENGINEERING AND TECHNOLOGY HYDERABAD

RURAL BANKING BASED CLOUD COMPUTUING ANALYSIS

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ABSTRACT
According to the United Nations, almost 50 percent of world population and more than 70 percent of that of developing countries are living in rural areas. Majority of this population live in poverty especially in North and sub Saharan Africa. Rural population face unique problems compared to their urban counterparts in terms of access to technologies, infrastructure, markets and social services. Experts have identified ICT as the tool for overcoming the inefficiencies in traditional methods for the empowerment of rural masses. In this paper, we study how cloud computing can be used to meet the ICT requirements for rural development in terms of opportunities and challenges of implementing and using the new technology.

1 INTRODUCTION

Cloud computing is internet-based computing, where shared servers provide computing power, storage,development platforms or software to computers and other devices on demand. This frequently takes the form ofcloud services, such as 'Infrastructure as a Service' (IaaS), 'Platform as a Service (PaaS)' or 'Software as aService' (SaaS). Users can access web-based tools or applications through a web browser or via a cloud-basedresource like storage or computer power as if they were installed locally, eliminating the need to install and runthe application on the customer's own computers and simplifying maintenance and support. There are severalpossible deployment models for clouds, the most important being public, private and hybrid.[1]

Cloudcomputing is the fastest growing field that provides many different services, which are provided on demand ofthe client over the web. Cloud computing is based on the model of pay-as-you-go.This gives the user cost reduction, fast and easy way to deploy the applications. Cloud computing usage in theInformation Support Systems will facilitate businesses to run smoothly and efficiently. A number of virtual machines and applications can be managed very easily using a cloud. With the use of cloud in businesses willnot only save the cost of staff required to maintain servers, but will also require lesser servers and with that lesspower consumption. [2]

The most important sector which requires a lot of information, data and computing power is healthcaresystem. Doctors require medical history of the patients in critical times and within no time. But we see thatdifferent departments of a healthcare system has have different information of the patients medical history, withrequire time to get assembled. Doctors have to start the treatment without the complete information of patient'smedical history, which sometimes, is life threatening for the patient. Technologies could be used in healthcaresector to provide better healthcare facilities and reduce the operations costs. In our country we see that there isscarcity of doctors, nurses and pharmacy. But still there is rapid growth in healthcare services, while diseasesare becoming more complex. More and more new and efficient diagnostic techniques and new way oftreatments are being developed and used in healthcare sector so as to provide the patients with best possibletreatment and in their budget. Many healthcare organizations are providing different kind of services to cater tohighly diversified economic population which in turn has resulted in competition in the market. So theorganizations which do not perform well are out of business. [3][4]

As healthcare providers need cost effective automating processes which gives more profits, cloud computingwill provide perfect platform in the healthcare information technology space. Many hospitals may shareinfrastructure with large number of systems linked together. By this pooling the hospitals automatically reducethe cost and increase utilization. The resources are delivered only when they are required. This also means real-timeavailability of patient information for doctors, nursing staff and other support services personnel from anyinternet enabled device [5].

The recent capture of a group of 50 defrauders using fake invoices to claim medical reimbursement in China's Guangxi Zhuang Autonomous Region revealed loopholes in the country's New Rural Cooperative Medical Scheme (NRCMS). According to Xinhua, China's state media, the scheme has enabled 98 percent of therural population to receive 60 to 100 percent of medical coverage after submitting an annual fee of 60 yuan (about 10 U.S. dollars). Despite of its benefits, the program has been criticized for lacking a national information sharing network to prevent misappropriation of rural residents' funds, guarantee the safety of sensitive medical data, as well as facilitate migrant workers to receive reimbursement in cities where they currently reside. Facing poverty and the many structural deficiencies, rural communities are facing immense challenges as they overcome their disadvantages to diffuse cloud technology in the medical insurance system.

2. LITERATURE REVIEW

This paper also describe some approaches of E-learning service. Like E-learning program based on computer, computer based training and effective approach is computer supported collaborative learning approach CSCL focuses on behaviour of student in classroom, sharing of information R.kamala, E.ramganesh, (2013) In this paper describe effective to contribute of cloud computing in education in various method. Cloud computing offer more beneficial and reliable services to user like high returns on investment, reduces maintenance cost, flexible infrastructure etc. this paper also describe many application that regard to improve educational environment. Amazon cloud service are the most extensive cloud service to provide resizable compute capacity. Microsoft educational cloud computing are of about power of choice . A hybrid model of resources it also provide ability to use same Microsoft technology in the educational institution. Microsoft@edu it is popular browser to support tools for student as well as researcher. Another popular application of cloud is GAE (Google Application for Education)it is more popular for sharing educational idea for staff, teacher, student it available on free of cost. This paper also describe IBM cloud services it offers design to help education system and also provide services to faculty, student, researcher at school, collages and university. Salesforce is another pioneer application of cloud . it is trusted leader in cloud and CRM it provide big discount on educational product R.kamala and E.Raganesh(2013) This paper describe knowledge about specific learning disabilities among teacher, educator in puduchery. In classroom teaching there are all student intelligence quality are not same and also many learning disability problem are faced by student. This paper indicate proper method to reducing and knowing learning disability . investigators developed a closed ended questionnaire which consist of 35 item four dimension were taken namely dyslexia, dysgraphia, dyscalcula and behavaral problem of specific learning disabled student. Vaishnavi.J.Deshmukh et.al.(2013): In this paper describe. the architecture or cloud computing .this paper describe method to improve current education system or traditional education system an adaptive e-learning system designed. in this paper adopt B/A/S Model namely Browser/Agent/Server Model. Adaptive E-learning System structure are build to solving the problem of integration , interexchange and demonstration of multimedia this paper also discuss business and dataflow of adoptability test in adoptability Elearning system to compare the traditional computing and cloud computing. this paper bind the traditional learning to modern cloud based learning. Cloud based E-learning can not completely replace the teacher. it is only updating for technology. modified system architecture can combine cloud environment and institution. This paper also explain the benefits of proposed cloud architecture like, powerful computing storage capacity , high avability , high security, virtualization. Madhumathi.c and Gopinath ganpathy(2013): Cloud based learning provide new pathway from traditional learning to solve existing learning disabilities in rural education. This paper describe characteristics of cloud computing like any time, any where and any device. this paper also introduce ho cloud computing environment is useful for universities, colleges and academic environment of school. This paper also introduce a academic framework that addresses the services and deployment of cloud and each layer of this framework specifies component needed to academic cloud. Kamal Dhull(2013): Development of country is depends on education system of that country. Education contributes to poverty reduction and increase economical growth. This paper describe eLC model it offer software development platform for E-learning task management. eLC is based on model view controller design pattern paradigm. This paper introduce a new shared pool environment for university, colleges, and school. Subodh Kumar(2013) This paper describe behaviour disorder of children and also focus on learning disabilities. This paper conclude that while planning intervention program for children with behaviour disorder one has to take care of their learning disabilities .this paper can give new broad way of thinking about effective education which incorporate strategies for learning disabilities and behaviour disorder intervention. M.Sanir Abou EI-Seoud et.al.(2013): This paper describe effective web based education in Egypt through cloud and there positive effect on higher education. Cloud based E-learning solved the problem of transportation, high prices of traditional educational books, over crowded classroom and providing educational resources over internet in low cost. This paper also analyse growth of internet user and there purpose . individual user 46.03 % people uses internet for educational aspect in Egypt. the yearly growth rate of internet user in February 2012 is 29.37%, January 2013 is 32.49% and in February 2013 is 32.67 the annual growth rate of internet user is 11.24% cloud based E-learning enhance traditional E-learning system activities for improving learning system. Larib nasir et.al.(2013): In this paper author just want to checkout the writing skill of sample student. Then his question arising there how we can improve the writing skill of some sample student. The intervention prove to bring out significant improvement is the enhancing the writing skill of the sample student.

3. PROBLEM DEFINITION

3.1 INTRODUCTION

Cloud computing is used by IT Services companies for the delivery of computing requirements as a service to a heterogeneous community of end-recipients. The vision of computing utilities based on a service provisioning model anticipated the massive transformation of the entire computing industry in the 21st century whereby computing services will be readily available on demand, like other utility services available in today's society. Similarly, users need to pay providers only when they access the computing services. In addition, consumers no longer need to invest heavily or encounter difficulties in building and maintaining complex IT infrastructure.

In such a model, users access services based on their requirements without regard to where the services are hosted. This model has been referred to as utility computing, or as Cloud computing. The latter term denotes the infrastructure as a "Cloud" from which businesses and users can access applications as services from anywhere in the world on demand. Hence, Cloud computing can be classified as a new paradigm for the dynamic provisioning of computing services supported by state-of-the-art data centers that usually employ Virtual Machine (VM) technologies for consolidation and environment isolation purposes .

Cloud computing delivers infrastructure, platform, and software (applications) as services, which are made available to consumers as subscription-based services under the pay-as-you-go model. In industry these services are referred to as

- Infrastructure as a Service (IaaS)
- Platform as a Service (PaaS), and
- Software as a Service (SaaS)

Clouds aim to drive the design of the next generation data centers by architecting them as networks of virtual services (hardware, database, user-interface, application logic) so that users can access and deploy applications from anywhere in the world on demand at competitive costs depending on their QoS (Quality of Service) requirements .

Clouds are virtualized datacenters and applications offered as services on a subscription basis. They require high energy usage for its operation. Today, a typical datacenter with 1000 racks need 10 Megawatt of power to operate, which results in higher operational cost. Thus, for a datacenter, the energy cost is a significant component of its operating and up-front costs. According to a report published by the European Union, a decrease in emission volume of 15%–30% is required before year 2020 to keep the global temperature increase below 2 C. Thus, energy consumption and carbon emission by Cloud infrastructures has become a key environmental concern

3.2 Green Computing

Green computing is the eco-friendly use of computers and related resources. Such practices include the implementation of energy-efficient central processing units, servers, peripherals as well as reduced resource consumption and proper disposal of electronic waste.Green computing is a study and practice of designing , manufacturing, using, and disposing of computers, servers, and associated subsystems—such as monitors, printers, storage devices, and networking and communications systems—efficiently and effectively with minimal or no impact on the environment." The goals of green computing are similar to green chemistry; reduce the use of hazardous materials, maximize energy efficiency during the product's lifetime, and promote the recyclability or biodegradability of defunct products and factory waste. Research continues into key areas such as making the use of computers as energy-efficient as possible, and designing algorithms and systems for efficiency-related computer technologies.

There are several approaches to green computing namely

- Algorithmic efficiency
- Resource allocation
- Virtualization
- Power management

3.2.1 Need of green computing in clouds

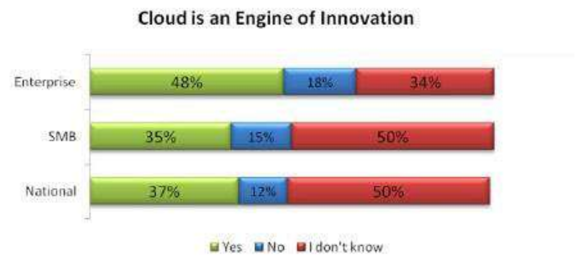
Modern data centers, operating under the Cloud computing model are hosting a variety of applications ranging from those that run for a few seconds to those that run for longer periods of time on shared hardware platforms. The need to manage multiple applications in a data center creates the challenge of on-demand resource provisioning and allocation in response to time-varying workloads. Normally, data center resources are statically allocated to applications, based on peak load characteristics, in order to maintain isolation and provide performance guarantees. Recently, high performance has been the sole concern in data center deployments and this demand has been fulfilled without paying much attention to energy consumption. The average data center consumes as much energy as 25,000 households. As energy costs are increasing while availability dwindles, there is a need to shift focus from optimizing data center resource management for pure performance to optimizing for energy efficiency while maintaining high service level performance. According to certain reports, the total estimated energy bill for data centers in 2010 is $11.5 billion and energy costs in a typical data center double every five years.

Data centers are not only expensive to maintain, but also unfriendly to the environment. Data centers now drive more in carbon emissions than both Argentina and the Netherlands. High energy costs and huge carbon footprints are incurred due to massive amounts of electricity needed to power and cool numerous servers hosted in these data centers. Cloud service providers need to adopt measures to ensure that their profit margin is not dramatically reduced due to high energy costs. For instance, Google, Microsoft, and Yahoo are building large data centers in barren desert land surrounding the Columbia River, USA to exploit cheap and reliable hydroelectric power.

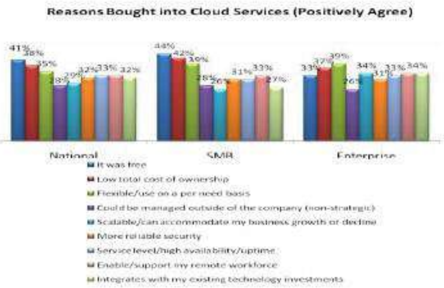
Lowering the energy usage of data centers is a challenging and complex issue because computing applications and data are growing so quickly that increasingly larger servers and disks are needed to process them fast enough within the required time period. Green Cloud computing is envisioned to achieve not only efficient processing and utilization of computing infrastructure, but also minimize energy consumption. This is essential for ensuring that the future growth of Cloud computing is sustainable. Otherwise, Cloud computing with increasingly pervasive front-end client devices interacting with back-end data centers will cause an enormous escalation of energy usage.

4. RESULTS AND DISCUSSION

Slightly more than one-third of SMB ITDMs believe cloud is an engine of innovation, but that percentage is far fewer than that of the Enterprise, with nearly half agreeing.While low cost of total ownership motivates the ITDMs nationally, SMBs appear a reason to buy intocloud services is because it's free. Enterprise companies show more concern for total cost of ownership.

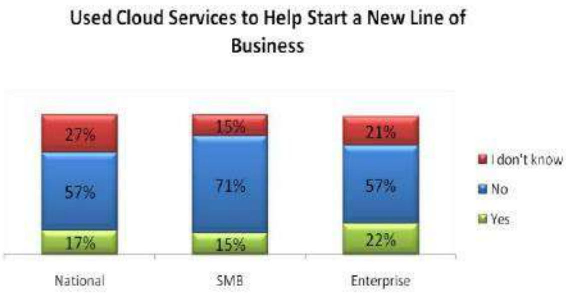


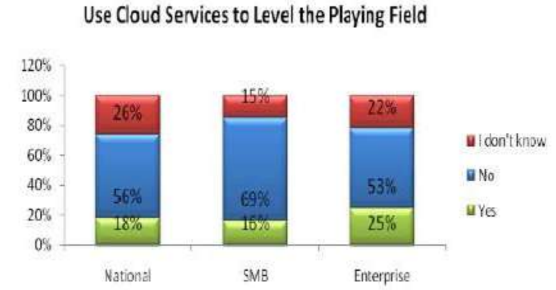
For those SMBs that already bought into cloud more than two-fifths (44%) say they did so because it was free. Total cost of ownership (42%) is also mentioned as a reason to buy cloud services.Flexibility and usage on a per need basis is cited by SMBs and Enterprises in equal percentages, however, this reason is selected most often by ITDMs at Enterprise businesses.

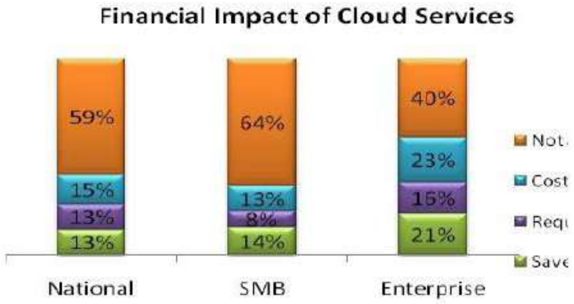


Regardless of size of company, only around 10% of ITDMs say they've used cloud services to help start anew business. A high percentage (approximately three-quarters) of respondents have not.

On average, the majority of respondents have not realized the potential of starting a new line ofbusiness using cloud services as only 15% of SMBs and 22% of Enterprise businesses have done so.Approximately the same percent claim to have used cloud services to level the playing field.Of those implementing cloud services, ITDMs at SMBs claim their company has saved money versusrequiring more budget.

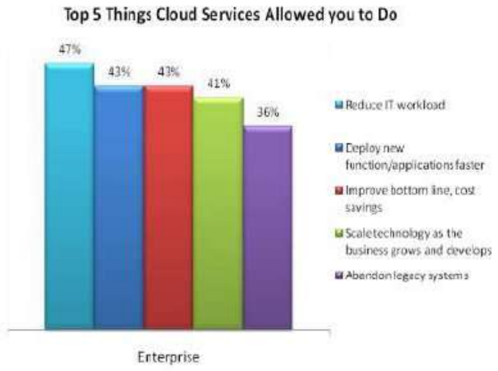






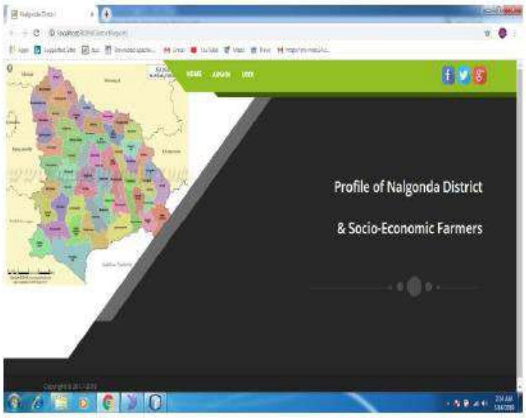
Cloud Services will Impact Hiring Practices

While both company-size segments agree that the IT workload was reduced, the bottom line saved and faster deployments were achieved, SMB ITDMs say cloud services provided increased security (45%) and ensure the latest versions of technology (41%). Enterprise ITDMs were able to abandon legacy systems (41%) and scale technology with the business (36%).



Cloud computing provides elastic, scalable, on-demand services through CSPs to consumer over the Internet. The cloud provides applications online that can be directly utilized by users, including platform and infrastructure for delivering services. There are clouds that can serve an organization, a dedicated group or a combination of groups. E-governance aims at delivering effective and efficient services through government to business, citizen and other government agencies. The cloud provides the enabling environment and infrastructure to handle the enormity of E-governance activities. E-governance can leverage on the cloud to offer services using the different cloud services types, in particular the SaaS. Several countries are using the concept of E-governance and some have adopted cloud computing in government. The cloud will continue to be relevant to individuals, businesses and government. Further work can be done in terms of Therefore, the paper recommends that various agencies of local, state and the federal government leverage on the advantages of cloud computing to improve service delivery and enhance the performance of government.

5. RESULTS



CONCLUSION AND FUTURE WORK

Cloud computing is a technology of rapid development, however security problems have become obstacles to make the cloud computing more popular which must be solves. This paper proposed a security model and framework for secure cloud computing environment that identifies security requirements, attacks, threats, concerns associated to deployment of the clouds. At the same time cloud computing technology is not just a technical problem, it is also involves standardization, supervising mode, laws and regulations, and many other aspects, cloud computing is accompanied by development opportunities and challenges, along with the security problem be solved step by step, cloud computing will grow, the application will also become more and more wide.

Future research should be directed towards the management of risks associated with cloud computing. Developing risk assessment helps organizations make an informed decision to whether cloud computing is currently suitable to meet their business goals with an acceptable level of risks. Research should be persued finding methods for qualitative and quantitative risk analysis in cloud computing. These methods should enable organizations to balance the identified security risks against the expected benefits from cloud utilization.

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2. **Name of the teacher**: Korra Srinivas,Dr.Joseph Prakash Mosiganti

Title of the Paper: Cloud Technology Applications On rural Banking

Link: https://ijiemr.org/public/uploads/paper/2309_approvedpaper.pdf

CLOUD TECHNOLOGY APPLICATIONS ON RURAL BANKING

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ABSTRACT

ICT are transforming all human activities, including agriculture which is the mainstay of rural India. ICT is a powerful and productive system which can accelerate economic and social development in rural areas. We discuss in this issue, how this new age technology is helping rural India live a better life. Cloud computing can be helpful for the rural development in terms of rural population in overcoming the huge costs incurred the infrastructure and software. It can be lead rural area development as well as economic progress of nation. In India 73% population lives in the rural areas and villages . The cloud computing to reduce price will create a world without poverty.

1. INTRODUCTION

ICT is transmits information and knowledge to individual to widen their choices for economic and social empowerment. Importance of ICTs for Rural Development in national development, countries across the globe have put in place mechanisms such as Universal Service Funds and other forms of Government intervention to achieve Universal Access to ICTs. ICTs people in rural areas can connect with the local, regional and national economy and access markets, banking/financial services and employment opportunities. India still breathes in villages and this becomes obvious when the fact is taken into consideration that more than 700 million of its population reside in about 636 thousand villages of this country.

2. SIX BIG BENEFITS OF THE CLOUD:

2.1 Less Cost: Cloud computing means banks will not have to invest heavily in dedicated hardware, software and related manpower. It is much easier for them to update their IT infrastructure and the cloud's modular, pay-on-demand model means they pay only for the hardware and software they need.

2.2 Improve flexibility and scalability: Cloud gives banks the ability to respond quickly to changing market, customer and technological needs. They can scale up and scale down technology according to requirement. The ability to respond quickly will be an important competitive edge.

2.3 Increase efficiency: Banks will enjoy improved efficiency ratios and operating leverage. The standardisation inherent in the cloud could makes it easier to integrate new technologies and applications in the future. Because technology and business operations can be much more closely aligned, the cloud gives banks a golden opportunity to drive out complexity.

2.4 Serve clients faster: Cloud computing makes new and bundled products and services easier to develop and launch, either on a stand-alone basis or in partnership. It eliminates procurement delays for hardware and software. Banks will be able to boost computing power to meet demand peaks and provide the latest treasury solutions without needing to worry about whether the technology is up to date. Corporates will be able to access bank systems using web browsers from anywhere at any time.

2.5 Good client relationships: The combination of big data and potentially unlimited computing power will allow banks to develop systems capable of providing better insight into clients and make better decisions on their behalf. Services could become more customised.

3. PROPOSED SYSTEM

The cloud plays a key role in the bank's efforts to transform its business and operating model. From a technical viewpoint, the cloud automatically assembles, integrates and configures technology resources to meet business goals. In business terms, it eliminates the need for a physical infrastructure to be present at each location from where the bank operates, thus making it easier for the bank to deploy services rapidly and at a lesser cost. Owing to its enhanced computing power and capacity, the cloud can store information and real time data about customer preferences that can help a bank in product and/or service customization. Using this stored information, the banks can personalize customer interactions and offer their customers a unique experience. The cloud can also help banks to streamline operations. By aligning business, operations and technology, it enables banks to drive higher growth and profit margins and increased flexibility. The cloud also helps banks to scale up IT resources on-demand for expanding its business operations. Banks can also respond to customer and market demands much faster and rapidly adjust processes, products and services to suit the changing needs. This creates an environment of innovation, competitive differentiation and also speeds up time to market. Banks are offering Internet banking and moving the payment function to the cloud, simply because of the great promise of cost savings, efficiency and reliability. By moving the payment function to cloud, banks can fend off the threat of disintermediation from Telco's and other mobile payment service providers. Payments are a huge source of revenue for the banks and banks will not let it go off that easily. Moving payments to the cloud not only eases the pressures on the bank from the point of view of managing an entirely IT setup for this but also benefits their customers.

Fig 1 Rural Banking in India using Cloud Computing

4. THE FIVE MAIN CHALLENGES:

4.1 Security and compliance: Maintain at all times the security of data. Banks need to demand stringent safety measures from suppliers and ensure new applications meet the latest and most rigorous security standards. Service Level Agreements (SLAs) are a must.

4.2 Reliability: It ensure that applications and data are always available in the event of a natural disaster or an unpredictable event. Banks need to have stringent SLAs in place, complete with guarantees, end-game scenarios and remedies if a provider fails to meet service levels.

4.3 Cloud management: To achieving visibility and measuring performance are harder to do, especially if, as seems likely, large banks will source cloud services from several providers and to use them for both internal – or private – and external, or public, services. This could result in a bank having to handle multiple security systems, and the need to ensure all parts of their business can communicate with each other and where necessary with clients. Increased use of various technology infrastructures and a mix of different cloud environments internally and externally mean banks will need to develop fully-fledged cloud management platforms. They will be a necessity to ensure banks can fully realise the cost savings and flexibility benefits of cloud computing.

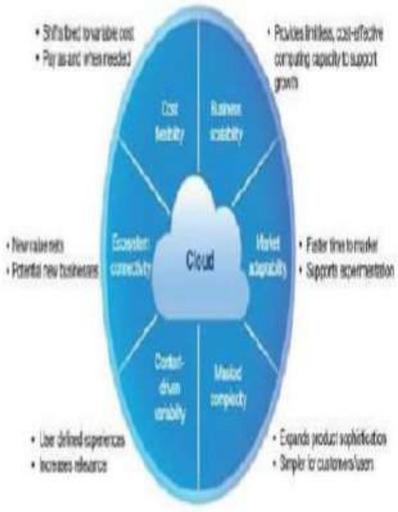
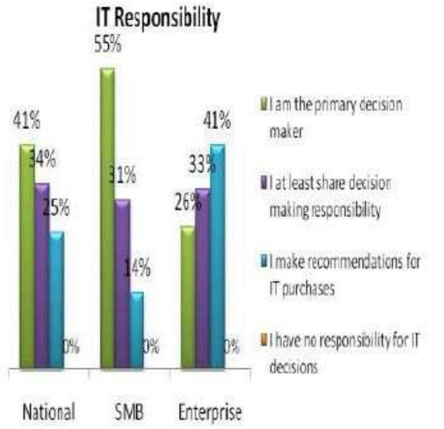


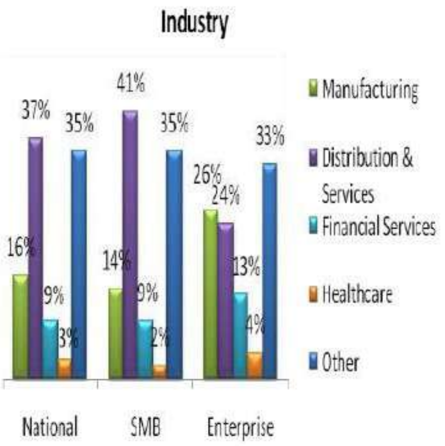
Fig 2 Cloud Computing Business Models

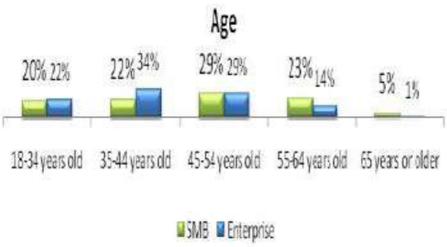
4.4 Interoperability: Banks will need to ensure data and applications can be moved across cloud environments from a number of providers. They should look to develop a single interface and management layer that can work across different platforms internally and externally.

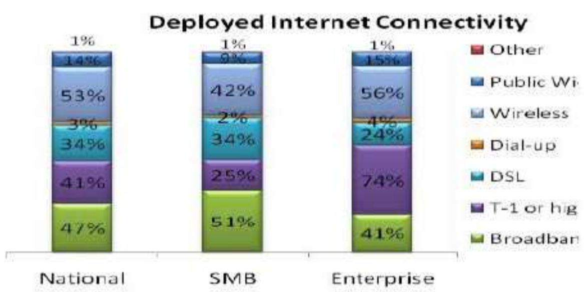
4.5 Regulation: The rules governing the cloud vary from country to country. Many countries' data protection laws impose constraints on where data is kept, limiting take-up. This is why the EC's move to regulate the cloud is welcome.

5. RESULTS AND ANALYSIS



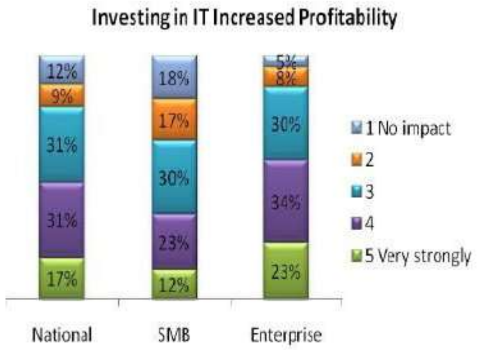


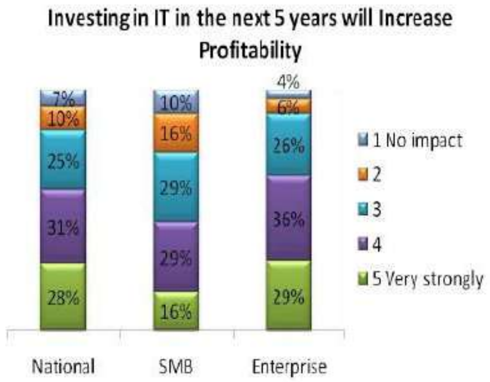




Investing in IT Promotes Profitability

More than one-third of SMBs and more than half of Enterprise companiessurvedagree that investing in IT increased profitability.





SMBS agree that the IT department must present an opportunity for the company to grow in revenue (68%) and address the requirement to work anywhere at any time (66%), while Enterprise companies are more concerned with addressing internal clients' needs (82%) and business process issues (82%).

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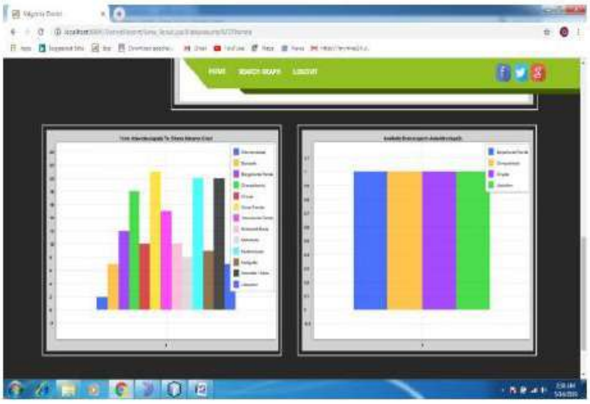

CONCLUSION

In future, Cloud technologies along with analytics, mobile technologies and big data will enable banks to unlock value from existing data and processes to address risk management and drive customer engagement. By advantage on standard development processes, scalability and collaboration enabled by the cloud, the banks will be able to create new and Innovative product and service offerings for their customers. The cloud architecture also offers flexibility in deployment models, thereby; enabling banks to become more agile and respond to market changes must faster and transform their businesses. As far as security in the cloud is concerned, in many cases, the security mechanisms put in place by global cloud providers may actually be stronger than those in many banks' internal systems. The future of banking in the cloud holds great promise.

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3. **Name of the Teacher:** Korra Srinivas,Dr.Joseph Prakash Mosiganti

Title of the Paper: Analysis of Rural Networks Based Cloud Computing

Link : http://www.ijarst.in/admin-panel/papers/290_approvedpaper.pdf

INTERNATIONAL CONFERENCE ON EMERGING TRENDS ON ENGINEERING SCIENCE, TECHNOLOGY AND MANGEMENT

ADITYA INSTITUTE OF TECHNOLOGY AND MANAGEMENT(AITAM)

ANALYSIS OF RURAL NETWORK BASED CLOUD COMPUTING

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ABSTRACT

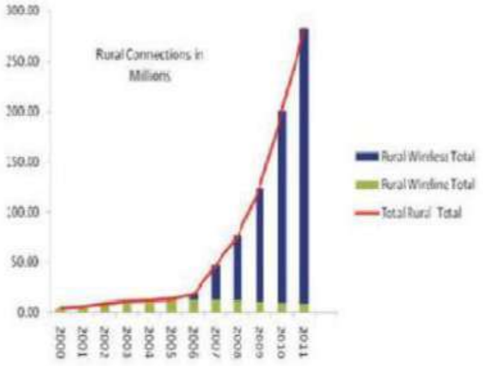
The Rural Banking introduced in villages to give good and better services to the people for the development of their agriculture sector or to help for their small-scale business. The banking sector in India has witnessed a complete transformation both in its functioning and delivery of services to their customers.The banking services in rural areas helps in developing economic factor that changed the rofile of the village and the life of its residents. The rural banking plays a major role in the economic development of a country cannot be overlooked. The main goal is based on Cloud computing to help rural banking. Today technology being the main driving force for businesses has made banking customers to sit back at home and run their accounts without walking into the banks for anything and everything. As the advancement of technology has taken place with immense use of internet, mobile phones and online bill payments banking sector in India has a new facet altogether. The cloud computing is one of the developing technology which is being use by all industrial domain in the IT field. In this paper, I proposed the concept of using cloud computing to develop a banking system for rural areas. It considers various factors such as lack of devices and amenities in rural areas and provides efficient functionality to fulfil those gaps. It uses the latest variations of cloud computing technology for filling in the various technological gaps in village areas.The new technologies had made banks to offer new services and products to its customers, which would help improve economic activities.

1. INTRODUCTION

India has become a major center in the world market known for its ability in the IT field due to its intellectual prowess in this field. But, there is also a part of India which is very far away from technology and its advantages that is the rural side of India. The farmers mostly lives in the rural population and need credit for agricultural activities which has the following problems related to banks. Usually, the problem in the villages is, either there is an ATM of a particular bank or there is no ATM. In the first case, if there is an ATM, people using it will have to pay the ATM usage charges if they are non-members of the bank and in the second case they will have to travel long distances and then the scenario might be same as the first case. So, the majority of funding is provided by private money lenders that exploit the farmers. Recent, attempts by government to help the farmers by letting off their loans taken from banks was a failure as most of the poor farmers didn't even have their bank account and rich farmers got benefit from it. Now the focus has been shifted to rural banking as most of the banks have become technology enabled and it has been made compulsory for all Indian banks to open at least span of their incremental branches in

the rural areas. As the working expenses of the public sector banks have shot up extensively, it has become a huge problem for the public sector banks to open up and run them, making the rural banking profitable. To overcome these problems and make a profitable outcome to run a bank in rural areas, cloud
technology helps to do in a well suitable manner to all people and in the banking sector.

India have been seen a veritable telecommunications revolution which have effective regulatory and policy environment coupled with an enterprising telecommunications sector made of both public and private service providers. The growth of rural Teledensity is remarkable as it has risen to 36% as on 30th August 2011 from a mere 1.7% in 2004. In fact, today rural teledensity is growing at a much faster rate than urban teledensity. At the beginning of 2011, there were 282.29 million rural connections as compared to a mere 4.84 million (only landline) phones in the year 2000. Practically all growth has come from mobile telephony and the private sector has played a huge role in this expansion. Certainly the growth of rural telephony, especially mobile telephony has brought about improved connectivity. However, much more needs to be done if the benefits of telecommunications connectivity are to translate into overall rural development. Improving broadband penetration is one key focus area and this is being addressed actively by the Department of Telecommunications.



2. A Catalytic Intervention for Empowering Rural India

India still breathes in villages and this becomes obvious when the fact is taken into consideration that more than 700 million of its population reside in about 636 thousand villages of this country; but even after sixty years of independence, rural India is characterised by severe poverty, illiteracy, lack of health services, lack of employment opportunities and over all backwardness. To empower the rural communities with a sustainable approach, ICT has been one of the most effective instruments and the following table provides a better insight to this fact. ICT and Sustainable Rural Growth 1.Strengthening Rural Governance, 2.Encouraging Social Transformation,3. Ensuring A Better Quality of Life, 4.Strengthening the Information-base of rural communities.,5.Intensifying Effort towards implementation of the rural development initiatives process

3. Rural Telephony for Rural Development

Information is critical to the social & economic activities that comprise the development process. Telecommunications, as a means of sharing information, is not simply a connection between people, but a link in the chain of the development process itself." [Hudson 1995] India achieved substantial socio-economic development since independence. Unfortunately this development has not been shared equitably by all. Some sections of the society have been left out and some areas, like rural, tribal and remote areas, could not keep pace with urban areas in development. If vast sections of society and areas are left out, it breeds unrest and is not conducive to a sustainable development of the country. The Government has initiated several schemes to correct these anomalies: to restore equitability by reducing the rural-urban divide, to eradicate poverty and hunger from the rural landscape, to assure basic needs for the villagers, to improve their gainful employment, to improve the socioeconomic infrastructure in the rural areas and to safeguard and improve the fertility of land and other natural resources. Improvement of the socio-economic infrastructure in the rural areas for ensuring integrated development includes attention to roads, irrigation, housing, water supply, electricity, sanitation, natural resources development and Information and Communication Technology (I.C.T.). Indian telecom sector is more than 165 years old. The entire evolution of the telecom industry can be classified into three distinct phases:-Phase I- Pre-Liberalization Era (1980-89), Phase IIPost Liberalization Era (1990-99), Phase III- Post 2000.

4. DEFINITION OF CLOUD COMPUTING IN PAAS

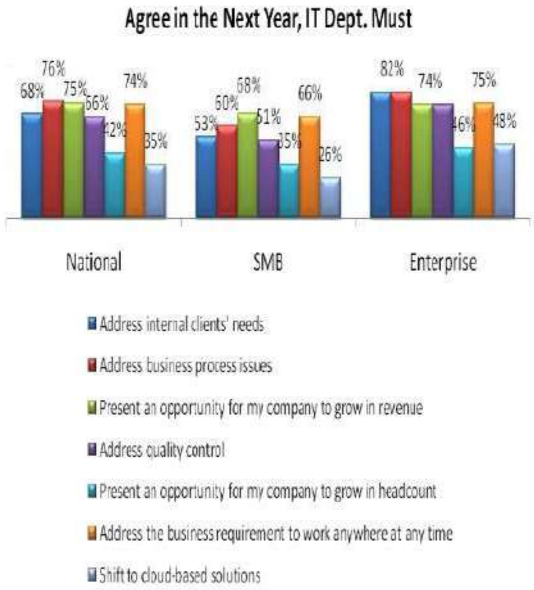
"Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction". Cloud computing is an emerging computing paradigm in which resources of the computing infrastructure are provided as services of the internet. Cloud computing allows consumers and businesses to use applications without installation and access their personal files at any computer with internet access. Cloud computing can be categorized into three groups:1.Platform as a Service (PaaS) 2.Infrastructure as a Service (IaaS) 3.Software as a Service (SaaS) . Cloud computing has been include platforms for building and running custom applications, a concept known as Platform-as-a-Service. To develop a software you should buy databases, servers, networks, and a host of development tools. And then you needed the staff to install, optimize, and maintain it all.

There are number of PaaS providers available today **AppEngine** from Google based on Python and Java.

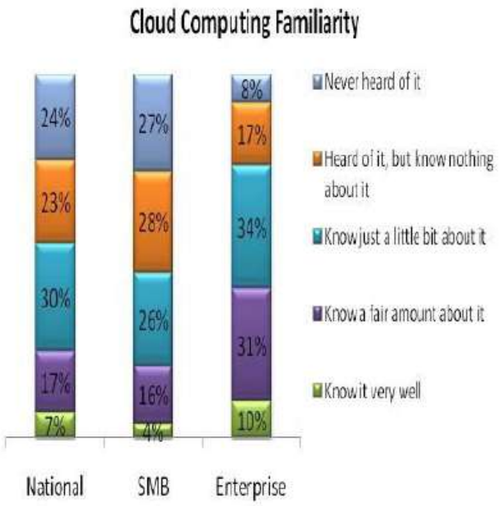
Force.com from SalesForce based on the SalesForce SaaS infrastructure and Apex language. **Bungee Connect** provides a Visual Development Studio based on Java. Platform as a Service (PaaS) provides infrastructure on which software developers can build new applications or extend existing applications without requiring the need to purchase development, QA, or production server infrastructure. PaaS is middleware which can include access management it specific vendors of PaaS include Force.com, Google, AppEngine and Coghead. The beneficial use of PaaS is the development of standardized software programs. In this model the cloud providers deliver a computing platform typically including operating system, programming language execution environment, database, and web server. Let's assume you want to build an application but building and running on-premise applications has always been complex, expensive, and risky. Your application required hardware, an operating system, a database, middleware, Web servers, and other software. Once you assembled this stack and you need a team of developers to navigate complex programming models like J2EE or .NET. You also need a team of network, database, and system management experts to keep everything up and running.

5. RESULT AND DISCUSSION

ICTs also serve as a instrument of awareness creation and feedback giving rural people a voice in the nation's sociopolitical life. ICTs can act as a channel of delivery of e-Government services including health and education. Rural areas are often regarded as information-poor and information provision has always been a central component of rural development initiatives i.e Strengthening Rural Governance, Encouraging social transformation, Ensuring A Better Quality of Life ,Intensifying Effoert towards implementation of the rural development initiatives, Enhancing people's participation in nationbuilding process, Strengthrning the Information-base of rural communities. The major constraints for the low rural teledensity have been lack of investible resources, nonavailability of appropriate technology combined with difficult geographical terrain and continental size of the country. Achievement of India's rural telephony objectives needs to be approached in a holistic manner wherein not only due policy and regulatory glitches need to be ironed out, but also various procedural concerns also need to be addressed. ICT initiatives in rural development emphasise adoption of a more systematic approach for integrating Traditional Knowledge Systems and ICT inputs to ensure sustainability of rural e-governance. All the literature related to rural development and e-governance has indicated various issues impeding success of such initiatives. The main issues are lack of localization of content for rural communities and inadequate participation of rural communities in design of rural ICT initiatives.



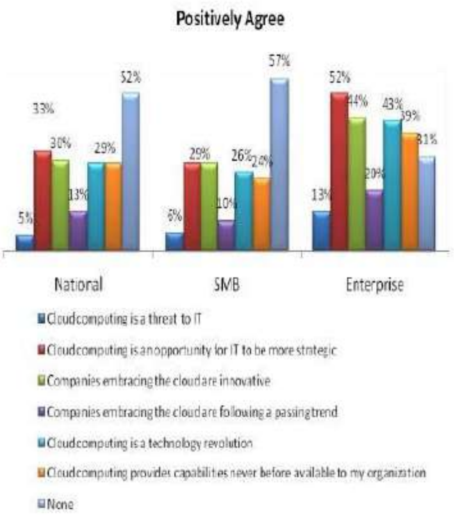
SMBs are less familiar with cloud computing, compared to ITDMs working with Enterprise-sized companies.Only 20% of SMBs claim to know cloud computing very well or a fair amount compared to 41% ofITDMs at Enterprises claiming the same.



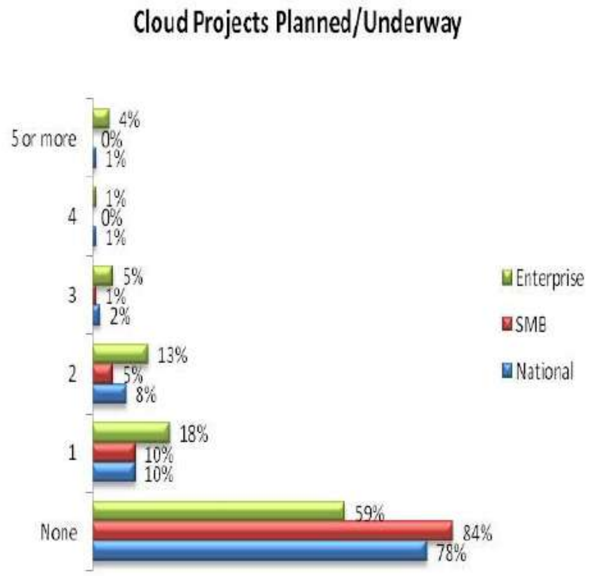
Cloud Computing is a Strategic IT Imperative

More than half of ITDMs at Enterprise businesses (52%) endorse cloud as a strategic opportunity for IT.

Though more than half of SMBs do not have an opinion of cloud computing (57%), nearly one-third (29%) agree that cloud is an opportunity for IT to be more strategic (29%).

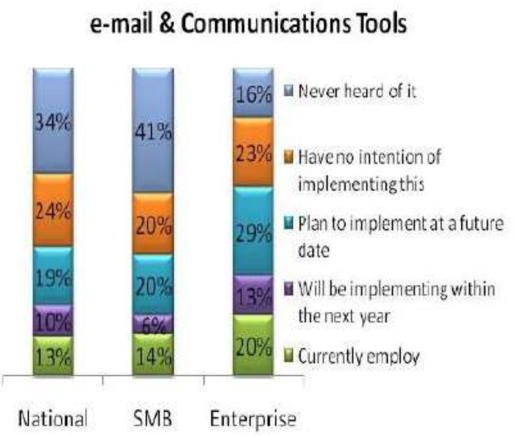


41% of Enterprise companies surveyed have at least one cloud project planned or underway compared to 16% of SMBs.

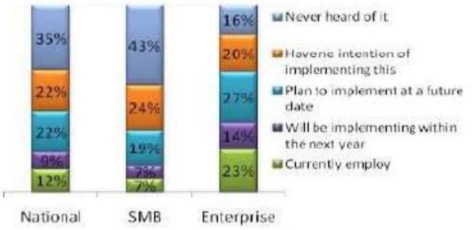


Cloud-based Tools are Used for Communication and Collaboration

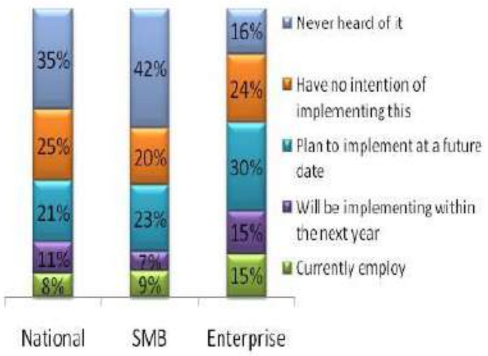
SMBs are most likely to be employing or planning to implement email and communication tools (20%) or cloud based backup and storage (18%). Enterprise companies are employing or planning to implementcloud-based collaboration tools.



Cloud-based Collaboration Tools



Cloud-based Productivity Apps



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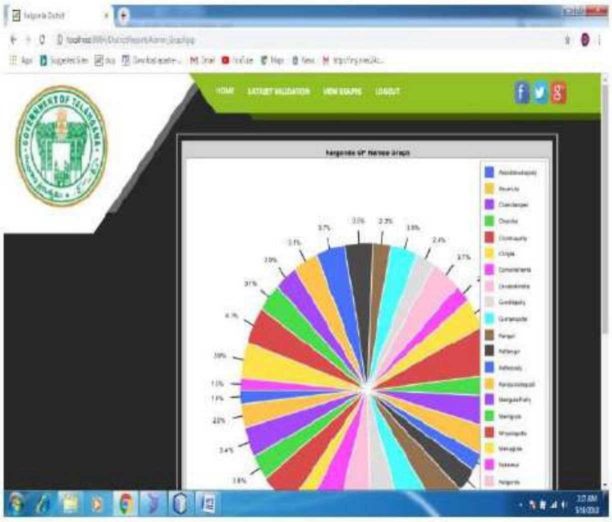

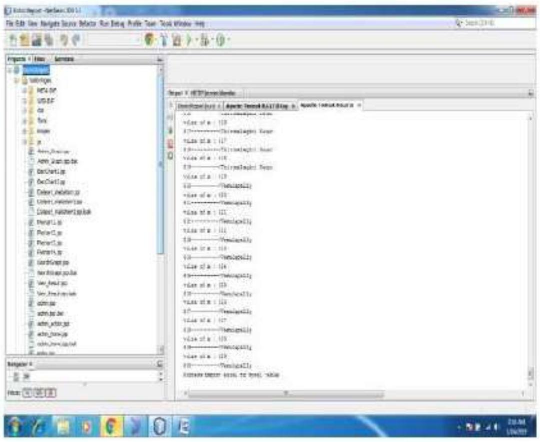

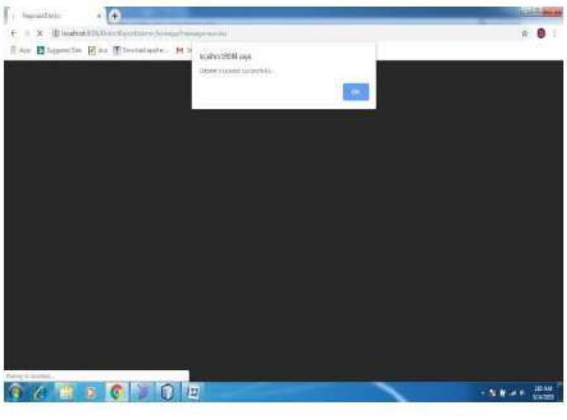

CONCLUSION

In future, Cloud technologies along with analytics, mobile technologies and big data will enable banks to unlock value from existing data and processes to address risk management and drive customer engagement. By advantage on standard development processes, scalability and collaboration enabled by the cloud, the banks will be able to create new and Innovative product and service offerings for their customers. The cloud architecture also offers flexibility in deployment models, thereby; enabling banks to become more agile and respond to market changes must faster and transform their businesses. As far as security in the cloud is concerned, in many cases, the security mechanisms put in place by global cloud providers may actually be stronger than those in many banks' internal systems.

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Title of the Paper: Implementation of ANN Trained Voltage Control Scheme for Grid islanded DG system

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Implementation of ANN Trained Voltage Control Scheme for Grid Islanded DG System

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Implementation of ANN Trained Voltage Control Scheme for Grid Islanded DG System

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Abstract. Distributed generation plays a significant role in power generation, but the standalone system has some limitations like excess power generation and sudden increment in load. Grid interconnected DG system mitigates all this type of problems but some different questions arise in this interconnection. How to synchronize the DG system with the grid? If any change in voltage or frequency they lead to disconnect the grid from DG system. But due to sudden loose of grid supply, the phase angle is changed in filter terminal voltage and leads same change in load voltage because when the grid is connected the load receives power from both DG and grid. In grid-connected system current controller is generally used, to maintain the constant current in load side, so in islanding conditions, the voltage profile will get damage and power factor is also dropped. This paper proposes a strategy of two controllers for both grid-connected and intentional islanding modes. PI controller based constant current regulator for grid-connected mode, while ANN based VC controller for intentional islanding mode. These two controllers are operated according to changes occurred at Point of Common Coupling (PCC).

Keywords: *ANN Based VC Controller, Current Controller, Distributed Generation, Intentional Islanding, Grid-ConnectedDG System, Pointof Common Coupling.*

1. Introduction

The DG is very useful in the case of “blackout”, due to different reasons like voltage, frequency dropouts. The DG is defined as the generation centre is located at the load centres for power supplies. Generally, buildings are the one example the top of the buildings PV panels are panels are placed the generated power is utilized by the consumers on the building. The excess power is connected to the grid. The anti-islanding circuits are provided for the continuous operation. In the proposedcase, intentional islanding is done for the constant voltage maintenances in the load centre. The intentional islanding test is very useful for DG system because the grid line is suddenly cut-off from the tie-line (P.C.C.). The most effective advantage of the PV connected grid system increases the effective utilization of power because the storage system is not required when there are no storage losses. A standalone system is not suitable for dynamic load changer so it needs without any fluctuations in output response so primary option is connecting a battery system to solar system but it is very costlier, so if the right conditions are possible the distributed generation system is connected to grid in the case the excess power is given to grid & at high load conditions or suddenly load increased conditions grid supplies the power to load centres. By supplying excesses power to the grid there is two advantageous

i) To avoid power wastage
ii) To generate the income by selling the excesses power to the grid depending on the agreement between both DC system and grid.

2. Literature Review

The Robust damping controllers are used to control the faulty current and disturbance from the external sources. The dg system with polytypic problems is reduced by using LCL filters and by the use of LCL filters the transient response is very fast and small peak overshoots [1]. The grid frequency fluctuations are a major problem when connected to the DG system & it should be eliminated or greatly reduced to protect the synchronization of grid and dg system. The feedback controllers are very much required for these problems. The robust grid current feedback active damping controller provides the constant current to the load centre.

The synchronous reference frame quasi PI controller is required in some areas to get the good stability margin along with resonant peak under the impedance variations of the grid system. The RGCFD&SRFQPI are used to compensate PQ variations under heavy loads & light load conditions for sudden step response [2]. In DG connected systems the reactive power variations are very common but they may lead to change the frequency values also. The quasi-proportional resonant controller provides the improvement in the reactive power & reactive current responses by using the reactive current detective algorithms & it can perform better when compared to regular phase delay controller. The dc link voltages may also improve by using this type of controllers. The stability margin improvements are also analyzed by the bode plot for clear observations [3].

Load shedding is one of the best adaptive methods for balancing of both voltage and frequency variations. It will give the optimal way of the solution in emergency conditions by avoiding the interruption of power supply to a high number of consumers. Most commonly it also named "Defense Plan"[4]. In wind energy based DG systems facing two types of problems: i) the output power from the wind systems are not constant in a day/month. So the maximum power point tracker needs to avoid this type of problems, ii) load side voltage and frequency problems due to sudden load shedding and it can be overcome by providing constant voltage controller along with frequency controller [5]. The renewable energy sources are not producing consistent energy over a day and the grid-connected renewable energy systems are creating the problems by varying the voltage levels, it may lead to "blackouts". To avoid this type of problems due to inconsistent energy supplies the islanding technique is introduced to protect the grid [6], [7].

3. PROPOSED STRATEGY

The inverter is placed between the PV systems to AC side. The inverter should monitor the voltage response of the rid continuously because of the synchronization process. Figure 1 shows the line diagram of DG connected grid system through inverter and filter devices. The inverter always produces slightly higher than the grid voltage for the smooth power flow outward from the solar energy.

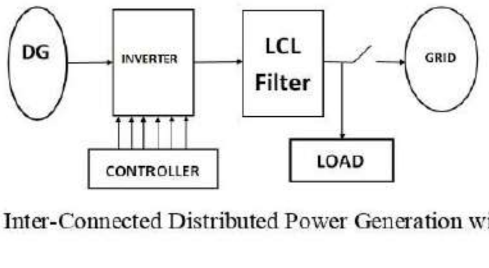

Figure 1: Grid Inter-Connected Distributed Power Generation with LCL filter.

3.1 Grid-Connected Mode:
In general, all the microgrids/DG systems are operated under constant current control mode. In this mode, the load current is constant w.r.t. reference value.

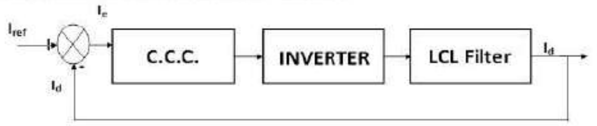

Figure 2: Block Diagram of Constant Current Controller.

The constant current controller is preferred based on the fast response and it directly controllers the load current which helps in the power supply reliability. The controller operation is explained the next section.

3.2 Islanding Mode/Grid Disconnected Mode:
Islanding situation occurs due to the deviation of voltage/frequency levels violation and it directly affects the grid synchronization. The intentional islanding is proposed in this paper by providing the comparison of grid voltage and DG system voltage levels as well as the frequency of the grid and DG system. If any deviation occurs then it sends the signal, to disconnect the DG system from the healthy grid. In this condition, the voltage and current are not maintaining constantly because the phase angle is changed due to sudden disconnection of one source and the deviated phase angle causes the low power factor. To avoid all these problems, the paper proposes ANNVCR for grid islanding conditions. By this controller the new phase angle is established, and then the voltage and current levels are maintained constantly.

3.3 Constant Current Controller (CCC):
Figure 2 shows the current controller which helps to maintain constant current as an output. The frequency will be determined by the device phase locked loop (PLL) and it also produces the reference angle of the point of common coupling. The reference angle is an important aspect for grid-connected DG systems synchronization. In current control mode, the output of the filter is transferred to the synchronous frame by using park's transformation equation (1).

$$i_d = \sqrt{\frac{2}{3}}\left\{i_a * \cos\theta - i_b * \cos\left(\theta + \frac{2\pi}{3}\right) - i_c * \cos\left(\theta - \frac{2\pi}{3}\right)\right\} \tag{1}$$

$$i_q = \sqrt{\frac{2}{3}}\left\{i_a * \sin\theta - i_b * \sin\left(\theta + \frac{2\pi}{3}\right) - i_c * \sin\left(\theta - \frac{2\pi}{3}\right)\right\} \tag{2}$$

$$i_o = \frac{1}{\sqrt{3}}\{i_a + i_b + i_c\} \tag{3}$$

$$v_d = \sqrt{\frac{2}{3}}\left\{v_a * \cos\theta - v_b * \cos\left(\theta + \frac{2\pi}{3}\right) - v_c * \cos\left(\theta - \frac{2\pi}{3}\right)\right\} \tag{4}$$

$$v_q = \sqrt{\frac{2}{3}}\left\{v_a * \sin\theta - v_b * \sin\left(\theta + \frac{2\pi}{3}\right) - v_c * \sin\left(\theta - \frac{2\pi}{3}\right)\right\} \tag{5}$$

$$v_o = \frac{1}{3}\{v_a + v_b + v_c\} \tag{6}$$

$$\begin{bmatrix} i_o \\ i_d \\ i_q \end{bmatrix} = \frac{2}{3}\begin{bmatrix} \frac{1}{2} & \frac{1}{2} & \frac{1}{2} \\ \cos\theta & \cos\left(\theta+\frac{2\pi}{3}\right) & \cos\left(\theta-\frac{2\pi}{3}\right) \\ \sin\theta & \sin\left(\theta+\frac{2\pi}{3}\right) & \sin\left(\theta-\frac{2\pi}{3}\right) \end{bmatrix}\begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} \quad (7)$$

In matrix form, it can be represented as

$$\boldsymbol{I_{dqo}} = \boldsymbol{P} * \boldsymbol{I_{abc}} \quad (8)$$

$$\begin{bmatrix} v_o \\ v_d \\ v_q \end{bmatrix} = \frac{2}{3}\begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ \cos\theta & \cos(\theta+2\pi/3) & \cos(\theta-2\pi/3) \\ \sin\theta & \sin(\theta+2\pi/3) & \sin(\theta-2\pi/3) \end{bmatrix} \times \begin{bmatrix} v_a \\ v_b \\ v_c \end{bmatrix} \quad (9)$$

In matrix form, it can be represented as

$$\boldsymbol{v_{dqo}} = \boldsymbol{P} * \boldsymbol{v_{abc}} \quad (10)$$

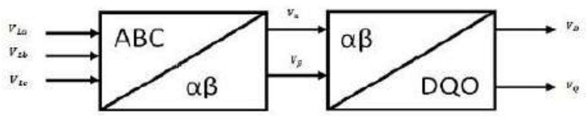

Figure 3: Conversion of Load Voltage by using Parks Transformation.

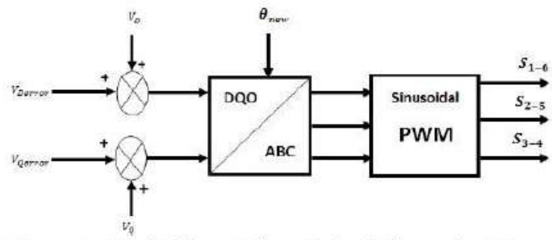

Figure 4: Inverter Switching Pulses Calculation using Error Values.

Where θ = ωtand ω is the frequency of the electric system.

Figure 3 & 4 shows the conversion of three phase system into dqo form is represented schematically and the new angle establishment after inverse parks transformation is also shown in that. The error detector is used to find an error in DC quantity by comparing the I_{Dref}, I_D and I_{Qref}, I_Q and it is connected to PI controller (current controller), then the current controller produces values of V_D, V_Q. The error detector is used one more time to produce a required terminal voltage by comparing error signals of V_{Derr}, V_{Qerr} and output value of V_D, V_Q. The inverse park's transformation is used to convert DC quantities of voltage into three phases. The phase angle is re-established by generating new θ value by PLL.

3.4 ANN Based Voltage Current Regulator (ANNVCR):

ANNVCR is mainly used in grid islanding condition due to uncontrolled voltage magnitude and phase angle. In general, the grid-connected condition the voltage levels are monitored by PCC and the controller is provided only for constant current levels but in the islanding condition already the voltage/frequency levels deviate from the fixed values.

$$i_a = \{-i_d * \cos\theta + i_q \sin\theta + \frac{1}{2} i_o\} \quad (11)$$

$$i_b = \left\{-i_d * \cos\left(\theta - \frac{2\pi}{3}\right) + i_q * \sin\left(\theta - \frac{2\pi}{3}\right) + \frac{1}{2} i_o\right\} \quad (12)$$

$$i_c = \left\{-i_d * \cos\left(\theta + \frac{2\pi}{3}\right) + i_q * \sin\left(\theta + \frac{2\pi}{3}\right) + \frac{1}{2} i_o\right\} \quad (13)$$

$$\begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} = \begin{bmatrix} -\cos\theta & \sin\theta & \frac{1}{2} \\ -\cos(\theta - 2\pi/3) & \sin(\theta - 2\pi/3) & \frac{1}{2} \\ -\cos(\theta + 2\pi/3) & \sin(\theta + 2\pi/3) & \frac{1}{2} \end{bmatrix} \begin{bmatrix} i_d \\ i_q \\ i_o \end{bmatrix} \quad (14)$$

$$v_a = \{-v_d * \cos\theta + v_q \sin\theta + \frac{1}{2} v_o\} \quad (15)$$

$$v_b = \left\{-v_d * \cos\left(\theta - \frac{2\pi}{3}\right) + v_q * \sin\left(\theta - \frac{2\pi}{3}\right) + \frac{1}{2} v_o\right\} \quad (16)$$

$$v_c = \left\{-v_d * \cos\left(\theta + \frac{2\pi}{3}\right) + v_q * \sin\left(\theta + \frac{2\pi}{3}\right) + \frac{1}{2} v_o\right\} \quad (17)$$

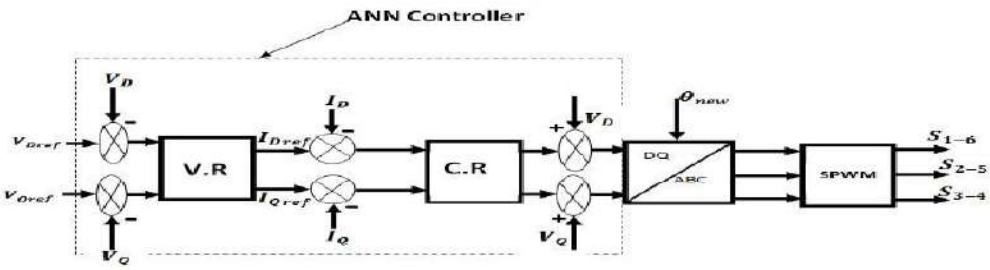

Figure 5: Block Diagram of ANN based Constant Voltage Current Regulator.

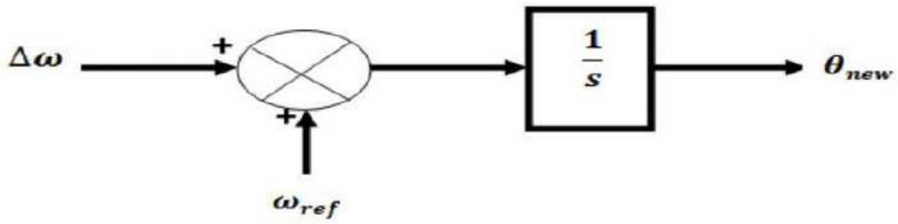

Figure 6: Block Diagram for New Phase Angle Calculation.

Now the controller needs to maintain both the current and voltage as well as phase angle establishment. But it also has one limitation, i.e., the ANNVCR response is slow when compared to the constant current controller because if write the transfer function of the two controllers the ANNVCR has one additional pole. The additional pole gives the more stable conditions but response time is slow when compared to CCC. In this controller, the voltage is compensated through the current regulator. The load voltage is converted into dqo form by using park's transformation, to get the V_D, V_Q. The error will be calculated by using an error detector with a comparison of V_{Dref}, V_{Qref}. The error is generated & it is fed to voltage regulation to generate current reference signals I_{Dref}, I_{Qref}. The I_{Dref}, I_{Qref} are fed to error detector by combining I_D, I_Q as shown in figure 5 & the figure 6 shows the calculation of new phase angle using reference value. Now the process will be same as a current controller because the error signals current will feed to current regulator.

$$\begin{bmatrix} v_a \\ v_b \\ v_c \end{bmatrix} = \begin{bmatrix} -\cos\theta & \sin\theta & \frac{1}{2} \\ -\cos(\theta - 2\pi/3) & \sin(\theta - 2\pi/3) & \frac{1}{2} \\ -\cos(\theta + 2\pi/3) & \sin(\theta + 2\pi/3) & \frac{1}{2} \end{bmatrix} \begin{bmatrix} v_d \\ v_q \\ v_o \end{bmatrix} \quad (18)$$

$$V_\alpha = \{\tfrac{2}{3}V_{ab} + \tfrac{1}{3}V_{bc}\} \quad (19)$$

$$V_\beta = \left(\frac{1}{\sqrt{3}}\right)V_{bc} \quad (20)$$

$$V_D = -V_\alpha * \cos\theta + V_\beta * \sin\theta \quad (21)$$

$$V_Q = V_\alpha * \sin\theta + V_\beta * \cos\theta \quad (22)$$

Finally, the high switching pulses are generated by using SPWM. The Transfer Function of the ANNVCR can be expressed as equation (23).

$$T(s) = \frac{s^4 + 8.79 * 10^3 s^3 + 6.56 * 10^7 s^2 + 8.06 * 10^9 s + 6.45 * 10^7}{s^5 + 1.42 * 10^4 s^4 + 1.46 * 10^8 s^3 + 6.4410^{11} s^2 + 3.4910^{13} s + 2.7910^{11}} \quad (23)$$

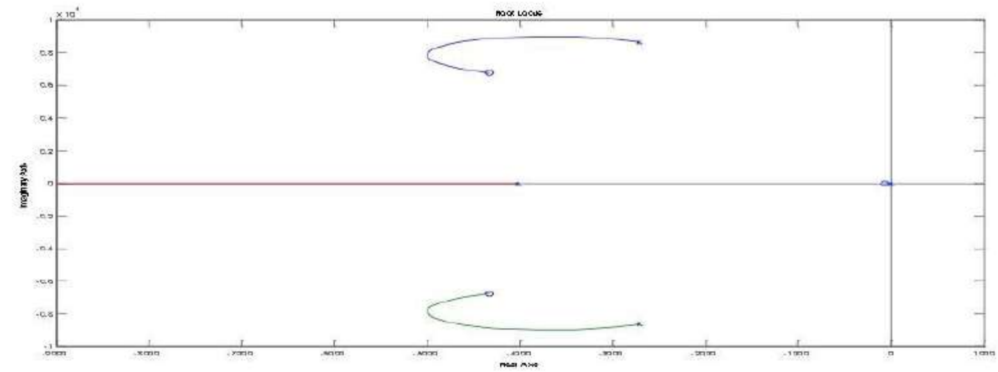

Figure 7: Stability Analysis for ANN Based Constant Voltage Current Regulator.

Figure 7 shows the stability analysis of proposed ANN based voltage current controller using root locus technique, the added loop in addition to voltage controller along with current controller loop simply the pole is added to the existing system and it leads to improve the stability as well as steady state performance of the system and the steady state error is also reduced.

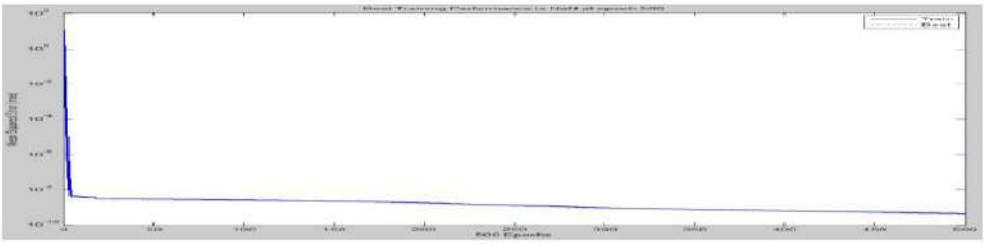

Figure 8: ANNVCR Mean Square Error Response.

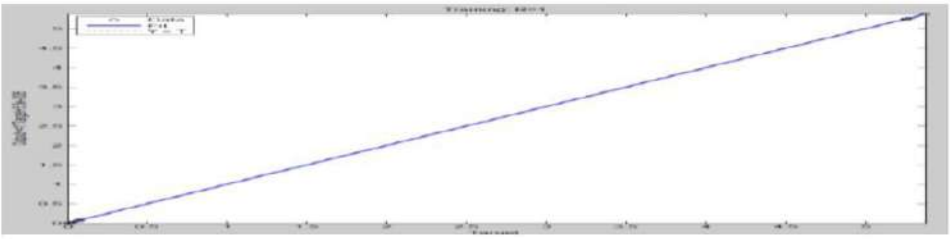

Figure 9: Regression of Trained ANN.

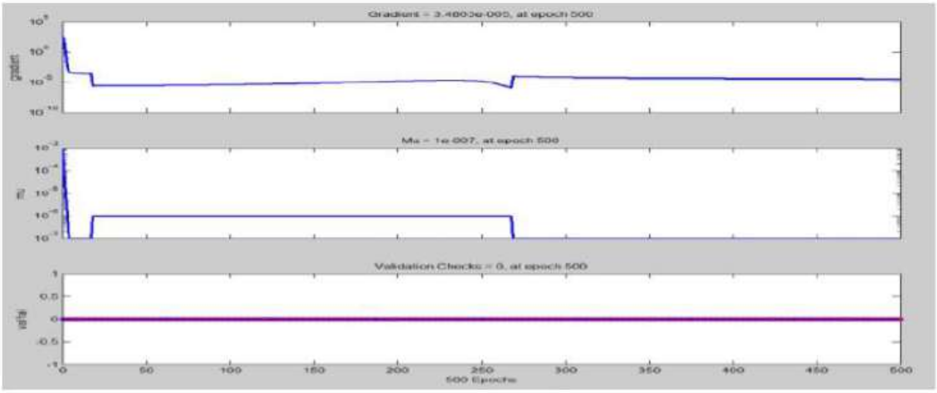

Figure 10: Response of Gradient, mu, val fail w.r.t. Epochs.

Figure 8, 9, & 10 shows the proposed ANN trained voltage current controller mean square errors, regression and gradient response w.r.t. to Epochs all these specifications are indicates that the proposed controller performance is ideal and there is no error and disturbances in the voltage current controller training process.

4. RESULTS & DISCUSSION

The Figure 11 shows the voltage response of the distributed power system and it is collected from the end terminals of the LCL filter, which is directly connected to Grid via PCC. The total response of the system is shown in that Figure. From the 0 to 0.2 sec the DG and Grid systems are connected but at 0.2sec the grid is intentionally disconnected from the DG due to change in voltage of the DG system.

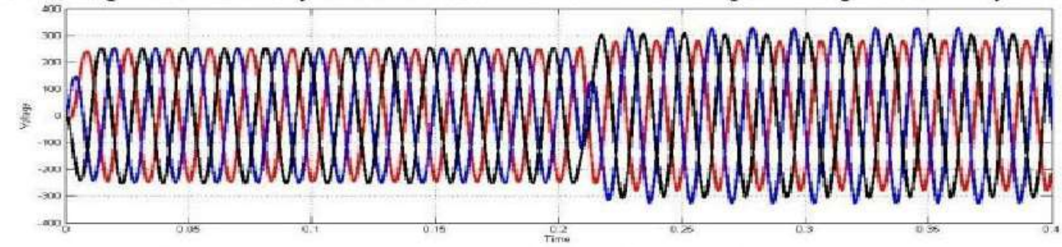

Figure 11: Three Phase Voltage of Distributed Generation System Output.

In general, the constant current controller is used for the Grid connected DG systems because the grid is connected to any DG system when the voltage and frequencies are same. But in this paper the grid is islanded from DG system by the change in frequency at the instant 0.2 sec, therefore the voltage is not controlled in the DG system and phase sequence is also changed and it can be observed clearly in the extended view of the DG system Voltage response because in that controller there is no control over voltage, it regulates only the current value in the load center properly.

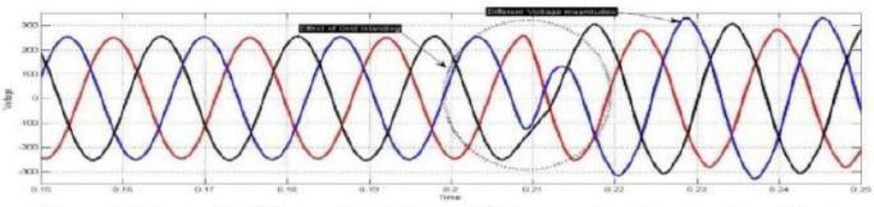

Figure 12: Expanded View of DG Output Voltage under Islanding Condition.

Figure 12 shows the extended view of the DG output response observe the dotted ellipse portion the voltages are going out of phase in that instant because of grid islanding & this phenomenon leads to poor power factor. The voltage magnitude is also changed in three phases and it is also represented by arrow line. Most of the time all these issues lead to voltage collapse because of unequal phase angle differences and low power factor.

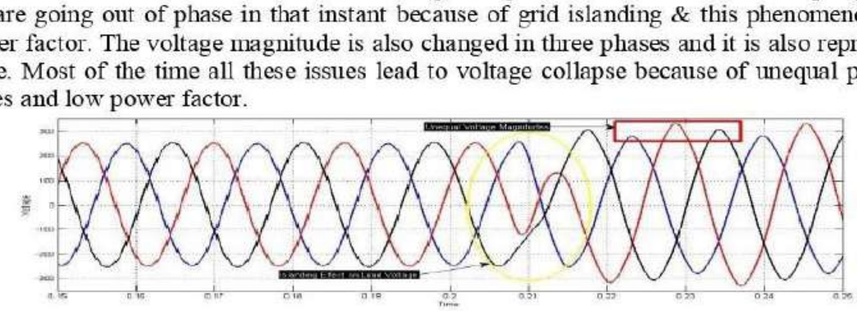

Figure 13: Expanded View of Load Voltage Variations under Grid Islanding Conditions without Voltage Regulation.

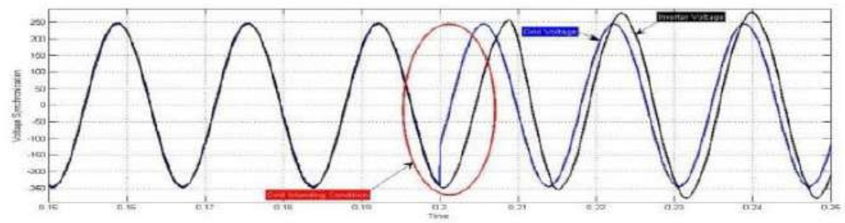

Figure 14: Expanded View of Synchronization of DG &Grid Voltage Responses without Voltage Regulation.

Figure 13 & 14 shows the expanded view of load voltage and synchronization of DG & grid response of islanded conditions. From the synchronization graph we can observe from 0 to 0.2 sec the grid voltage and DG system output voltages are in phase when the disturbances occurred in the DG system then the grid is disconnected from DG system and the islanding is occurred in DG side, in that instant onwards the phase angle of the inverter voltage is changed along with its magnitudes. Even after some time duration also the disturbance is not cleared by this constant current controller.

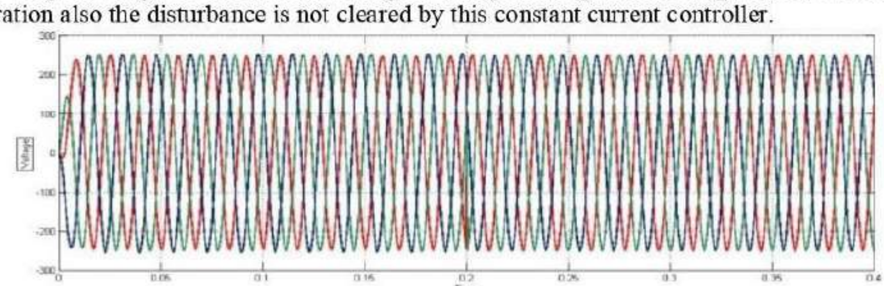

Figure 15: DG System Output Voltage Response under both Grid-Connected& Islanding Cases with Both ANNVCR.

Figure 15 shows the output voltage response of the DG system with ANN controller, the effect of islanding condition is limited to very few milliseconds and the DG system output voltage magnitude is maintained constant even though the grid is disconnected from the DG system.

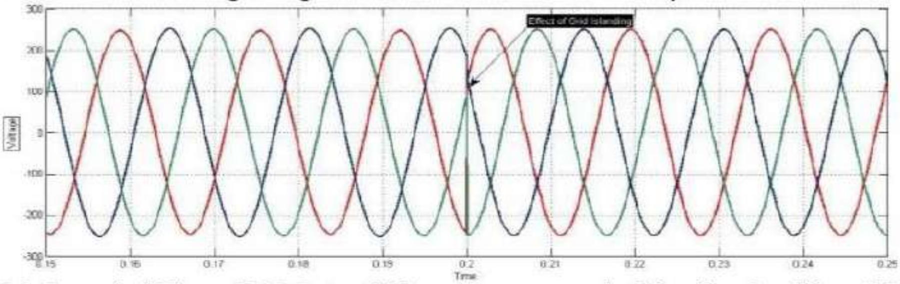

Figure 16: Expanded View of DG Output Voltage Response under Islanding Condition ANNVCR.

Figure 16 shows the expanded view of the DG system output voltage from 0.15 to 0.25 sec. At 0.2 instant the voltage response suddenly collapsed but it is limited that particular time only i.e. 0.2 by providing the islanding detector it senses the islanding situation in the system and immediately changes the controller from the constant current controller to ANN controller. Even after islanding state, the phase sequence is not changed in the output voltage of the DG system and the same time the voltage magnitude is also constant.

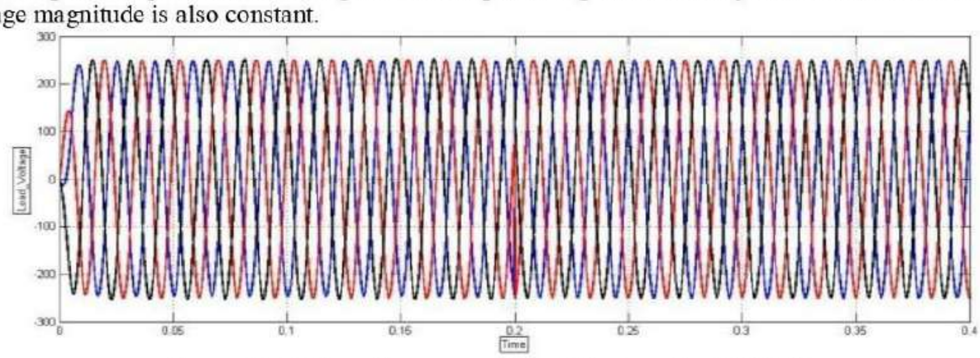

Figure 17: Voltage Response of Load Center with ANNVCR.

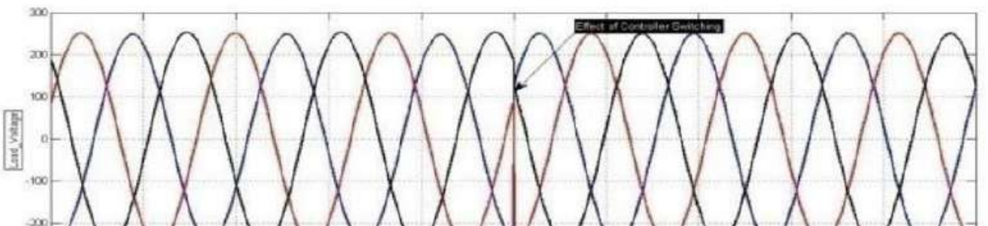

Figure 18: Expanded View of Voltage Response in Load Side At 0.2 Islanding Instant ANNVCR.

Figure 17 & 18 shows that voltage response of the load centre and expanded the view of voltage response at islanding situations. In general, load receives the current from grid side and DG side but in the islanding situation there is no supply from the grid side and completely based on DG system only, the voltage is also disturbed in that condition but with the use of ANN controller the voltage variations are mitigated.

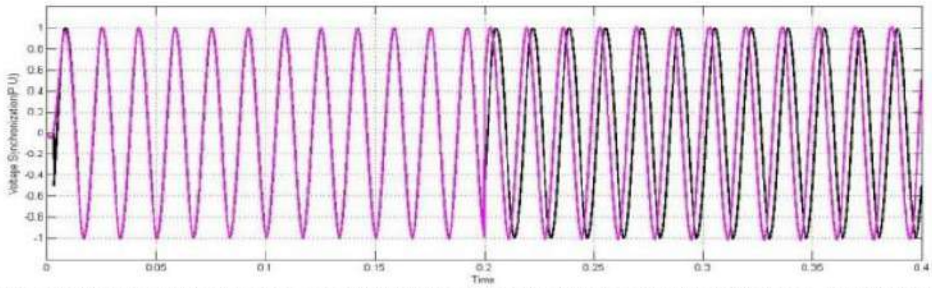

Figure 19: Synchronization of Grid Voltage &DG System Output Voltage ANNVCR.

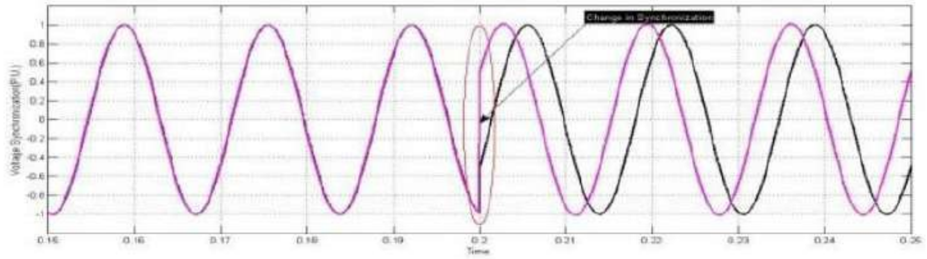

Figure 20: Expanded view of Synchronization under islanding condition ANNVCR.

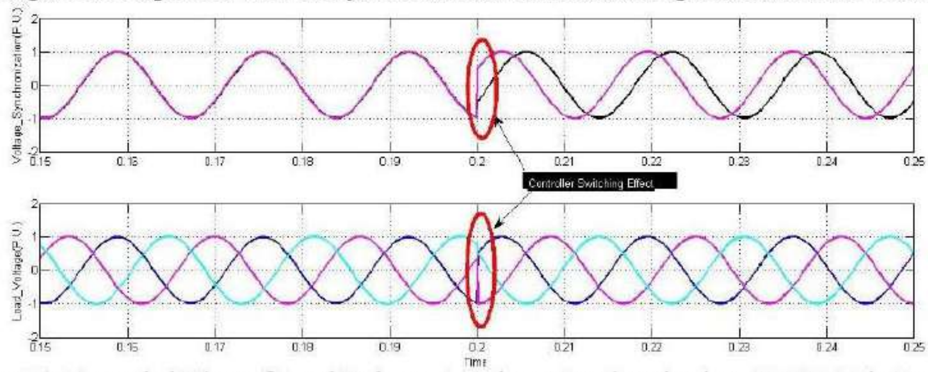

Figure 21: Expanded View of Load Voltage & Voltage Synchronization ANNVCR in Per Unit Representation.

Figure 19, 20 & 21shows the expanded view of the load voltage and synchronization of the DG system output voltage and grid voltage. The islanding condition is marked with the red mark ellipse due effect of switching controller action from constant current controller to ANN controller the sequence and magnitude are re-established. We can compare the two control schemes by synchronization graph with the help of ANN voltage phase angle is not changed even after grid islanding condition but in the first case i.e. in constant current controller case the phase angle difference is not equal and magnitude is different in three phases of the DG system flowed by load centre. The PV system acts as a distributed power generation and the PV system is connected to an inverter, to change the dc power supply into AC world. The resonant filter (LCL) is used for a perfect sine wave. The filter terminals are connected to three phase grid via PCC. The load is located after the filter terminals. Under normal operating conditions (i.e., grid-connected systems) the current controller is used to maintain the constant current in the load centre. In normal operating condition, the synchronization is already established between DG systems to grid.

In this condition, the following should be maintained:

i) Voltage levels should be same.

ii) Frequency should be same.
iii) Phase sequence is also same.

By all these conditions, at load centres constant. Voltage level should be maintained because of synchronization. Additionally, the current controller provides a constant current. Therefore in the loadcentres constant current, voltages are available with same phase sequence. If the grid is disconnected due to any technical problem (generally because of variations in frequency, voltage levels), the phase sequence is changed and voltage levels are also changed & the controller provides only constant current in load centre but due to phase sequence variations the load centresdon't work properly and the power factor is decreased due to voltage phase angle variations. In this standalone condition, we proposed an ANN controller for both constant voltage & current.

$$k = V_{ina}V_{Ga} + V_{inb}V_{Gb} + V_{inc}V_{Gc}$$
$$k = \frac{3}{2}\cos\theta$$
$$g = V_{ina}V_{Ga} + V_{inb}V_{Gb} + V_{inc}V_{Gc}$$
$$g = \frac{3}{4}\left(-\cos\theta + \sqrt{3}\sin\theta\right)$$
$$\cos\theta = \frac{2}{3}k \tag{24}$$
$$-\cos\theta = \frac{4}{3}g - \sqrt{3}\sin\theta$$
$$\cos\theta = \sqrt{3}\sin\theta - \frac{4}{3}g \tag{25}$$

From above equations (24) & (25),

$$\frac{2}{3}k = \sqrt{3}\sin\theta - \frac{4}{3}g$$
$$\sqrt{3}\sin\theta = \frac{4}{3}g + \frac{2}{3}k$$
$$\sin\theta = \frac{1}{3\sqrt{3}}\{4g + 2k\} \tag{26}$$

The ANN controller is used to maintain the constant voltage levels in the inverter output terminals as well as load centres also. In this ANN controller, the input response is an error in voltage V_{Dref}, $V_D$andV_{Qref}, V_Q are compared to producing the error value and it is sent to ANN controller. It contains two regulators first one is voltage regulator and the second one is the current regulator. The voltage regulator receives the error quantity & integrates the error value and changed to current quantities respectively based on historical databases by trained ANN controller.

The output of the ANN-based voltage regulator is I_{Dref}, I_{Qref}. The current value collected from load side is converted into DQO form compared with the output response of the voltage regulator I_{Dref}, I_{Qref}. Now the error detector generates the error value in terms of current quantity. The error values are collected by the current regulator and it acts as an integrator and generates the required voltage level in terms of magnitude and phase angle. The output compensated voltage is added to V_D, V_Q respectively. But all these quantities present in the DQO form and it is converted to ABC form by inverse parks transformation. The angle θ_{new} will generates by using fig7. The θ_{new} will help to re-establishes the voltage levels in three phase system with phase angle.

The SPWM technique is used to generate the pulses required for the three-phase inverter the output of ANN controlled and compared with carrier signals then it generates the required pulses.

5. Conclusion

Through this Paper, two control strategies are implemented along with islanding detection algorithm, for Grid-Connected and islanding mode operations in the distributed power system. From the results which are shown in the previous section that clears, proposed control strategy is capable of maintaining constant voltage and current levels at load centres in grid-connected and islanding conditions. By ANNVCR, voltage fluctuations are mitigated and voltage, current levels are maintained in acceptable levels when grid-connected and islanding DG system from remaining utility system.

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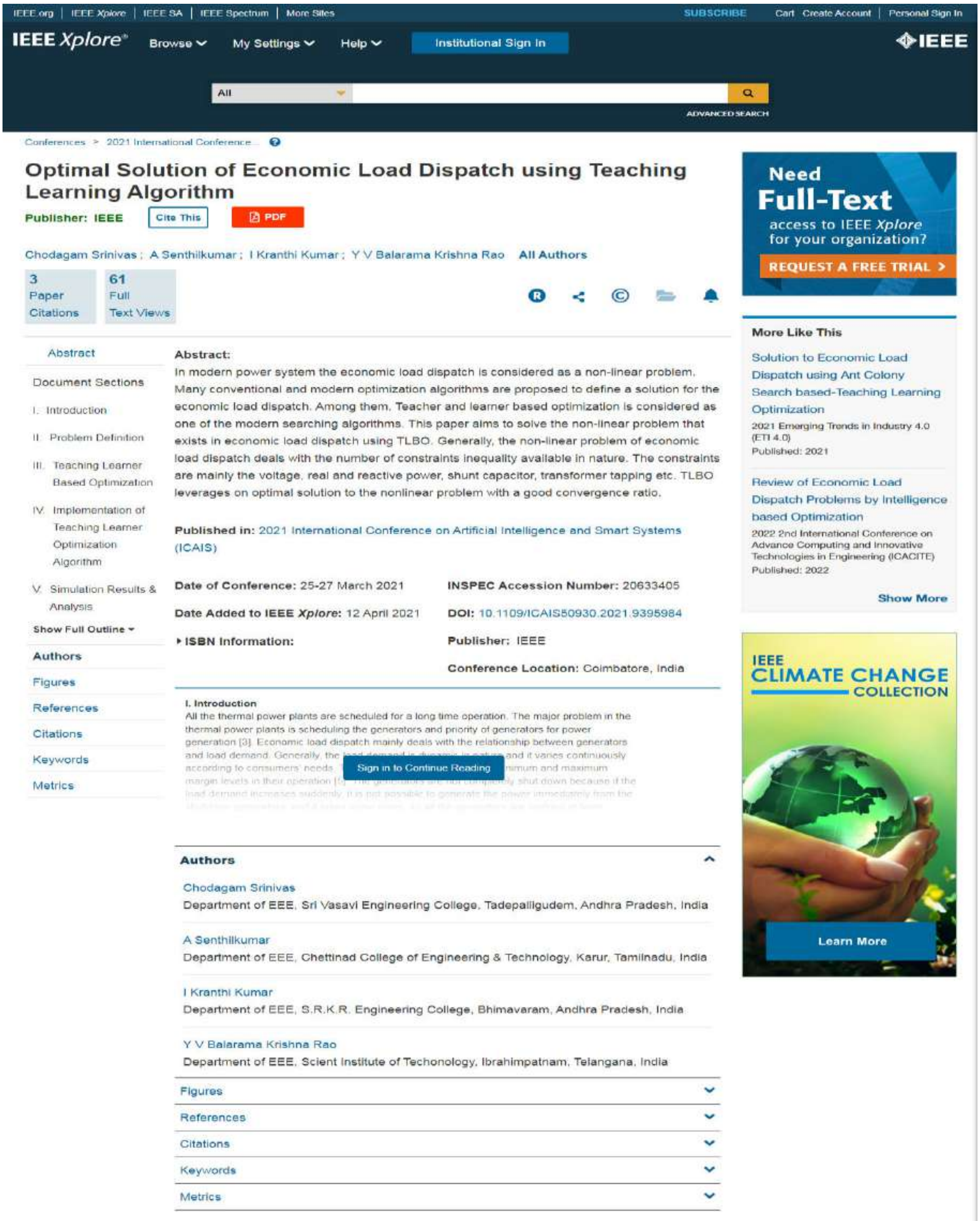

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Abstract — Document Sections — I. Introduction — II. Problem Definition — III. Teaching Learner Based Optimization — IV. Implementation of Teaching Learner Optimization Algorithm — V. Simulation Results & Analysis — Show Full Outline — Authors — Figures — References — Citations — Keywords — Metrics

Abstract:
In modern power system the economic load dispatch is considered as a non-linear problem. Many conventional and modern optimization algorithms are proposed to define a solution for the economic load dispatch. Among them, Teacher and learner based optimization is considered as one of the modern searching algorithms. This paper aims to solve the non-linear problem that exists in economic load dispatch using TLBO. Generally, the non-linear problem of economic load dispatch deals with the number of constraints inequality available in nature. The constraints are mainly the voltage, real and reactive power, shunt capacitor, transformer tapping etc. TLBO leverages on optimal solution to the nonlinear problem with a good convergence ratio.

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I. Introduction
All the thermal power plants are scheduled for a long time operation. The major problem in the thermal power plants is scheduling the generators and priority of generators for power generation [3]. Economic load dispatch mainly deals with the relationship between generators and load demand. Generally, the ... and it varies continuously according to consumers' needs ... minimum and maximum

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Optimal Solution of Economic Load Dispatch using Teaching Learning Algorithm

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ABSTRACT:

In modern power system the economic load dispatch is considered as a non-linear problem. Many conventional and modern optimization algorithms are proposed to define a solution for the economic load dispatch. Among them, Teacher and learner based optimization is considered as one of the modern searching algorithms. This paper aims to solve the non-linear problem that exists in economic load dispatch using TLBO. Generally, the non-linear problem of economic load dispatch deals with the number of constraints inequality available in nature. The constraints are mainly the voltage, real and reactive power, shunt capacitor, transformer tapping etc. TLBO leverages on optimal solution to the non-linear problem with a good convergence ratio.

Keywords: Differential evolution, Economic load dispatch, Multi objective optimization, PSO.

I. INTRODUCTION

All the thermal power plants are scheduled for a long time operation. The major problem in the thermal power plants is scheduling the generators and priority of generators for power generation [3]. Economic load dispatch mainly deals with the relationship between generators and load demand. Generally, the load demand is dynamic in nature and it varies continuously according to consumers' needs. The generators will always have minimum and maximum margin levels in their operation [5]. The generators are not completely shut down because if the load demand increases suddenly, it is not possible to generate the power immediately from the shutdown generators, and it takes some times, so all the generators are working at least working in the banking mode.

The fuel cost characteristics curve gives the total cost of power generation consumed by each generator. By using economic load dispatch, the generators operating range will be selected based on the following factors:

i) To satisfy the load demand.
ii) Maintaining all the constraints within limits.

The economic load dispatch is solved by using NR, GS methods conventionally.

Several optimization techniques are also used to solve the ELD and produce better results previously.

The necessity of modern optimization technique is the convergence ratio. Many conventional methods found solution like linear, non-linear programming but the sometimes the constraints are not satisfied. Quadratic programming is used to find the optimal solution, but the size of the problem affects the convergence ratio and it is high. In modern era the PSO, GA, ANN techniques are applied to test the benchmark functions and found better results with good convergence ratio [8], [11]. TLBO is also considered as one of the most popular searching algorithms in recent times. ELD search space is non linear and the constraints operation within the specified limits are difficult. The TLBO is applied to the standard ELD function in this paper and TLBO is evaluated with other searching algorithms [1], [2], [4].

II. PROBLEM DEFINITION

Here the non-linear problem with inequality is shown below with two variables x, u and the main aim to obtain the minimum value and it is expressed as

$$\text{Mini } j(x,u) \quad (1)$$

Subject to

$$k_n(x,u) = 0 \quad (2)$$

$$j_{min} \leq j(x,u) \leq j_{max} \quad (3)$$

The equation (1) shows the primary objective i.e., minimization of cost, the equation (2) shows how to minimize the considered function and the equation (3) shows the non-linearity by considering the inequality constraints.

Variable x is the representation of state factor. The vector contains the data of power system network real, reactive power, node voltages, and phase angle and represented as follows:

$$u = \{P_{G1}..P_{Gn}, Q_{G1}..Q_{Gn}, V_{i1}..V_{in}, \delta_{i1}..\delta_{in}\} \quad (4)$$

Optimal flow or economic load dispatch having two types of constraints:

i) Equality Constraints,
ii) Inequality Constraints.

Equality constraint:

In this constraint, the total power generation is always equal to total load demand (P_D) and losses in the system (P_L) and it will be represented as

$$\sum_{i=1}^{n} P_g = P_D + P_L \quad (5)$$

The above equations exhibit the property of linearity and very easy find optimal power generation cost.

Inequality constraints:

Real power generation & reactive power limits of the generator, node voltage limits, and load angle swing limits, transformer tapings, and reactive power support from the capacitor banks are considered.

$$P_{gi}^{min} \leq P_{gi} \leq P_{gi}^{max}, i = 1,2,3, \dots n \quad (6)$$

$$Q_{gi}^{min} \leq Q_{gi} \leq Q_{gi}^{max}, i = 1,2,3, \dots n \quad (7)$$

The equation (6), (7) shows the real and reactive power limitations of various generators considered in the proposed system or in a plant is expressed inequality constraints. These two parameters are also helpful to load flow analysis in load bus.

$$V_i^{min} \leq V_i \leq V_i^{max}, i = 1,2,3, \dots n \quad (8)$$

$$\delta_i^{min} \leq \delta_i \leq \delta_i^{max}, i = 1,2,3, \dots n \quad (9)$$

Equations (8), (9) show the node point voltage and load angle with inequality constraints in the considered testing system.

$$T_n^{min} \leq T_n \leq T_n^{max}, n = 1,2,3, \dots k \quad (10)$$

The equation (10) shows the transformer tap settings considered to adjust proper voltage levels maintenance according to load demand with inequality constraints.

$$Q_{si}^{min} \leq Q_{si} \leq Q_{si}^{max}, i = 1,2,3, \dots n \quad (11)$$

The above equation shows the capacitor bank support according to reactive power requirement as well as load demand with inequality constraints.

Fuel cost minimization is the primary objective function and is represented as follows and the function is the cost coefficient equation of each generator [3], [14]. All the equations from (6) – (11), are the non-linear equations and by satisfying the all these constraints to get the optimal power generation cost. While the traditional iteration methods sometimes fail to reach the best power generation cost.

Considered problem statement and its minimum function is expressed as

$$\min(f) = \sum_{i=1}^{n} f_n(P_{gi}) \quad (12)$$

The quadratic nature of the generators used in the power generation in thermal power plants.

$$\text{Where } f_n P_{gi} = a_i + b_i P_{gi} + c_i P_{gi}^2 \quad (13)$$

III. TEACHING LEARNER BASED OPTIMIZATION

The algorithm is explained in the different phases:

i) Teacher Phase
ii) Learner's Phase

In this algorithm, teacher phase is the deciding phase and it generates the solution which is used for learners phase as an input and the learner's phase are for the fitness function [1], [2], [7].

Teacher phase:

Number of generators/fuel cost characteristics is considered as the designed parameters or simply number of subjects in the class room. The primary aim of the teacher is to increase the knowledge of the learners and improve the percentage of exam clearing learners and mean value of marks in the subjects. If the mean value is increased then the best solution is achieved by his or her. The best solution is treated as the teacher in this algorithm [2], [4].

The mean value is calculated by using equation

$$X_{solnew} = X_{solold} + r\,(X_{best} - (T_F)\,MEAN) \quad (14)$$

Where MEAN is mean value of the working generators in the plant.

T_F is teaching factor and it is generated by using a random number r and the value of T_F is always either 1 or 2.

$$TF = rand*[1+rand\ (0,\ 1)\ \{2-1\}] \quad (15)$$

In TLBO, population size a designed variable are treated only input parameters not teaching factor. After the calculation of mean difference updated the solution and consider this solution as input to the learner's phase [1].

Learners phase:

In the TLBO the second phase is learners phase, in this phase one intelligent learner is identified by the teacher and the learner knowledge is updated by sharing the knowledge with other learner. At that time both the learners are updating their knowledge. Let us consider two learners A&B, both learners sharing knowledge and in the process of sharing their knowledge will be improved and updated. Now compare the mean value difference of two learners and the better learner acts as the teacher in the next stage. The intelligent learner becomes teacher indicates the fitness function and the best solution is treated as the teacher in the first phase.

IV. IMPLEMENTATION OF TEACHING LEARNER OPTIMIZATION ALGORITHM

step 1 : Initialization of population.

step 2 : Creating criterion of termination.

step 3 : Determine the design variables mean value of each one.

step 4 : Recognize the best solution and estimate the variables.

step 5 : Update the estimated variable values based on the available best solution. Using equation (14).

step 6 : Now check the updated solution is better than current solution or not. If it is not better than the current solution rejects the updated/modified solution. Continue with previous solution.

step 7 : If the updated solution is better than existing solution then select randomly two sets of solutions named X_i and X_j

step 8 : Update the two solutions by the consideration of $X_i > X_j$ and $X_j > X_i$ in a two different cases.

step 9 : Compare the two different cases of solution. If any case violating limits rejected the solution but if the both solutions satisfies all the limits consider the best solution among them.

step 10 : Check the solution is satisfies all the constraints or not.

step 11 : If it doesn't satisfies the then go to mean difference of design variable i.e. step 3.

step 12 : Otherwise it is the global best solution.

Here in the implementation of TLBO based ELD solution, all the cost curve function data is read and the mean value of the all generators are calculated based on the population used in the algorithm.

In the implementation of TLBO, the students are treated as solutions of economic load dispatch problem the subjects are considered as different constraints as mentioned in section II. The student able to satisfy the minimum levels and which are gets the best among the remaining students, that particular student is treated as best and in this algorithm implementation the student is treated as best solutions of economic load dispatch.

The main objective of the ELD is minimum cost function, so from the available values, the local minimum value is treated as a teacher and teacher phase is started from this point. Once the teacher phase started, the learner knowledge levels are improved by the teacher (available solution is tested with all the constraints are satisfying or not) and the new knowledge levels (new solution) is obtained by equation (14). The new solution is obtained from the teacher phase then all the possible solutions are obtained by ending of teachers phase. Now the learners phase begins here, all the learners interacting with each other (solutions which are available from teachers phase are compared). When the algorithm reaches the maximum iterations, the best learner becomes the teacher (among the available solution one solution is treated as the best like global best solution by comparing the all constraints satisfaction and minimum cost value).

V. SIMULATION RESULTS & ANALYSIS

The TLBO algorithm is tested on the standard test system IEEE-30 bus system which consists of six no. of generators in various locations in the network, each generator has its own cost coefficients and cost curve [9], [10], and [13]. The generator active power limitations are considered here as shown in table I along with price coefficients [3], [5]. #indicates the generator is in the working condition; sometimes generators are kept in banking mode and shunt-down when load demand is comparative less with the generated power as per historical data and load predications.

Table I: Standard Power plant with six generators limitations data "IEEE-30 bus system"

Generator number	Price cost coefficients			Min MW	Max MW
	a	b	C		
#1	0.0	2.00	0.00375	50	200
#2	0.0	1.75	0.01750	20	80
#5	0.0	1.00	0.06250	10	50
#8	0.0	3.25	0.00834	10	35
#11	0.0	3.00	0.02500	10	30
#13	0.0	3.00	0.02500	12	40

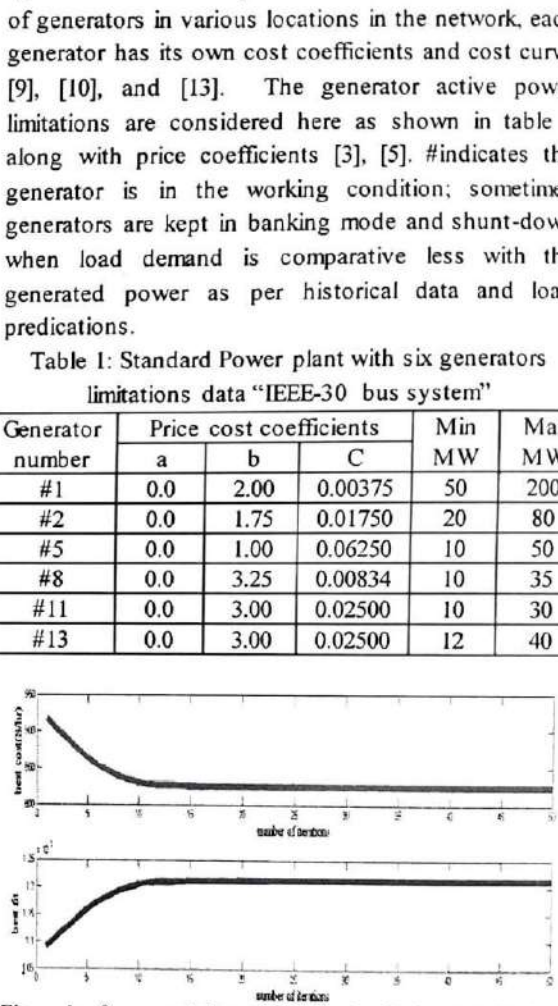

Figure 1: after completion of 50 iteration fuel cost under load demand 283.5MW.

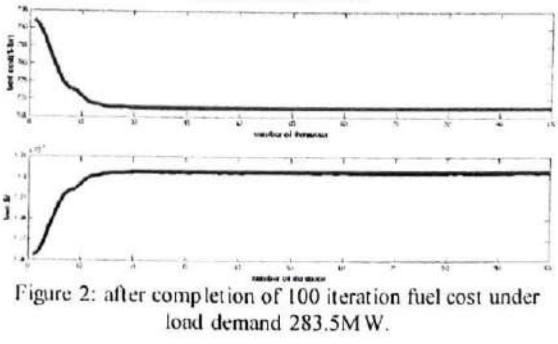

Figure 2: after completion of 100 iteration fuel cost under load demand 283.5MW.

two examples, each fish/bird has individual knowledge and they move with the swarm for the global best solution. If they are limited with individual knowledge it is treated as the local best and by considering and sorting of local best solutions, the global best is developed [5]. The particle swarm optimization has the local trap disadvantage various types of improved and modified versions of PSO algorithms [6]-[8], addressed the economic load dispatch by considering time-varying double-weighted PSO [9], chaotic particle swarm optimization [10], biogeography-based learning particle swarm optimization[11], multi-area economical load dispatch problem addressed by evolutionary particle swarm optimization [12], improved quantum particle swarm optimization [13], improved coordinated aggregation based PSO [5].

In this modern era, different new approaches are developed for non-linear problems and many of the algorithms addressed the economic load dispatch problem. Presently the power consumption is continuously increasing, leads to the DG system concept using renewable energy resources like solar and wind most commonly. The uncertainties are very high in this type of microgrid systems interconnected generator scheduling. Approximate dynamic programming (ADP) is one of the effective algorithms that addressed the economic load dispatch in grid-connected microgrid systems. Historical data is used for the improvement of accuracy in generator operation and scheduling by calculating error distribution in an effective manner [14]. Valve point loading and unscheduled add-on loads lead to deviating the optimal solution.

Kho-kho is another new optimization algorithm is developed by abhishek srivastava & dushmanta kumar das, which addressed the combined emission economic dispatch and combined heat & power economic dispatch problems. Kho-kho algorithm is examined under 29 benchmark functions, superior performance is exhibited comparably other existing [15].

Whale optimization is one of the new meta-heuristic techniques developed and examined in this modern era. This algorithm addressed several benchmark non-linear functions. combined heat & power economic load dispatch problem is addressed by whale optimization algorithm with different permutation and combination of power & heat units and the optimal solution is obtained [16]. Self-adaptive-based cuckoo search is one of the modified versions of the traditional cuckoo algorithm, addressed the non-linear problem of economic load dispatch and satisfactory results are generated [17]. Grey wolf optimization technique is also applied to economical load dispatch by moumita pradhan, provas kumar roy, tandra pal, performance is examined and gets better results [18].

The teaching-learning-based optimization (TLBO) algorithm is developed in recent years and it successfully addressed many benchmark non-linear fumctions[19]-[21]. Economical load dispatch problem is addressed by the TLBO algorithm and obtained the optimal results using less no. of variables [22].

II. Problem Statement

Here the problem is defined as:

$$\sum C_{Min} f(z,u) \qquad (1)$$

Subject to

$$f_{min} \leq f(z,u) \leq f_{max} \qquad (2)$$

Variable x is the representation of the state factor. All the data related to the concerned power plant is represented in the vector which contains real power, reactive power, node voltages, power angle, and transformer tap settings. Economic load dispatch is a combined function of both equality and inequality constraints. The equality constraint relates the power generation and load demand; here the transmission losses are neglected.

$$\sum_{j=1}^{n} P_j = P_D \qquad (3)$$

$$\min(C) = \sum_{i=1}^{n} C_n(P_{Gi}) \qquad (4)$$

$$where\ P_{Gi} = a_i + b_i P_i + c_i P_i^2 \qquad (5)$$

The inequality constraints are represented as:

$$P_j^{min} \leq P_j \leq P_j^{max}, j = 1,2,3, \ldots . n \qquad (6)$$

$$Q_j^{min} \leq Q_j \leq Q_j^{max}, j = 1,2,3, \ldots . n \qquad (7)$$

$$V_j^{min} \leq V_j \leq V_j^{max}, j = 1,2,3, \ldots . n \qquad (8)$$

$$\delta_j^{min} \leq \delta_j \leq \delta_j^{max}, j = 1,2,3, \ldots . n \qquad (9)$$

$$T_j^{min} \leq T_j \leq T_j^{max}, j = 1,2,3, \ldots . k \qquad (10)$$

$$Q_j^{min} \leq Q_j \leq Q_j^{max}, j = 1,2,3, \ldots . n \qquad (11)$$

III. *Proposed Algorithm*

The teaching-learning-based optimization technique is inspired by the classroom concept and it is quite easier to understand while considering/mapping the real-time constraints with the classroom concept. In general students/stakeholders get the knowledge in two ways. The first one is a purely teacher-oriented method, the second one is sharing the knowledge/information of students among them.

The same system is represented in the TLBO, to get the optimal solution for the non-linear problem. The convergence rate is very high and this algorithm doesn't need any additional algorithm variables. In a classroom the student's IQ levels are different and their knowledge, skill levels are considered as different inequality constraints and represent the non-linearity in the function. The execution of the algorithm is divided into two phases. They are i). Teacher Phase, ii). Learner/student Phase.

In the teacher phase, based on the strength or knowledge of the teacher the students improve their knowledge and information. The learners improve their knowledge based on

$$\boldsymbol{Z_{new} = Z_i + rand(0,1) * (Z_{teacher} - (T_F Z_{mean}))} \qquad (14)$$

Rand(0,1) gives the different solutions and it represents the various knowledge levels of students who are represented in the class.

ii). Learner Phase: in this phase, the learners/students exchange their information/knowledge, which is gained in the teacher phase. In that teacher phase, only the mean value is calculated by considering their class or based on the total number of students' knowledge level. The new level of learner's knowledge is represented by

$$\boldsymbol{Z_{new} = Z_i + rand(0,1) * (Z_i - Z_{ii})} \qquad (15)$$

Here Z_i *and* Z_{ii} are the two different learner's and based on their levels the Z_i+based on the random value the difference in knowledge is added and $Z_{new}$is updated, considered as a

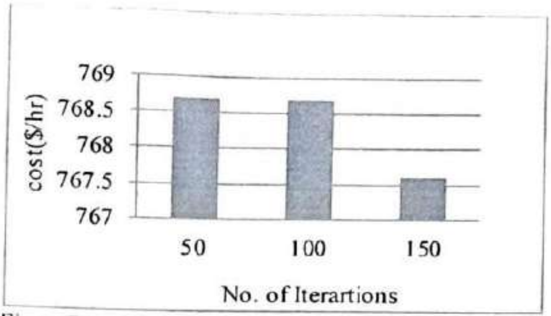

Figure 7: cost variation w.r.t. iterations@283.5MW

Figure 7 shows the fuel cost ($/hr) variations/changes according to the iterations which are considered in the test case as 50, 100, and 150. At 150iterations the change in cost is observed but significantly it is very low nearly $1 when load demand is 283.5MW. It shows that by using TLBO, the optimal fuel cost is achieved very quickly as observed in figure 1 to 6 as above. The power generation (MW) sharing is shown in pie chart form among the six generators in IEEE 30 bus system. Here two different load demands are separately shown for power sharing with different number of iterations.

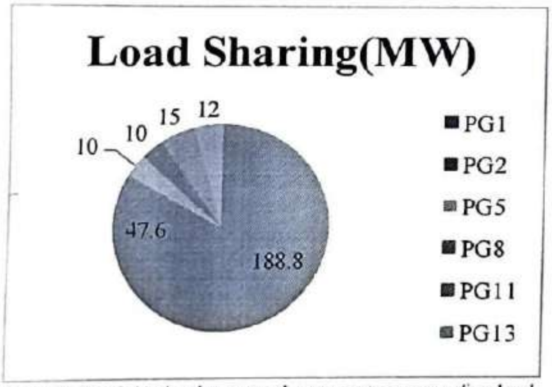

Figure 8: load sharing between the generators according load demand 283.5MW with 50 iterations.

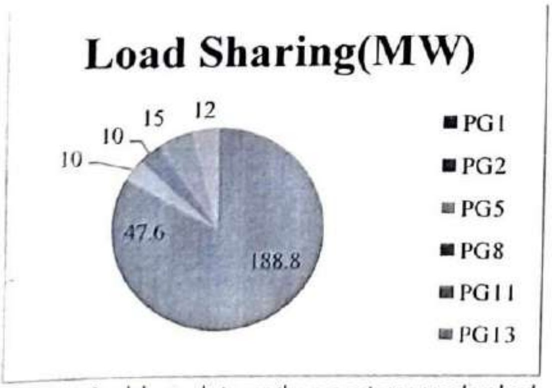

Figure 10 load sharing between the generators according load demand 283.5MW with 100 iterations.

Fig. 8-10 represents power generation sharing between the six generators based on the load demand 283.5MW. Here the convergence of the algorithm shows very fast and the sharing power generation doesn't vary from 50-150 iterations and it shows the fastness of the TLBO convergence.

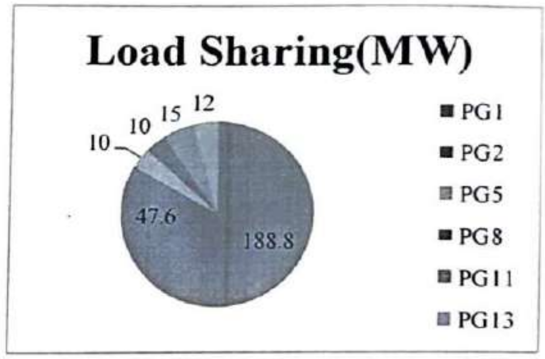

Figure 11: load sharing between the generators according load demand 283.5MW with 150 iterations.

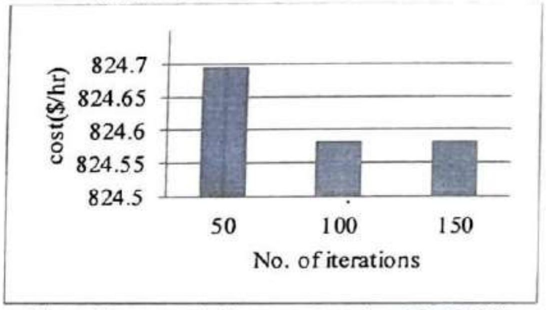

Figure 12: cost variation w.r.t. iterations@300MW

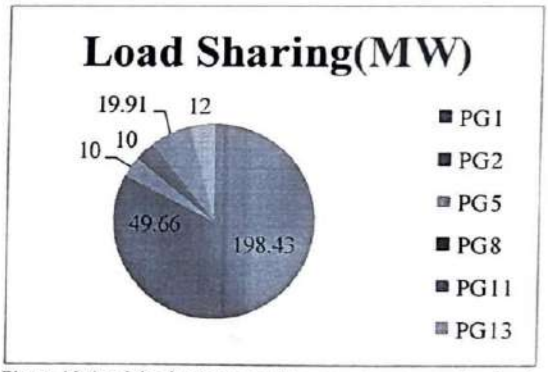

Figure 13: load sharing between the generators according load demand 300MW with 50 iterations.

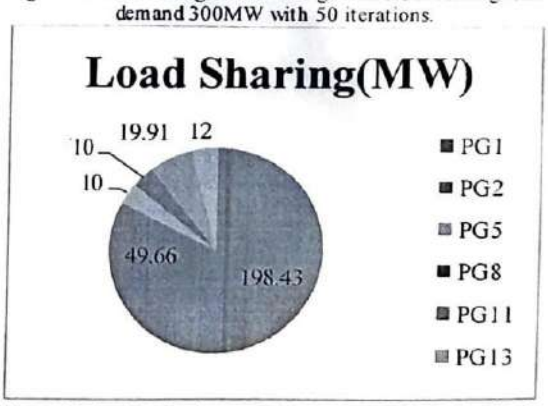

Figure 14: load sharing between the generators according load demand 300MW with 100 iterations.

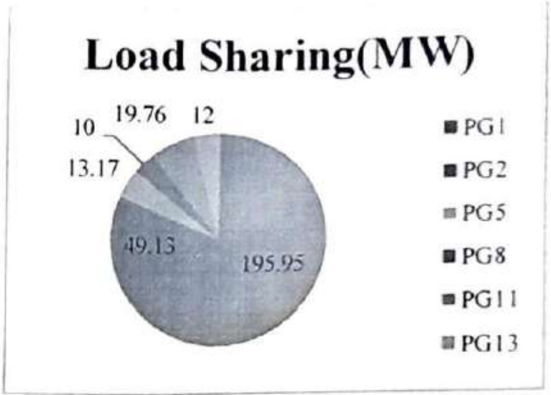

Figure 15: load sharing between the generators according load demand 300MW with 150 iterations

The load sharing of total load demand by six generators are continuously varying according to no. of iterations, it shows the robustness of the TLBO algorithm with the help of figure 12 to 15. With the load demand 300 MW along with iterations changes.

Table 3: Generation cost comparison with TLBO, PSO and conventional Gradient approach.

Units	Min	Max	TLBO	Gradient Based	Power simulator world
1	50	200	185.40	187.219	197.99
2	20	80	46.87	53.781	44.00
5	10	35	10	16.955	22.00
8	10	30	10	11.288	10.00
11	15	50	19.12	11.287	10.00
13	12	40	12	13.353	12.00
Fuel cost($\hr)			767.6021	$804.853	$811.5

Table 3 shows the optimal power generation cost of IEEE 30 bus system under same constraints with three different approaches compared and the proposed algorithm shows the superiority and the optimal cost sounds the algorithm robustness and accuracy with less number of control variables.

IV. CONCLUSION

Proposed algorithm tested and satisfies the various equality and inequality constraints which are considered in optimal load dispatch. The optimal solution of economic load dispatch gives the best generation cost and load demand is shared according to their generation cost function solutions obtained by TLBO. Here the algorithm is tested with different load demands while is the TLBO is sustained for dynamic changes in the power systems. For better time convergence understanding purposes the different iterations are considered along with load demand conditions which are used in ELD problems. Under all the tested conditions optimal cost is obtained without violating the generator limits in any condition. The optimal solutions is also achieved in less no. of iterations with this algorithm but for any possibility of changes it is tested up to 150 iterations and at each is trial 10 means values are considered.

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Paper Title: **OPTIMAL SOLUTION OF ECONOMIC LOAD DISPATCH USING TEACHING LEARNING ALGORITHM**

Author/s: **Chodagam Srinivas, I Kranthi Kumar, A Senthilkumar, Y V Balarama Krishna Rao**

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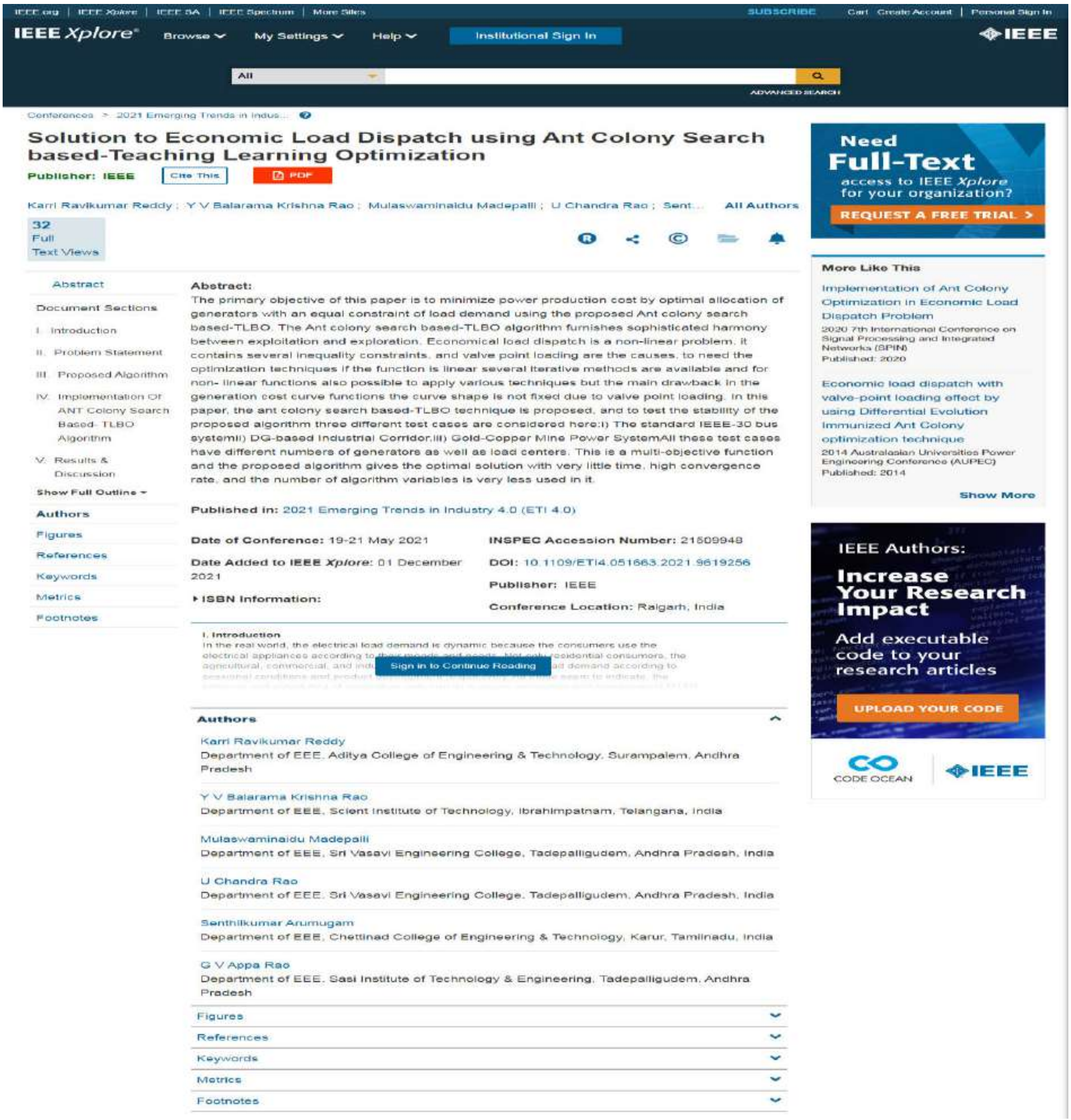

Solution to Economic Load Dispatch using Ant Colony Search based-Teaching Learning Optimization

Publisher: IEEE Cite This PDF

Karri Ravikumar Reddy ; Y V Balarama Krishna Rao ; Mulaswaminaidu Madepalli ; U Chandra Rao ; Sent... All Authors

Abstract:
The primary objective of this paper is to minimize power production cost by optimal allocation of generators with an equal constraint of load demand using the proposed Ant colony search based-TLBO. The Ant colony search based-TLBO algorithm furnishes sophisticated harmony between exploitation and exploration. Economical load dispatch is a non-linear problem. it contains several inequality constraints, and valve point loading are the causes, to need the optimization techniques if the function is linear several iterative methods are available and for non- linear functions also possible to apply various techniques but the main drawback in the generation cost curve functions the curve shape is not fixed due to valve point loading. In this paper, the ant colony search based-TLBO technique is proposed, and to test the stability of the proposed algorithm three different test cases are considered here:i) The standard IEEE-30 bus systemii) DG-based Industrial Corridor,iii) Gold-Copper Mine Power SystemAll these test cases have different numbers of generators as well as load centers. This is a multi-objective function and the proposed algorithm gives the optimal solution with very little time, high convergence rate, and the number of algorithm variables is very less used in it.

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I. Introduction
In the real world, the electrical load demand is dynamic because the consumers use the electrical appliances according to ... residential consumers, the agricultural, commercial, and ind... Sign in to Continue Reading ...ad demand according to

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A solution to economic load dispatch using ANT colony search based-Teaching Learning based optimization

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Abstract :

The primary objective of this paper is to minimize power production cost by optimal allocation of generators with an equal constraint of load demand using the proposed Ant colony search based-TLBO. The Ant colony search based _TLBO algorithm furnishes sophisticated harmony between exploitation and exploration. Economical load dispatch is a non-linear problem, it contains several inequality constraints, and valve point loading are the causes, to need the optimization techniques if the function is linear several iterative methods are available and for non-linear functions also possible to apply various techniques but the main drawback in the generation cost curve functions the curve shape is not fixed due to valve point loading. In this paper, the Ant colony search based -TLBO technique is proposed, and to test the stability of the proposed algorithm three different test cases are considered here:

i. The standard IEEE-30 bus system
ii. DG-based Industrial Corridor.
iii. Gold-Copper Mine Power System

All these test cases have different numbers of generators as well as load centers. This is a multi-objective function and the proposed algorithm gives the optimal solution with very little time, high convergence rate, and the number of algorithm variables is very less used in it.

Keywords: *Ant Colony Search, Economic Load Dispatch(ELD), Equality Constraints, Evolutionary Algorithm, Inequality Constraints, Load Demand, Teacher-Learner Optimization.*

I. Introduction

In the real world, the electrical load demand is dynamic because the consumers use the electrical appliances according to their moods and needs. Not only residential consumers, the agricultural, commercial, and industrial loads are also varying the load demand according to sessional conditions and product development respectively. All these seem to indicate, the planning and scheduling of generators very crucial in power generation and management [1]-[3].

Economical load dispatch and unit commitment play a significant role in power generation. Mainly economic load dispatch is used to find the low-cost power production by optimal allocation of generators in the power plants. Economic load dispatch is a non-linear problem, various equality and inequality constraints are considered in terms of load demand, voltage, real & reactive power flows, shunt capacitances, and transformer tap settings [3]. Traditional linear programming is fit for the economic load dispatch problems due to its non-linear nature in the cost curve characteristics. The non-linear programming & quadratic programs are also addressed constraints due to valve point loading, ramp rate limits are incorporated in the objective function. Various traditional optimization techniques are addressed the economic load dispatch problem and obtained fruitful results by satisfying all the constraints.

The valve point loading, ramp rate limits, and multi-fuel inputs are causes the cost curve to shape not in a regular manner and pieces wise nature they conventional methods are given compromised solutions with constraints which are considered in economic load dispatch problems. For competitive satisfactory results, the traditional optimization techniques are addressed the economic load dispatch problem and get satisfactory results. Initially, the classic calculus techniques considered to solve the economic load dispatch problem like lambda method, interior point method, gradient method, linear programming methods[4] for linear nature of the economic load dispatch. But due to the non-linearity all the above methods not reaching the best solution so it leads to numerical techniques quadratic programming and dynamic programming [4] to address the non-linearity. Future optimization techniques are used to solve the economic load dispatch problem to avoid the effect of non-linearity. Differential evaluation, genetic algorithm, evolutionary programming, simulated annealing, harmony search, artificial immune network, tabu search, ant colony optimization, bacterial foraging optimization, cuckoo search optimization, grey wolf optimization.

Particle swarm optimization is inspired by natural social behavior like "fish schooling" and "bird flocking". In these two examples, each fish/bird has individual knowledge and they move with the swarm for the global best solution. If they are limited with individual knowledge it is treated as the local best and by considering and sorting of local best solutions, the global best is developed [5]. The particle swarm optimization has the local trap disadvantage various types of improved and modified versions of PSO algorithms [6]-[8], addressed the economic load dispatch by considering time-varying double-weighted PSO [9], chaotic particle swarm optimization [10], biogeography-based learning particle swarm optimization[11], multi-area economical load dispatch problem addressed by evolutionary particle swarm optimization [12], improved quantum particle swarm optimization [13], improved coordinated aggregation based PSO [5].

In this modern era, different new approaches are developed for non-linear problems and many of the algorithms addressed the economic load dispatch problem. Presently the power consumption is continuously increasing, leads to the DG system concept using renewable energy resources like solar and wind most commonly. The uncertainties are very high in this type of microgrid systems interconnected generator scheduling. Approximate dynamic programming (ADP) is one of the effective algorithms that addressed the economic load dispatch in grid-connected microgrid systems. Historical data is used for the improvement of accuracy in generator operation and scheduling by calculating error distribution in an effective manner [14]. Valve point loading and unscheduled add-on loads lead to deviating the optimal solution.

Kho-kho is another new optimization algorithm is developed by abhishek srivastava & dushmanta kumar das, which addressed the combined emission economic dispatch and combined heat & power economic dispatch problems. Kho-kho algorithm is examined under 29 benchmark functions, superior performance is exhibited comparably other existing [15].

Whale optimization is one of the new meta-heuristic techniques developed and examined in this modern era. This algorithm addressed several benchmark non-linear functions. combined heat & power economic load dispatch problem is addressed by whale optimization algorithm with different permutation and combination of power & heat units and the optimal solution is obtained [16]. Self-adaptive-based cuckoo search is one of the modified versions of the traditional cuckoo algorithm, addressed the non-linear problem of economic load dispatch and satisfactory results are generated [17]. Grey wolf optimization technique is also applied to economical load dispatch by moumita pradhan, provas kumar roy, tandra pal, performance is examined and gets better results [18].

The teaching-learning-based optimization (TLBO) algorithm is developed in recent years and it successfully addressed many benchmark non-linear fumctions[19]-[21]. Economical load dispatch problem is addressed by the TLBO algorithm and obtained the optimal results using less no. of variables [22].

II. Problem Statement

Here the problem is defined as:

$$\sum C_{Min} f(z,u) \quad (1)$$

Subject to

$$f_{min} \le f(z,u) \le f_{max} \quad (2)$$

Variable x is the representation of the state factor. All the data related to the concerned power plant is represented in the vector which contains real power, reactive power, node voltages, power angle, and transformer tap settings. Economic load dispatch is a combined function of both equality and inequality constraints. The equality constraint relates the power generation and load demand; here the transmission losses are neglected.

$$\sum_{j=1}^{n} P_j = P_D \quad (3)$$

$$\min(C) = \sum_{i=1}^{n} C_n(P_{Gi}) \quad (4)$$

$$where\ P_{Gi} = a_i + b_i P_i + c_i P_i^2 \quad (5)$$

The inequality constraints are represented as:

$$P_j^{min} \le P_j \le P_j^{max}, j = 1,2,3, \dots n \quad (6)$$

$$Q_j^{min} \le Q_j \le Q_j^{max}, j = 1,2,3, \dots n \quad (7)$$

$$V_j^{min} \le V_j \le V_j^{max}, j = 1,2,3, \dots n \quad (8)$$

$$\delta_j^{min} \le \delta_j \le \delta_j^{max}, j = 1,2,3, \dots n \quad (9)$$

$$T_j^{min} \le T_j \le T_j^{max}, j = 1,2,3, \dots k \quad (10)$$

$$Q_l^{min} \le Q_j \le Q_j^{max}, j = 1,2,3, \dots n \quad (11)$$

III. *Proposed Algorithm*

The teaching-learning-based optimization technique is inspired by the classroom concept and it is quite easier to understand while considering/mapping the real-time constraints with the classroom concept. In general students/stakeholders get the knowledge in two ways. The first one is a purely teacher-oriented method, the second one is sharing the knowledge/information of students among them.

The same system is represented in the TLBO, to get the optimal solution for the non-linear problem. The convergence rate is very high and this algorithm doesn't need any additional algorithm variables. In a classroom the student's IQ levels are different and their knowledge, skill levels are considered as different inequality constraints and represent the non-linearity in the function. The execution of the algorithm is divided into two phases. They are i). Teacher Phase, ii). Learner/student Phase.

In the teacher phase, based on the strength or knowledge of the teacher the students improve their knowledge and information. The learners improve their knowledge based on

$$\boldsymbol{Z_{new} = Z_i + rand(0,1) * (Z_{teacher} - (T_F Z_{mean}))} \quad (14)$$

Rand(0,1) gives the different solutions and it represents the various knowledge levels of students who are represented in the class.

ii). Learner Phase: in this phase, the learners/students exchange their information/knowledge, which is gained in the teacher phase. In that teacher phase, only the mean value is calculated by considering their class or based on the total number of students' knowledge level. The new level of learner's knowledge is represented by

$$\boldsymbol{Z_{new} = Z_i + rand(0,1) * (Z_i - Z_{ii})} \quad (15)$$

Here Z_i *and* Z_{ii} are the two different learner's and based on their levels the Z_i+based on the random value the difference in knowledge is added and Z_{new} is updated. considered as a

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solution for the given objective function. Here onwards the EA acts into force, by considering total student (population) solutions to avoid local minima trap. the solutions/students knowledge levels are arranged in a systematic order in classroom first position to the last position based on their knowledge levels. With this type of arrangement, the first position learner easily acts as a teacher in the next level. The evolutionary algorithm is used for rearranging students according to their knowledge levels with the directional way of descending order.

Ant colony search:

In 1992 macro dorigo very first time used the concept of ant colony optimization in his ph.d thesis to address the non-linear problems [23]. Ant colony optimization is inspired by nature. Simply the self-organization and modification according to surrounding environmental conditions. Now consider the ant food search case, here ant moves towards the food source, and in that processes the node points are marked which helps for remaining ants in their food search, this communication technique is named as "pheromone" & it's a local communication technique between the ants [24].

IV. Implementation of ANT colony search based-TLBO Algorithm

step 1: Initialize the student knowledge

step 2: upgrade the student knowledge using the equation

$$X_{new} = X_i + rand(0,1) * (X_{teacher} - (T_F X_{mean}))$$

step 3: calculate the mean value of designed variables like node voltage, real power, reactive power, transformer tap setting, and shunt capacitances.

step 4: calculate the cost of the fuel required for the power generation based on load demand+losses using

$$C_i(P_j) = a_j + b_j P_j + c_j P_j^2$$

For all the generators participated in power production i.e., unit commitment.

step 5: check and update the equation while it satisfies all the constraints (both equality & inequality) or design variables.

Learner's Phase initiated

step 6: In this phase learners exchange their ideas sharing their knowledge. So here compare the solutions (solutions that satisfied all the constraints). If not then the algorithm moves back to step1.

step 7: using Ant colony search, the global/best solution is identified. The main purpose of Ant colony search is to found the global solution in less time because in the traditional TLBO there is no additional variables are used, it has the advantage in applying the optimization technique to any non-linear problem and the disadvantage is it takes much time while compared to other optimization techniques.

step 8: Here the solutions are placed in the appropriate node positions according to the objective function and all the remaining solutions which are generated by the TLBO are placed according to the ant colony global updating rule [23], [24].

step 9: finally the global solution is obtained and the algorithm is terminated.

The directional arrangement is the novelty in the proposed Evolutionary based directional TLBO. The proposed algorithm is demonstrated in three distinct cases as discussed here.

Case i: Standrad IEEE 30 Bus System

IEEE 30 bus system is a benchmark test case to check the stability of the proposed algorithm. The IEEE 30 bus system consists of six generators with different operating ranges in power generation. Six generators have different cost curve characteristics and they are tabulated shown below:

Table 1: fuel cost curve characteristics of benchmark IEEE 30 bus system

Generator No.	Price Coefficients			Min MW	Max MW
	a	b	c		
*G1	0.0	2.00	0.00375	50	200
*G2	0.0	1.75	0.01750	20	80
*G5	0.0	1.00	0.06250	10	50
*G8	0.0	3.25	0.00834	10	35
*G11	0.0	3.00	0.02500	10	30
*G13	0.0	3.00	0.02500	12	40

*indicates generators are in active conditions.

Case ii: DG Based Industrial Corridor

In this DG-based industrial corridor, the load centers are considered different categories of loads like factories, workers' residential houses, and commercial lighting. The conventional type generators i.e., diesel are used as fuel are used in this industrial corridor with a capacity of 21 MW.

The load demand is only 10.9 MW and for the load demand, one generator system is considered as a standby. The generator which is considered as a standby is completely based on cost curve characteristics and the maximum level of power generation by G6 is 6.5 MW and it is the highest among the five generators which are considered in this case.

Table 2: fuel cost curve characteristics of generators in DG-based Industrial Corridor.

Generator No.	Price Coefficients			Min MW	Max MW
	a	b	c		
*G1	40.54	103.01	17.61	1.05	2.1
*G2	40.30	105.03	16.71	1.05	2.1
*G3	41.59	104.20	17.08	1.05	2.1
*G4	43.46	100.50	18.12	1.05	2.1
*G5	81.31	87.38	0.0250	3.05	6.1
#G6	111.73	68.01	0.0250	3.25	6.5

# indicates the standby condition.

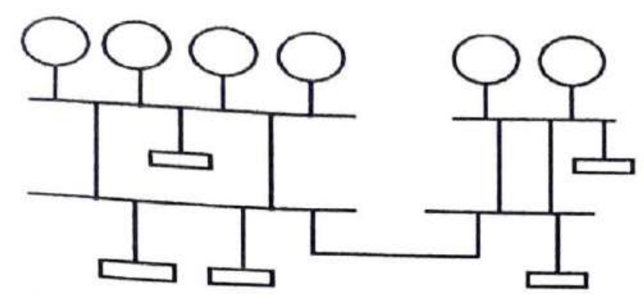

Figure 1: One line diagram of the Distributed power plant.

Case iii: Gold-Copper Mine Power System

Gold-Copper mine power plant contains 20 no. of generators, all the generators having the same range of minimum & maximum power generation capacity and 18 load points with different load natures like residential, commercial, and industrial types. The average load demand is calculated based on the load forecasting by daily database consideration. The considered load demand is 27.56MW is supplied by 11 generators out of 20 generators, 4 generators are considered as standby for any sudden changes in load demand to avoid load schedule. The remaining 5 generators are under maintenance.

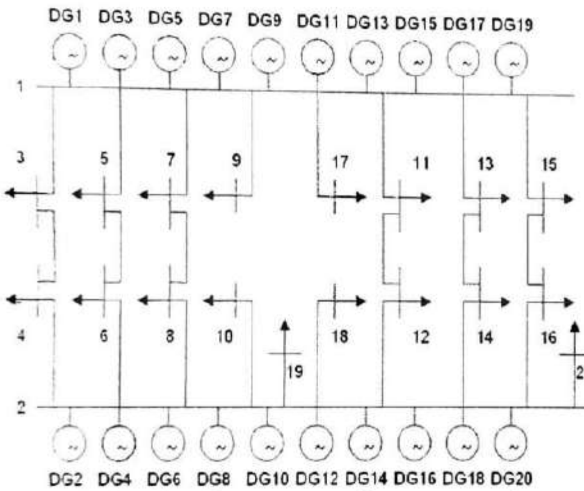

Figure 2: One line diagram created to represent the power plant with 20 no. of generators.

Table 3: fuel cost curve characteristics of generators in Gold-Copper mine power plant

Unit No	Price Coefficients			Min MW	Max MW
	a	B	c		
*G1	68.96	100.64	4.79	2.0	4.0
*G2	174.17	2.32	24.40	2.0	4.0
*G3	169.99	5.73	25.88	2.0	4.0
^G4	39.48	114.80	2.21	2.0	4.0
*G5	169.99	5.73	25.88	2.0	4.0
#G6	194.74	0.57	25.08	2.0	4.0
^G7	188.41	8.75	25.04	2.0	4.0
*G8	107.84	71.33	10.27	2.0	4.0
#G9	169.99	5.73	25.88	2.0	4.0
*G10	176.28	21.23	20.60	2.0	4.0
^G11	169.99	5.73	25.88	2.0	4.0
#G12	136.39	52.90	15.30	2.0	4.0
*G13	169.99	5.73	25.88	2.0	4.0
*G14	128.74	44.39	16.67	2.0	4.0
*G15	146.36	48.14	15.54	2.0	4.0
*G16	144.54	38.57	18.12	2.0	4.0
^G17	181.47	9.95	23.66	2.0	4.0
^G18	146.36	48.14	15.54	2.0	4.0
G19	18.29	121.40	0.85	2.0	4.0
*G20	38.37	114.34	1.12	2.0	4.0

* indicates generator in operating condition.
# shows the generators in standby mode.
^ indicates the maintenance condition.

V. Results & Discussion

The proposed algorithm is successfully tested on the three distinct cases and the results of the IEEE 30 bus system are compared with the basic TLBO algorithm; it shows the superiority of the proposed algorithm and the numerical results shows the minimum power generation cost.

Table 4: optimal load sharing among the generators in IEEE30 bus system

Units	Min. MW	Max. MW	Modified TLBO
G1	50	200	187.27
G2	20	80	45.46
G5	10	35	10.00
G8	10	30	10.52
G11	15	50	18.16
G13	12	40	12.00
Fuel price($\hr)			$767.6718

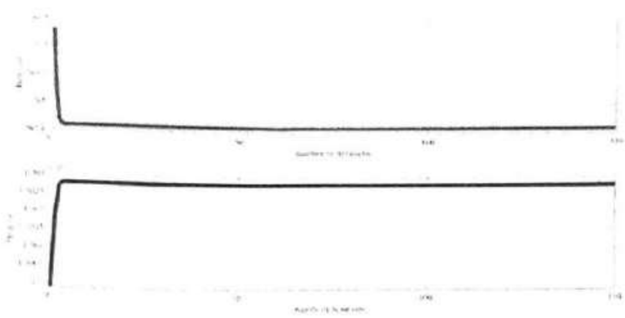

Figure 3: optimal power generation cost of IEEE 30 bus system

Table 6: optimal load sharing among the generators in DG integrated industrial park

Units	Min	Max	Proposed approach
G1	1.05	2.1	1.1177
G2	1.05	2.1	1.2565
G3	1.05	2.1	1.2194
G4	1.05	2.1	1.1177
G5	3.25	6.5	3.2500
G6	3.05	6.1	3.0500
Fuel price($\hr)			$ 454.3399

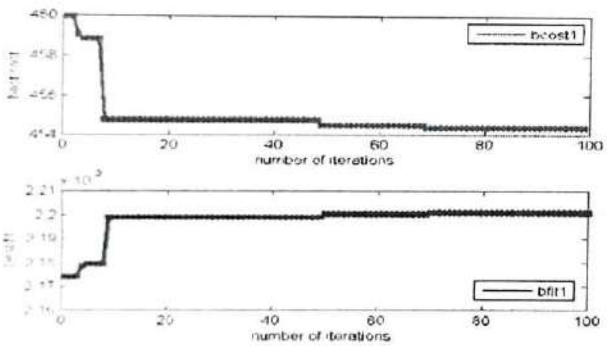

Figure 4: optimal solution of power generation cost of DG integrated industrial park.

Table 6 shows the DG integrated industrial park power generation sharing within the acceptable levels. Figure 4 shows the response of cost curve for 100 iterations and the variations/momentum change in the cost curve is observed up-to 70 iterations and the global best is achieved with a settled and smooth curve representation.

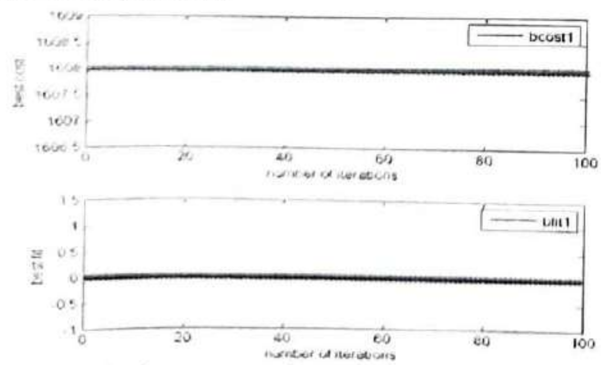

Figure 5: optimal power generation cost of gold-copper mine power system.

Table 7: optimal load sharing among the generators in gold-copper mine power plant.

Units	Min	Max	Proposed approach
G1	2.0	4.0	4.0
G2	2.0	4.0	2.813
G3	2.0	4.0	2.926
G5	2.0	4.0	2.963
G8	2.0	4.0	2.960
G10	2.0	4.0	2.942
G13	2.0	4.0	2.599
G14	2.0	4.0	2.599
G15	2.0	4.0	2.599
G16	2.0	4.0	2.599
G20	2.0	4.0	2.599
Fuel price($\hr)			$1,608.3

Table 7 shows the power generation sharing within the specified maximum and minimum MW limits of gold-copper mine power plant. Figure 5 shows the best cost and fitness levels and the proposed algorithm gives settled performances even it is tested for 100 iterations.

Table 8: comparison between conventional gradient based method, TLBO and proposed Ant colony search based-TLBO

Units	Min. MW	Max. MW	Ant colony-TLBO	Gradient Based[1]	TLBO[22]
G1	50	200	183.69	187.219	188.8
G2	20	80	48.88	53.781	47.6
G5	10	35	10.00	16.955	10
G8	10	30	10.52	11.288	10
G11	15	50	18.83	11.287	15
G13	12	40	12.00	13.353	12
Fuel price($\hr)			$767.5896	$804.853	$768.71

Table 8 shows the comparison between the proposed Ant colony search based-TLBO, TLBO and gradient based methods w.r.t. fuel price ($/hr) and proposed method shows the comparable low cost.

Conclusion

The proposed EA-TLBO algorithm has been prosperously implemented to solve non-linear problem economic load dispatch with various constraints like convex, non-convex, valve point loading, ramp rate limits and multi-fuel inputs are treated to predominantly examine stability and performance of the proposed Ant colony search based -TLBO algorithm. The proposed Ant colony search based -TLBO is tested on three distinct cases and by this manifestation, the numerical results show the performance of the algorithm is superior to the other modern optimization techniques which are discussed in the literature survey in terms of convergence rate, robustness, and accuracy. The ambitious superiority of the proposed Ant colony search based -TLBO shows that the algorithm is capable of dealing with real-world non-linear problems by providing the optimal solutions.

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Internet of Things based Data Security Management using Three Level Cyber Security Policies

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***Abstract*- The Internet of Things devices is rapidly becoming widespread, as are IoT services. Their achievement has not gone unnoticed, as threats as well as attacks towards IoT devices as well as services continue to grow. Cyber attacks are not unique to IoT, however as IoT becomes more ingrained in our lives as well as communities, it is imperative to step up as well as take cyber defense seriously. As a result, there is a genuine need to protect IoT, which necessitates a thorough understanding of the dangers and attacks against IoT infrastructure. The purpose of this study is to define threat types, as well as to assess and characterize intrusions and assaults against IoT devices as well as services**

Key words—Data Security, IoT, Internet of Things, Cyber Attack, Security Threat, Cyber Security.

I. INTRODUCTION

As a result of its ability to provide a wide range of services, the Internet of Things (IoT) has emerged as the fastest-growing technology, having a significant influence on social life as well as commercial contexts. There is a rising amount of Internet of Things (IoT) intrusion into all aspects of contemporary life. IoT involves the storage of sensitive information about individuals and organizations, financial data transfers, product development and marketing, as well. In order to fulfill the rising need for millions, if not billions, of connected devices and services throughout the world, the IoT has resulted in an enormous requirement for strong security [3][5]. Constantly, new dangers are emerging, both in terms of number and sophistication. Potential attackers and the size of networks are increasing, but the tools available to them are growing more sophisticated, efficient, and effective as well. [6][7].[8].

For IoT to reach its full potential, it must be protected from both external attacks and internal weaknesses. For the purposes of this definition, security refers to the process of protecting an item (or system) against harm such as physical damage, theft, or illegal access, while also ensuring that the object's information is kept secret and intact. A safe state for any material or intangible item, according to Kizza [7], cannot exist since no object can ever be completely secure while still being useful. To be considered secure, a process must be able to maintain its maximum intrinsic value across a wide range of conditions. The security standards for IoT systems are the same as those for other types of information and communications technology (ICT). Because of this, ensuring IoT security means maintaining everything's highest inherent worth, whether it's intangible or not. We want to improve our knowledge of threats by focusing on the characteristics (motivation and capabilities) of various invaders, such as corporations and intelligence organizations. This essay aims to do this. In order to define a complete set of security criteria and to determine if the security strategy is secure from malicious attacks, threat and vulnerability identification is important.

1.1. Understanding IoT Devices and Services

The Internet of Things [1][2] extends the Internet into real world, allowing users to interact with objects in their immediate environment. Figure 1 depicts the interconnections of entities, devices, and services in the Internet of Things domain. Depending on the project, they may have a distinct term or connotation. With regard to business processes, this part defines and categorizes key IoT concepts and explains the connections among IoT components.

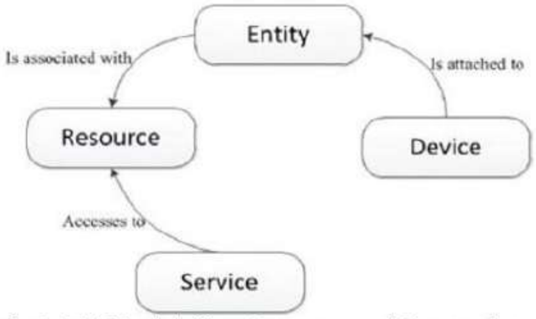


Fig.1 IoT Model: Key Concepts and Interactions

1.2. IoT Device

As a result of the presence of this device, the creature may interact with the digital world. Also known as a smart object, it may be anything networked and equipped with sensors that provide information about physical environment, actuators, and embedded computers, including household appliances, healthcare devices, vehicles, buildings, and factories. Connectivity is a key feature of the Internet of Things (IoT). Mobile (3G or LTE) and other technologies (WLAN, wireless, etc.) are only some of the ways these devices interact. Classification of Internet of Things (IoT) devices is based on a variety of factors, including their size (small or normal), mobility (mobile or fixed), power source (external or internal), connectivity (intermittent or always-on), automation (automated or non-automated), logical or physical nature, and finally, if they are IP-enabled or not.

1.3. IoT Services

Internet of Things (IoT) services make it easier for IoT things to be integrated into service-oriented architecture (SOA) and service science environments.. Service provider as well as service customer is the parties involved in an IoT service, according to Thoma. By assessing the status of things or by starting activities that will trigger a change in those entities, it enables contact with the physical world. To interact with entities and associated processes, services provide an intuitive and well-defined user interface. The services access the hosted resources of a device to reveal its functionality.

1.4 Security in IoT Devices and Services

Protecting IoT devices as well as services from internal and external unwanted access is an important part of ensuring their security. Service providers, device manufacturers, and information and data storage providers all have an interest in ensuring the security of their resources and information. Data confidentiality, privacy, and trust were the three main issues we found with Internet of Things (IoT) devices and services. In IoT devices as well as services, data confidentiality is a major issue. In the Internet of Things, not just users but also approved objects have access to data. The access control, authorization method, authentication and identity management system must be addressed in order to do this. There must be a way for an IoT device to check that the entity (human or machine) is allowed before allowing them access to the service. Authorization aids in figuring out whether or not a person or device are eligible for a service after being identified. Access control is the process of giving or denying users access to resources based on a variety of criteria. The use of authorization as well as access control is critical when connecting various devices and services in a safe manner. The most pressing problem in this situation is making it simpler to establish, understand, and modify access control rules. Authentication as well as identity management should also be taken into account when dealing with secrecy. Because of the sheer number of people, objects, and gadgets that are part of the Internet of Things (IoT), this is a significant problem. The issue is how to safely handle user, things/object, and device identification. IoT devices and services face a privacy problem due to the pervasive nature of the IoT ecosystem. Users' privacy has become a hot topic in many research projects because of the way the internet connects people and data. Data privacy, sharing, and management, but also data security, are all unresolved research problems.

1.5. Security Threats, Attacks and Vulnerabilities

Prior to resolving security risks, it is necessary to identify the IoT's system assets (components). Knowing your asset inventory is critical, since it includes all of your Internet of Things (IoT) devices and services. An asset is a valuable and sensitive economic resource that belongs to a company. One of the most important assets in any IoT network is the system hardware (which may include things like buildings and equipment), software, and the services and data that these services provide.

1.6. Vulnerability

Denial-of-service (DoS) assaults and/or the execution of instructions are all possible when an intruder exploits vulnerabilities in a system. Vulnerabilities in IoT systems may be discovered in a number of different places. This includes flaws in system hardware and software, rules and processes utilized in the system, as well as human deficiencies [7]. IoT systems are made up of two major parts: hardware and software, both of which have many design faults. Even if a hardware vulnerability is discovered, it may be difficult to repair because of hardware compatibility as well as interoperability issues, as well as the time and effort required to do so. Operating systems, application software, and control software, such as communication protocols and device drivers, all have vulnerabilities. Human factors and program complexity are two of the many causes of software design errors. There are a lot of times when technical flaws are caused by human errors. Because of this, the project will start without a strategy, developers will have poor contact with users, resources will be scarce, and users would be unable to govern the system [7].

1.7. Exposure and Threats

When a flaw or error is identified in the system setup enables an attacker to collect sensitive information, that's called exposure. Resiliency against physical assaults is one of the most difficult problems in the Internet of Things. Most Internet of Things (IoT) applications allow devices to be left unattended as well as in places where they are vulnerable to attack. It's possible that an attacker may take advantage of this vulnerability to steal the device's data or obtain cryptographic secrets before modifying or replacing it with a malicious one.

A threat seems to be an activity that exploits a system's security flaws in order to cause harm to the system. Humans and nature are the two main sources of threats. Earthquakes, hurricanes, floods, as well as fires are just a few examples of natural disasters that may wreck havoc on computer systems. Natural catastrophes are difficult to prepare for, and no one can stop them from occurring. Backup and contingency plans, together with disaster recovery strategies, are the most effective ways to safeguard systems against the effects of natural disasters. A human threat is one that is brought on by humans, like malicious threats originating from inside (someone has been granted access) or outside the network (individuals or groups operating independently of the network) with the intent to damage or disrupt the system.

1.8. Attacks

Assailants that conduct system assaults or disrupt normal operations do so by exploiting vulnerabilities and employing a wide range of tactics and tools. Attackers launch attacks to fulfil their own ambitions or to exact vengeance. Attack cost is a metric for assessing an attacker's resources, motivation, and expertise. Attack actors [6] are those who represent a threat to the digital world. Thieves, hackers, or government agents might all be among them. Unencrypted network traffic is subject to active network assaults, which look for sensitive data; passive attacks, such as monitoring unencrypted network communications to decode weakly encrypted traffic and get authentication information; close-in attacks; insider exploitation; and so on. Common cyber-attacks include the following:

Physical Attacks: Hardware components are compromised in this assault. IoT devices usually operate in outdoor settings where they are extremely vulnerable to physical assaults due to the fact that they are unattended and dispersed.

Reconnaissance Attacks: system, service, or vulnerability discovery that is not allowed. A few example of reconnaissance attacks include scanning network ports (41), using packet sniffers (42), and doing traffic analysis (43).

Denial-of-service (DoS): As the name implies, the goal of this attack is to prevent legitimate users from using a computer or network resource. The majority of IoT devices are susceptible towards resource enervation attacks since they have limited memory and processing capabilities.

Access Attacks: Network or device breaches occur when unauthorized individuals get access. An intruder may get access to the physical device using one of two methods: physical access or remote access. The second is IP-connected devices are accessed remotely.

Attacks on Privacy: Remote access methods make it more difficult to safeguard privacy in the Internet of Things owing to the huge quantities of information that may be accessed quickly.

II. Related Study

M. Taneja et al., 2013 [8] proposed a paper related to security methods that are designed with the assumption that the final device is secure. This is not always the case. The IoT system itself may be compromised in an IoT network. If the device is stolen, the attacker will have access to it, which they may then use to launch more destructive assaults. This paper proposes an analytical framework that includes mobility behavior indicators calculated at network nodes as well as IoT devices, if desired. Using the lightweight protocol improvements described here, they are sent to the analytics server for analysis. These indications are used by the Internet of Things (IoT) user to specify anticipated behavior. These indications are analysed by the analytics server, which notifies users whenever it notices anything out of the ordinary.

G. M. Koien et al., 2013 [9] proposed a paper related to society which is quickly transforming towards a digitally-only environment. This offers a lot of advantages, but it also puts people's privacy at jeopardy. The danger comes not so much from a Big Brother of the 1984 kind as it does from a swarm of lesser Big Brothers. Big brothers are businesses we deal with, as well as government agencies and other non-profit organizations. There are many tiny big brothers that have been granted access to our personal data by us. The issue of privacy may be complex. It's personal freedom against public safety at its most severe. We're not going to take a position on what degree of personal freedom as well as privacy is appropriate when it comes to personal privacy. Understanding personal privacy and how new technology may help us reclaim some of it is the primary goal of Factors of Individual Privacy in Communications. We talk about what privacy is, how it differs from other types of privacy, and why it should be included by default. There are lines drawn between individual privacy and social expectations, and society will eventually impose restrictions on how far we can go in maintaining that private (Lawful Interception, etc.). There are tools available to help us reclaim some of our digital privacy. These are often referred to as technologies that enhance privacy (PETs). Onion Routing and other privacy-preserving techniques are some of the PETs we examine. Security in cellular systems, RFID, the Internet of Things (IoT), and sensor networks are only a few of the other issues. Cloud computing is also touched upon in a few places.

N. R. Prasad et al., 2007 [10] proposed a paper related to modeling network risks is critical for creating a safe network. The article proposes a technique for creating a threat model. The suggested approach will be compared to a number of currently used threat models and methods. The methodology's goal is to provide a logical, organized way to developing threat models. A threat model framework is provided, along with a set of methodological criteria. The technique will be used to create a threat model of Personal Networks based on the data collected. Tools like UML diagrams and attack trees, which are practical, have been used in the study. Methods for assessing risk will be covered as well. Profiles of threats and vulnerabilities have been provided for review.

III. Methodologies and Discussions

This paper is designed with respect to the security considerations as well as the integrity maintenance of the Internet of Things enabled system. The following are the main security objectives that must be understood in order to execute efficient IoT security successfully:

3.1 Confidentiality

Even while confidentiality is a critical security element in the Internet of Things, it isn't always required when data is made available to the general public. Although sensitive data should never be shared or accessed by unauthorized parties, this is not often the case. Patients' personal information, confidential business information, and/or military data, together with security credentials as well as secret keys, must all be kept secret.

3.2 Integrity

Integrity is almost always required as a security characteristic for providing dependable services to Internet of Things (IoT) customers. Different IoT systems have different criteria for system integrity. Because of information sensitivity, a remote monitoring system, for example, will include rigorous integrity checking to guard against random mistakes. Communication-related data loss or manipulation may result in the loss of human life [6].

3.3 Authentication and Authorization

In IoT settings, where communication between devices, humans, and/or humans-to-devices is possible, ubiquitous connection exacerbates the authentication issue because of nature of IoT environments. Diverse levels of authentication need a variety of system-specific solutions. Authenticity of bank card and bank systems, for example, necessitates the use of robust solutions. However, the majority will have to be global, such as ePassport, while the remainder will be regional [6]. There are certain network activities that can only be performed by authenticated entities when using the authorization attribute.

3.4 Availability

Access to services must be available to a user (or perhaps the device itself) at all times. IoT devices' hardware as well as software components must be resilient against hostile entities and unfavorable circumstances if they are to continue providing services. The level of availability required by various systems varies. For example, the availability requirements for fire detection and healthcare monitoring systems are likely to be greater than those for roadside pollution sensors.

3.5 Accountability

Accountability provides redundancy and responsibility to specific activities, responsibilities, and planning for the execution of network security rules while creating security methods for usage in a secure network. Being held accountable, although ineffective on its own, helps in making sure additional security measures are in place and functioning correctly. Security fundamentals like integrity and secrecy may be rendered ineffective if they are not tied to real consequences. An entity would really be tracked for its activities via an accountability mechanism in the event of a repudiation occurrence, which may be helpful for verifying what occurred and who was really accountable.

3.6 Auditing

A security audit measures how well a device as well as service complies with a set of predefined criteria in order to conduct a systematic assessment of its security. Security auditing is essential since most systems have many flaws and vulnerabilities that may be exploited to put the data at danger. Whether or not an IoT system requires auditing is determined on the application as well as the monetary worth of the system.

3.7 Non-Repudiation

When a user or device is unable to refute an activity, the characteristic of non repudiation yields definite proof. For the most part, non-repudiation is not seen as a critical security characteristic in the Internet of Things. For example, in payment systems where consumers or providers cannot refuse a payment action, it may be appropriate.

3.8 Privacy Goals

Privacy is the right of an entity to decide how much it interacts with its surroundings and how much information about the entity it is ready to share with others. For IoT, the following are the most important privacy goals:

Privacy in Devices: Relies on the privacy of the person's actual location and method of transportation. Theft or loss of the device can expose sensitive information, and the device may be vulnerable to attacks.

Privacy during Communication: The availability of the device, the integrity and dependability of that device are all factors. Devices connected to the Internet of Things (IoT) should only interact when necessary, preventing the exposure of private data in the process.

Privacy in Storage: Two considerations must be made in order to safeguard the privacy of the data kept on devices. Devices should be able to store any necessary quantities of data.

Privacy in Processing: The device as well as communication integrity are key factors. Third parties should not be informed that their data has been shared or kept.

Identity Privacy: Only an authorized entity (person or device) should be able to determine the identification of any given device..

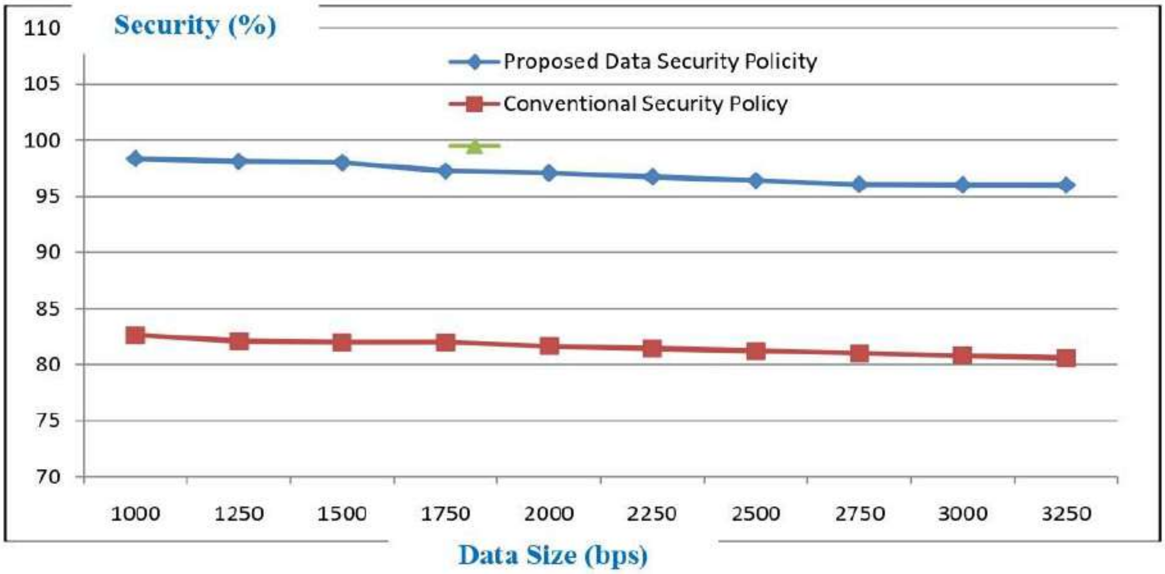
Location Privacy: There should be only authorized entity (human/device) find the geographical location of relevant devices.

3.9 Intruders, Motivations and Capabilities

Different intruders have various motivations and aims, including financial gain, public opinion manipulation, and espionage. Individual assailants to highly complex organized criminal groups all have different reasons and objectives for breaking into a system. The mobility of an assault is influenced by the resources, expertise, access, and risk tolerance of the intruders. Internal users have more control over a system than external users. A tiny number of invaders are well-funded, whereas the majority operates with little or no resources. Everyone who wants to launch an assault does so based on a variety of factors, including the available resources, money, and the attacker's previous experience [6].

There has been an increase in security and privacy concerns as a result of the Internet of Things' rapid expansion. Hackers' criminality and poor usage system resources are to blame for many of these dangers. The Internet of Things (IoT) must be designed in such a manner that users can easily and safely regulate how it is used. To get the advantages of the Internet of Things while avoiding security and privacy concerns, consumers must have complete trust in the technology. Viruses and denial-of-service attacks, two frequent dangers to IoT devices and services, affect the vast majority of them. Avoiding threats as well as managing with system vulnerabilities can't be accomplished by just following basic processes; instead, policies must be implemented smoothly and be backed up by solid procedures to ensure their success It's important to have a firm grasp on all of a system's assets before attempting to discover any vulnerabilities or dangers that may exist. The assets of the system must be identified, as well as the threats to those assets. Assets were described in this article as anything of value in the system, both physical and intangible, that has to be safeguarded. Data and information as well as services-related assets such as service reputation are all examples of generic IoT assets. In order to distribute better system mitigation resources, it has been demonstrated that it is critical to understand threats and system vulnerabilities. System developers can better allocate resources when they are aware of such threats. DoS, physical assaults, and invasions of privacy are three of the most well-known dangers. This study examined three distinct kinds of intruders: lone wolves, organized crime syndicates, and foreign intelligence services. Each kind of assailant is distinct in terms of ability, money, drive, and willingness to take risks. Understanding the different attack actors and which ones are often likely to target a system is critical. Once threats and actors are described and documented, it becomes simpler to determine which danger is most likely to exploit what flaws in the system. In general, IoT intruders are presumed to have full DY intruder skills, as well as some relatively limited compromise capability. At worst, a small percentage of the total quantity of IoT devices will be affected by physical compromise attempts since we will assume that they do not scale. As a result, IoT architecture must be built to deal with and identify compromised devices. As a result, it's been determined that attackers use a variety of methods, tools, and strategies to exploit system vulnerabilities. It's critical for a company to know what motivated the attackers and what they were capable of in order to stop the assault. More research is needed to fill in the knowledge gaps about threats, cybercrime as well as provide the necessary steps to mitigate possible attacks in order to reduce both the threats and their consequences.

The following figure, Fig-2 illustrates the proposed approach security performance and it proves the efficiency of this paper by means of cross-validating the outcome accuracy ratio with the conventional security policies, in which the figure proves the proposed accuracy level is far better than the conventional security policies.



V. CONCLUSION AND FUTURE WORK

Internet of Things (IoT) is facing a variety of dangers that must be identified in order to take preventive measures. IoT security issues and dangers are discussed in this article. As a whole, the objective was to discover resources as well as describe any dangers to the Internet of Things (IoT). One of the most significant IoT security issues was discussed, with an emphasis on IoT device and service security difficulties. Confidentiality, privacy, and confidence in the organization were highlighted as security issues. Security and privacy issues must be addressed if IoT devices as well as services are to be more widely accessible and safe. The conversation also covered cyber dangers such as actors, motivations, and capabilities that are fueled by the unique features of cyberspace. Intelligence agencies as well as criminal organizations provide more of a danger than individual hackers, as shown by this study. The reason for this is because their targets are more difficult to anticipate, and the effect of a single strike will be less severe. We came to the conclusion that both manufacturers and end users have a lot of work to do when it comes to IoT security. Future IoT security standards must solve existing IoT security mechanisms' flaws. Ongoing research will focus on better understanding IoT infrastructure risks, as well as identifying the probability and effects of attacks on IoT infrastructure.

Future study will include a flexible trust management structure and definitions of appropriate security methods including access control, authentication, and identity management should be addressed early in the product development process. Our goal is to assist research in the security field identify the most pressing problems in IoT security and get a better knowledge of the risks and characteristics posed by different invaders, such as businesses and intelligence agencies. We believe this survey will be helpful.

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Title of the paper: Security Enhancements for Software Defined Network

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SECURITY ENHANCEMENTS FOR SOFTWARE DEFINED NETWORK

Paper ID -1064

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ABSTRACT : Today's Internet applications require the underlying networks to be fast, carry large amounts of traffic, and to deploy a number of distinct, dynamic applications and services. Adoption of the concepts of "inter-connected data centers" and "server virtualization" has increased network demand tremendously. In addition to various proprietary network hardware, distributed protocols, and software components, legacy networks are inundated with switching devices that decide on the route taken by each packet individually; moreover, the data paths and the decision-making processes for switching or routing are collocated on the same device. IT infrastructure has been expanding very rapidly in recent years. With the invention of cloud computing, many ecosystem and business paradigms are encountering potential changes and may be able to eliminate their IT infrastructure maintenance processes. Real-time performance and high availability requirements have induced telecom networks to adopt the new concepts of the cloud model: software-defined networking (SDN) and network function virtualization (NFV). Most current network devices have control and data-flow functionalities operating on the same device. The only control available to a network administrator is from the network management plane, which is used to configure each network node separately. The static nature of current network devices does not permit detailed control-plane configuration. This is exactly where software-defined networking comes into the picture.

SDN Software-Defined, Networking, is a network architecture that empower the network to be intelligent, and centrally controlled or programmed using software applications. This should help to operate control the entire networks always and irrespective of the underly network technology. The ultimate goal of SDN is to "provide open user-controlled management of the forwarding hardware of a network element." SDN operates on the idea of centralizing control-plane intelligence, but keeping the data plane separate. Thus, the network hardware devices keep their switching fabric (data plane), but hand over their intelligence (switching and routing functionalities) to the controller. This enables the administrator to configure the network hardware directly from the controller. This centralized control of the entire network makes the network highly flexible Software-Defined Networking is new programmable and reconfigurable network architecture. On the other hand, it will be designed to "manage growing multi-tenant cloud computing with 5G. SDN

(Software Defined Networking) has introduced the extensive change to the traditional networks with the integration of the network by decoupling the forwarding hardware (data plane) from the control logic of the network (control plane).

Keywords : Legacy networks, Software Defined networking, Network function visualization

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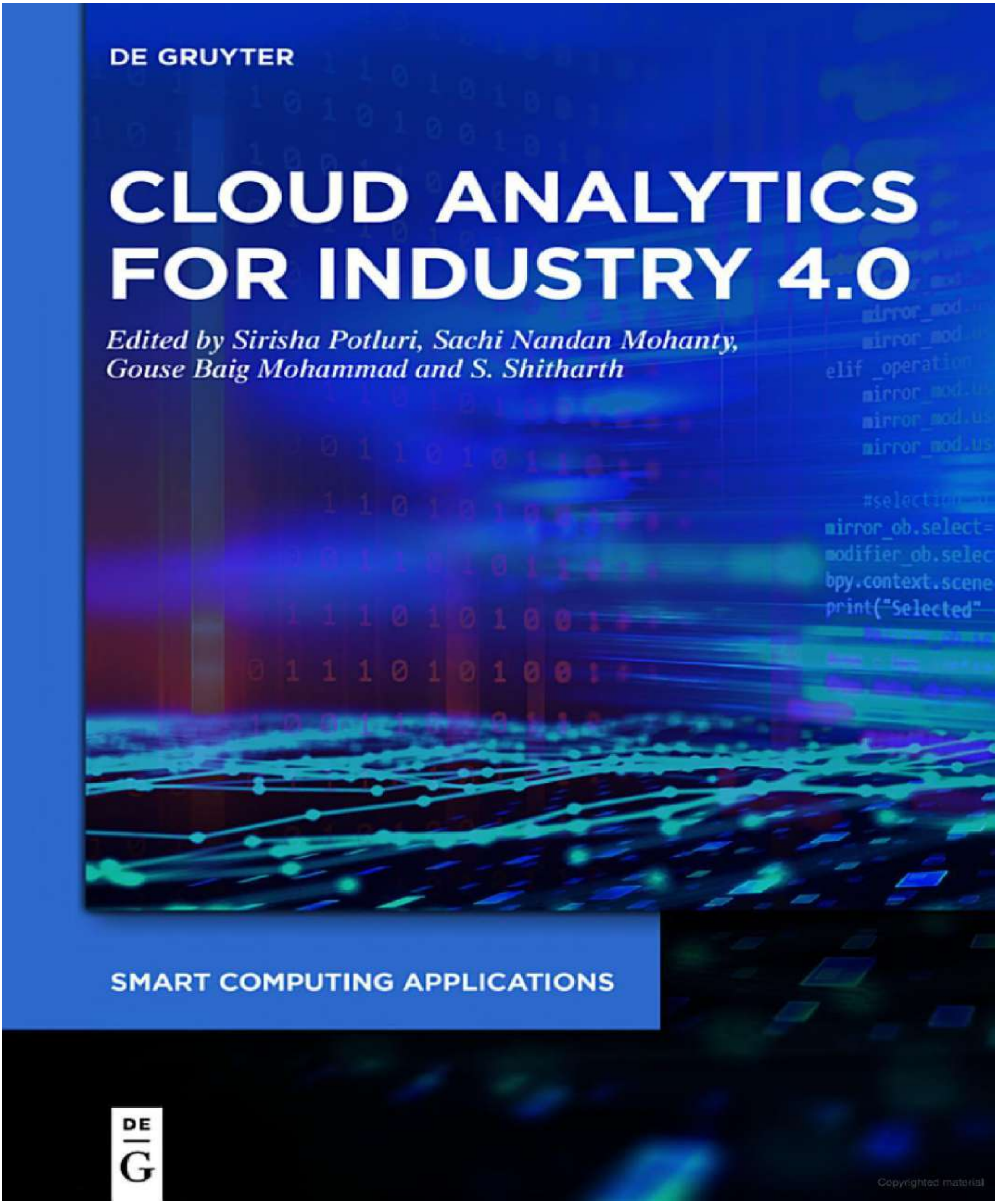

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An impact of robust Industry 4.0 strategy on supply chain management

Abstract: Automated systems and processes, digitalization, and data interchange are all part of the "Industry 4.0" concept. Its ultimate goal is to create a smart factory that can respond more quickly to consumer demands and unexpected events while also increasing overall productivity. Improvements to the production process, the supply chain, and logistics can all be attributed to using this theory in these areas. Innovative and significant, supply chain management's (SCM) implementation of Industry 4.0 warrants further study. Industry 4.0 will bring new challenges and opportunities to supply networks. An important goal of the research is to examine how Industry 4.0 deployment will affect supply chains and provide a framework for its implementation. A system dynamics model is used to examine the impact of Industry 4.0 adoption on supply chain aspects. This model takes into account both the driving and inhibiting variables of this technological change. What this study sees here is a major shift in the overall direction. Consider both the positive and negative aspects of Industry 4.0 technology when conducting a simulation study. There is a connection between Industry 4.0 and supply chain deployment that is supported by both conceptual and empirical evidence. Based on simulation results, a conceptual model has been developed for the successful deployment and acceleration of the Industry 4.0 supply chain.

Keywords: Industry 4.0, implementation strategy, supply chain, smart factory, system dynamic

1 Introduction

The fourth industrial revolution (Industry 4.0) is a futuristic vision of how manufacturing will function in the not-too-distant future. In 2011, German officials announced the commencement of a program called "Industry 4.0" that aimed at

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increasing industrial automation. Sustainable manufacturing processes across all industries must be interconnected to achieve the fourth industrial revolution. By using disruptive technology the Internet of Things (IoT), there are several benefits when every device, machine, and process in the supply chain can communicate with one another digitally. The IoT includes sensors, networks, algorithms, and applications of various kinds. With the help of the IoT, businesses may strengthen their supply chain networks and increase their output [1]. The construction of a cyber-physical system (CPS) is the third pillar of Industry 4.0. CPS implementation can assist a wide range of industries, including healthcare, logistics, and automobiles. Logistics is a critical part of any company involved in the transfer of goods along a supply chain. Cyber-physical processes can be integrated into the supply chain to boost efficiency and competitiveness in manufacturing [2].

Automated-guided vehicles (AGV) are also a part of Industry 4.0. In 1784, mechanization and the development of water and steam power sparked the first industrial revolution. Mass production processes and assembly lines powered by electricity were adopted during the second industrial revolution in the 1870s. During the 1970s, computers began automating production processes, launching the third industrial revolution. Information communications technology (ICT), the IoT, services, and data can be combined to enable real-time production in the era of the IoT and other CPSs, known as "Industry 4.0." The term "Industry 4.0" refers to a trend in which products, value creation chains, and business models are more digitized. To increase production and minimize the expenses, Industry 4.0 framework uses IT solutions. An example of the four industrial revolutions is shown in Fig. 1. Using Industry 4.0 for a project is a viable option for every business. Industry 4.0 projects are led by project managers, who play a critical role in determining a company's destiny. To implement Industry 4.0, businesses need managers who are well versed in the technology [4]. As firms move forward, managers who are interested in digitalization will play a crucial role. Because of their efforts, corporations are increasingly becoming digital and using cutting-edge strategies such as integrating sensors into trucks, using radio frequency identification (RFID) on delivery goods, and restoring lost or deleted data in the cloud. It is possible to make fast judgments, decrease risk, and boost productivity with these technologies. This research is a useful beginning point for managers who want to understand Industry 4.0 and identify the main supply chain classifications in Industry 4.0.

Artificial intelligence (AI) technology is used to make judgments for AGV, allowing them to work independently [3]. For the corporation, this is a one-time investment that results in lower labor costs, more productivity, fewer injuries, and improved safety [4]. Digital factories are the future-oriented, intelligent factories where information and data may be shared, analyzed, and processed between each function of production to accomplish activities without the assistance of humans as part of Industry 4.0's smart factory idea [5]. To maintain a steady supply of products, smart factories employ automated equipment to connect sensors that hold information to complete the duties they are meant to execute. The concept is widely accepted by organizations, but the best-integrated solution has yet to be created. In addition, "drone" delivery is an element of the business when it comes to last-mile delivery in the supply chain, and the 4.0 umbrella is applicable. The distribution of goods within a city is made possible because of this technical innovation, which allows businesses to overcome the challenge of city logistics. The old truck delivery system is being replaced by unmanned aerial delivery [6]. Sustainable and more efficient distribution systems are more important to businesses now than ever before. Amazon has already begun offering a 30-minute last-mile delivery service for orders weighing less than 5 kg, but this service is only available to prime members. Google and DHL are also working to implement this technique [6]. Many German firms, including Volkswagen, BMW, and Daimler, have successfully applied this technology. In addition, governments such as of China have implemented initiatives to promote digitization in industries, such as "Made-in-China 2025" [7].

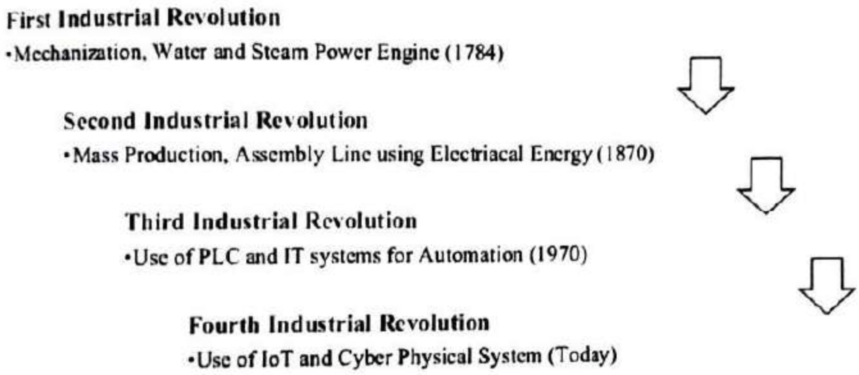

Fig. 1: The Industrial Revolutions of the Four Ages.

In today's global world, businesses must strive for social, economic, and environmental sustainability in all aspects of their operations. Sustainable operations are a goal for businesses looking to get an edge in the market. Companies are encouraged to focus on sustainability and innovation as a result of the use of digital manufacturing systems [8]. These developments have led to a wide range of policies and programs being implemented by both large and small industrial companies. Sustainability cannot, however, be fully integrated into the supply chain management process with the current knowledge and expertise. The number of greenhouse gases emitted into the atmosphere tends to rise as technology advances. This will cause global warming. These sustainability issues can be resolved, however, by making effective use of the latest technology and reducing lead times while optimizing all available resources [10]. Innovation firms have been experimenting with digitalizing manufacturing firms for the better part of the last decade. Researchers have also looked into the influence of Sector 4.0 technologies, which have a major impact on the industry. The integration of these technologies into the supply chain is a major concern for industrial enterprises.

Numerous studies have discussed the fundamental structures of Industry 4.0 and how it relates to manufacturing organizations.

Operational models and management approaches will be drastically altered as a result of changes in the business ecosystem to meet the new challenges that will inevitably arise. Companies have been adopting new ideas and technologies from the fourth industrial revolution in greater numbers since Industry 4.0's inception [9]. With its enormous impact on society, Industry 4.0 has the greatest potential for positive change. When it comes to their personal and professional lives, the normal user can now see the impact of Industry 4.0 more clearly. One example of how the new paradigm will impact the world is a smart house, smart city, smart office, and e-health systems. Industry 4.0 is predicted to have an impact on all aspects of manufacturing, logistics, and business process management. As the economy becomes more dynamic and competitive, supply chain (SC) systems must be digitalized to succeed. Managing the next generation of digital requires the use of new technologies and increasing data flow in the value chain.

1.1 Role of industry in supply chain management

To attain master supply chain (MSC), Industry 4.0 is projected to have a major impact on SCs, business structures, and operations, as shown in Fig. 2. When it comes to describing Supply Chain 4.0, supply chain management experts have used a range of terms, including the terms "digital supply network," "internet of things," and "e-supply chains." Automation and digitization of manufacturing are among the goals of

Fig. 2: The Number of Google Searches That Included the Keywords "Fourth Industrial Revolution" and "Industry 4.0" from January 2012 to December 2018.

Industry 4.0. This includes a digital process that promotes cross-departmental collaboration. Using Industry 4.0 in SC systems has an impact on SC integration, operations, purchasing, and distribution. Faster response times, shorter lead times, and higher decision-making quality are three of the primary advantages of Industry 4.0 in the SC. Enterprises can afford more complicated and dynamic SC processes for large-scale manufacturing and customer integration because of Industry 4.0's capabilities. Sales and operations planning can be improved, as well as the logistics process, with the help of Industry 4.0. It will be possible to make meaningful decisions based on real-time data after the introduction of Industry 4.0.

"Industry 4.0" enthusiasm has prompted an increase in demand for research on the deployment of Industry 4.0 in supply chain networks. It is necessary to have a comprehensive system strategy that takes complex systems like SCs into account, although Industry 4.0 frameworks and roadmaps already exist. To fill this obvious research need, researchers study how SC can adapt to Industry 4.0 and modify. As a starting point, consider what might spur, aid, and obstruct this technological transformation. Therefore, it is required to examine the literature to identify four main categories: strategic, organizational, technical, and legal/ethical drivers and obstacles to the implementation of the Industry 4.0 paradigm. A connection between these elements is also evaluated and computed by two practitioners separately. An analytical viewpoint is needed to understand the influence of these factors on the adoption of Industry 4.0 and crucial SC variables. An Industry 4.0-integrated SC's system dynamics (SD) models take into account the influence of various Industry 4.0 barriers and drivers on the SC's dynamics. Conventional SCs and Industry 4.0-ready SCs are compared based on their ability to perform. SC performance has been studied using RFID and cloud technology. Based on extensive literature review and quantitative model results, Industry-4.0 can be successfully implemented in SC networks [11]. This framework's theoretical base provides a wealth of practical information.

The rest of the paper is organized as follows. Section 2 includes important literature and research background. In Section 3, the research approach is described to better understand how Industry 4.0 adoption affects SCs, and the proposed SD model is discussed. In Section 4, this model takes into account various drivers and barriers of this paradigm. A conceptual framework for Industry 4.0 implementation at the SC level is presented. Section 5 summarizes the model's output and discusses the model's assumptions. Finally, the study's theoretical and practical implications, limits, and potential future research avenues are reviewed.

2 Literature survey

Industry 4.0 and its potential to improve SC management performance are discussed in this section, which helps to frame the study's research questions and hypotheses.

An examination of Systems Theory is then conducted to build the groundwork for a proposed Industry 4.0-based paradigm for the supply chain management.

After mechanization, electricity, and information technology sparked the previous three industrial revolutions, smart technologies have ushered in the fourth, dubbed "Industry 4.0." For example, the "Industry4.0" concept illustrates how business procedures have been decentralized due to technological advances in the sector. CPSs, AI, and big data analytics (BDA) are just a few of the many Internet-of-everything (IoE) technologies. CPSs and the Internet provide the backbone of Industry 4.0, which connects people, machines, devices, and enterprise systems. The industrial revolution has made it possible for these new industrial management paradigms and smart process management approaches [12]. Thanks to Industry 4.0-supported technologies, which have revolutionized corporate control systems and considerably improved the quality of products and services provided by enterprises, automation, and dynamic production are now conceivable. As a result, modern factories can make greater use of their resources and keep up their high standards for longer.

2.1 Supply chain management

One of the most difficult topics in the SC management literature is measuring the performance of the SC by looking at its flexibility, dependability, responsiveness, quality, and asset management. Look for performance indicators that measure responsiveness and reactivity, as well as quality [13]. Innovation, time, price, and availability of the product can all be used to quantify performance gains. An efficient SC relies largely on information communication between its various stakeholders. To increase SC performance by boosting information exchange, companies are investing in technological advancements. These developments aid in the development of efficient channels of communication and processes of collaboration [14]. In this way, a high degree of integration in the processes of firms is also regarded as vital. As a result, improving SC effectiveness necessitates connecting all parties involved. The development of end-to-end business processes is impossible without the integration of the SC [15]. The cost, quality, diversity, and level of service that can be provided can all be improved with better integration. Additionally, SC performance enhancement is facilitated through SC collaboration/integration. Effective information sharing is one of the benefits of integration, as we saw earlier. Improved operational flexibility and responsiveness can be achieved as a result. The ability to effectively manage SC risk is made possible by characteristics such as SC agility and resilience. Improved SC visibility and transparency are also seen to improve operational performance. Addressing the aforementioned concerns and improving SC performance has proven difficult because SC practices span functional boundaries. To deal with this issue, several businesses have begun implementing technical solutions, such as information technology (IT). SC integration and improved performance can be achieved through the use of IT to combine organizational activities. Many companies are already utilizing electronic business solutions to improve their operational efficiency and their capacity to combine and analyze data [16]. Integrating SCs with Industry 4.0-enabled technology can help. Enhanced connectivity and full integration, as well as major performance improvements, are anticipated in these technologies, which will have a profound impact on the supply chain management industry.

Designing and prototyping new products, using the remote control, diagnosing problems, doing predictive maintenance, tracking the location of equipment in use, creating real-time applications, and developing agility are just a few of the new skills that have been developed as a result. Everything is due to the advancements in technology. Personalized products, real-time data analysis, self-monitoring of the system, as well as increased productivity and efficiency are all possible benefits of this new technology [17]. The essential technologies of Industry 4.0, as well as their business applications, are described in the following sections:

Big data analytics: Organizations can utilize BDA to increase efficiency and productivity by making better use of large amounts of data. Utilizing the power of BDA, companies can make more effective use of the vast volumes of information they collect, while also becoming more responsive to their consumers' changing requirements. The collecting and interpretation of data from numerous systems will become standard practice for making fast, fact-based decisions in real-time.

Autonomous robots: Many businesses, including manufacturing, transportation, online retail, and education increasingly utilize robots' capabilities. This is another example of robots coexisting together with human operators and providing assistance to them. In the future, these robots should be more affordable and adaptable than the current models.

Cloud technology: This data is kept on distant servers known as cloud systems that are connected to a wide range of business gadgets and sensors. Big data can be accessed in real-time with cloud computing. We need increased data sharing between departments, sites, and company/organizational boundaries. It's no secret that cloud computing is transforming the way we conduct business [18].

Simulation: Analysis of all conceivable product design, development, production, and SC network scenarios can be done using data acquired from the cloud and big data platforms. Simulating the working world in a virtual environment is a common practice in business models that utilize real-time data. Through testing and optimizing future operations and services in a virtual environment, business continuity, setup time, and quality control can be minimized well before any physical alterations are made. How business is being transformed by the IoT and the Industrial Internet of Things (IIoT) platform is critical to Industry 4.0's ability to centrally manage and monitor numerous machines and systems. Through the IIoT's real-time traceability and tracking capabilities [19], analysts and decision-makers can work independently. As a result of the IIoT, companies will be able to operate more efficiently and effectively.

Additive manufacturing: Three-dimensional objects are built up in layers using additive manufacturing and 3D printing. Small batches of bespoke, tailor-made products may now be produced more rapidly and efficiently thanks to the widespread adoption of these new production technologies.

Augmented reality (AR): AR systems can be used for a wide range of applications. Mobile devices and other remote-control technologies can be used to organize a warehouse's layout and communicate maintenance instructions to workers. These technologies are still in their infancy, but AR will have a considerably greater impact on business operations and decision-making shortly.

Business intelligence (BI): Data acquired from several corporate sources is gathered, analyzed, stored, and displayed via technological platforms. Information and insights are generated from raw business data that can be used to make smarter decisions.

2.2 Industry 4.0's key drivers and barriers

Research continues to discover the possible drivers and restrictions of Industry 4.0, despite its rapid expansion. To gain a better understanding of what motivates and inhibits the adoption and utilization of Industry 4.0 technologies, a literature review was conducted. In the study's conclusions, the following are the main factors driving Industry 4.0 adoption:

Agility: Using Industry 4.0 in supply chains, for example, allows businesses to be more flexible to constantly shift market conditions by responding more swiftly to changes in supply and demand, along with pricing changes [20]. Foreseeing things like consumer behavior, delivery schedules, and industrial output may all be done with the use of business analytics. Delivery routing and tracking may be more nimble, more efficient, and more flexible with real-time information.

Customization: For example, drone delivery and micro-targeting, mass customization, and advanced scheduling practices can be used by organizations to deliver goods and services in the most efficient manner possible, can offer customers a wide range of options, efficiently solve the last-mile problem for high-value items, and expedite customers' orders while exceeding customer expectations [21].

Accuracy: Real-time, consistent, and accurate data can now be accessed thanks to Industry 4.0 technology. As a result, the entire value chain will be better visible thanks to new performance management technologies. Customers' satisfaction and order fulfillment levels are just two examples of data that are included in the SC's data.

Efficiency: SC efficiency can be enhanced by automating physical processes, planning, controlling, and exchanging information. Increasingly, companies are turning to automated SC solutions, according to [22]. Some examples of these technologies are fully automated warehouses, unmanned autonomous vehicles, cargo tracking, and automated pallet handling systems. Companies can work together and pool resources to get the most mileage out of their trucks and increase their transport options thanks to cross-company transportation optimization. The SC network architecture as a whole is always being optimized to meet business needs [23].

3 Proposed methodology

The exploratory study was carried out in two steps. After conducting a thorough literature analysis, we identified the driving causes and barriers of Industry 4.0. Secondary data, including academic research papers and journals, magazines, white papers, business reports, reports from consulting firms, blogs, webinars, and technical videos, was used to study the use of Industry 4.0 in supply chains. Several factors have been discovered to be the most significant drivers and hurdles to Industry 4.0 adoption. Based on this table, we developed a quantitative model [24]. By including effects from digital transformational drivers and barriers, the SD approach was used in the second stage to mimic an Industry 4.0-adopted SC. To represent complex and dynamic systems in a variety of ways, the SD technique was chosen. Because it is founded on systems thinking, SD can help with the creation of simulation models that can be used to evaluate complex systems holistically. After an issue has been translated into quantitative form, an SD model is built, and then the model is put through its paces. SD is a problem-solving strategy that begins by defining the problem and then determining the system's scope. The cascades of feedback mechanisms and interdependencies between system variables are depicted in a causal loop diagram (CLD) [25]. It is possible to see the structure of a problem by looking at CLDs, which show the relationship between numerous affecting variables. It is possible to express the polarity of an influence connection in a variety of ways, including arrows and influence connections (lines). The CLD can be used to create a stock-and-flow diagram for computer simulations. Stock-and-flow diagrams represent systems mathematically by utilizing stock, flow, and auxiliary variables. The commercial SD model development and simulation tools include Vensim, Analogic, DYNAMO, iThink, and Powersim, to mention just a few [26]. The Vensim software suite was used by researchers to create cause diagrams, stock-and-flow diagrams, and simulation assessments. Participants in the study were given a CLD to better understand the influence of their findings on the implementation of Industry 4.0 in SCs. Four distinct representations of these characteristics were used in the classification process (strategic, legal and ethical, technological, and organizational). The CLD that resulted from integrating these components into a larger SC system was extremely comprehensive. Both a standard SC and an Industry 4.0-enabled SC were built using this CLD. These models were used to investigate SC dynamics and the implementation of Industry 4.0. A general framework for the deployment of Industry 4.0 was established using the results of the simulation model and literature research.

4 Proposed SD model

To better understand how Industry 4.0 can affect SC dynamics, we constructed an SD model during this stage. Many of the drivers and constraints must be considered before adopting the SC model for Industry 4.0 solutions. An initial diagram was drawn up to show how those factors interacted with each other (see Fig. 3).

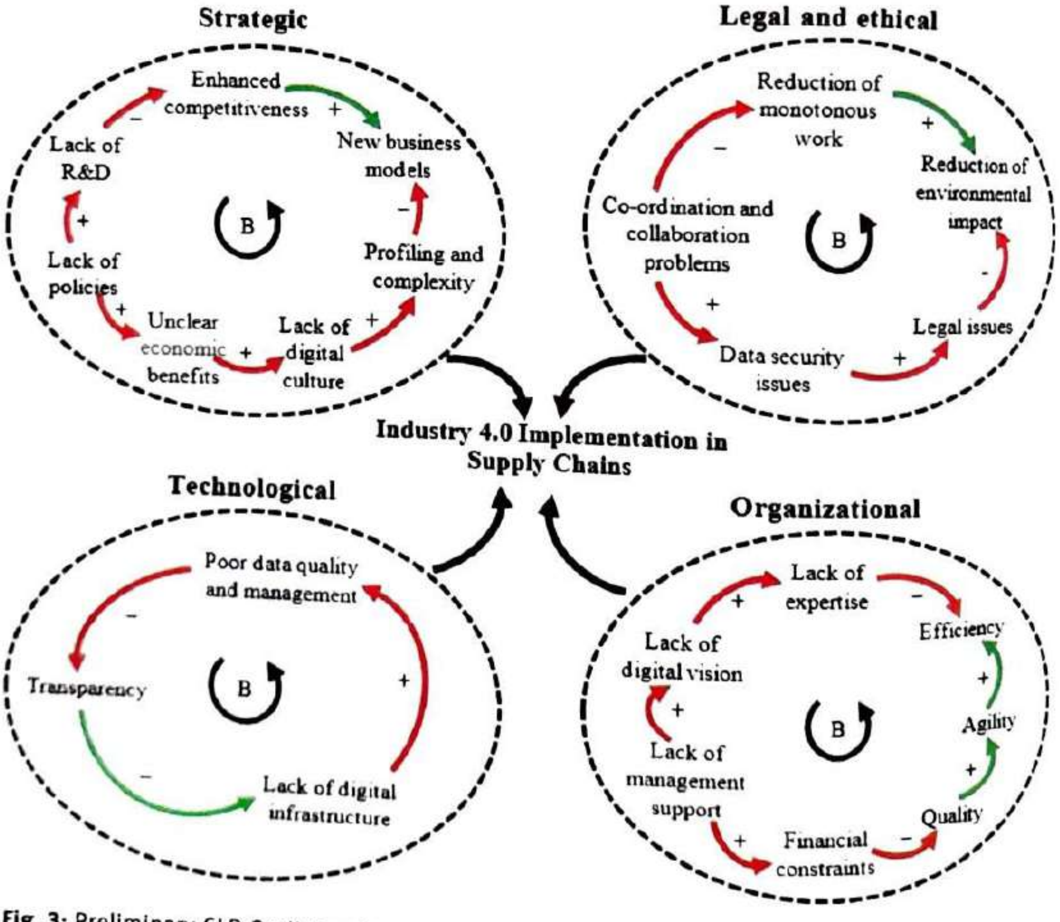

Fig. 3: Preliminary CLD Outlining the Possible Barriers and Drivers of Industry 4.0.

Figure 3 displays the four Industry 4.0 deployment causal loops: the strategic, legal and ethical, technical, and organizational (SLO). Using two specialists in the subject as a guide, the graphic displays the most significant relationships. Other relationships can be depicted by the red and green arrows, respectively. The "+" and "−" symbols are used to indicate positive and negative correlations between variables. The adoption of Industry 4.0 processes in supply chains is influenced by all four factors [27]. Additionally, new business models are being developed because of the rise in competition in Industry 4.0. Without policies, there are no R&D studies, no economic benefits calculations, and hence no digital culture. This adds difficulty to the implementation of Industry 4.0. When there is a lack of coordination and teamwork, there is a rise in data security risks as well as legal challenges. As a result of lack of digital infrastructure, high-quality data is difficult to obtain. An organization's ability to successfully implement Industry 4.0 depends on whether or not management is on board. Financial limitations are yet another hindrance to the successful application of Industry 4.0 technologies.

Here, we explain how supply chain elements such as production rate, manufacturer inventory levels, and shipment rates are linked in Fig. 4. The SC dynamics are connected by the blue arrows. As shown in this diagram, the driving forces of Industry 4.0 are represented visually by green arrows. In the causal loop, obstacles are depicted as external influences. The absence of digital infrastructure is one internal problem that may prohibit organizations from implementing Industry 4.0 techniques, but there are many other external concerns to consider as well [28]. People's unwillingness to adapt to new circumstances and lack of government help are a few examples.

Two independent stock-and-flow diagrams were then created to compare a typical SC with one that has been adopted by Industry 4.0. The supply chain's dynamics can be assessed by looking at the operational improvements that can be made as a result of a SC having Industry 4.0 capabilities. Cloud-based inventory management can make use of RFID technology to monitor inventories and objects [4]. Order fulfillment and inventory management in SC are made easier with real-time data exchange and improved visibility. For the research, the model is categorized into four tiers to track changes in critical performance indicators such as raw material inventory, manufacturer's inventory, distributor's inventory, and demand backlog.

5 Results and discussion

To simulate both classic SC models and Industry 4.0-adopted SC models, Vensim PLE was employed. Due to the importance of SC performance measures such as manufacturer inventory, inventory cost, and order fulfillment, it is only fair to compare these two models with differing levels of technology. Figures 5 and 6 show the simulation findings. Using cloud-based inventory management procedures with

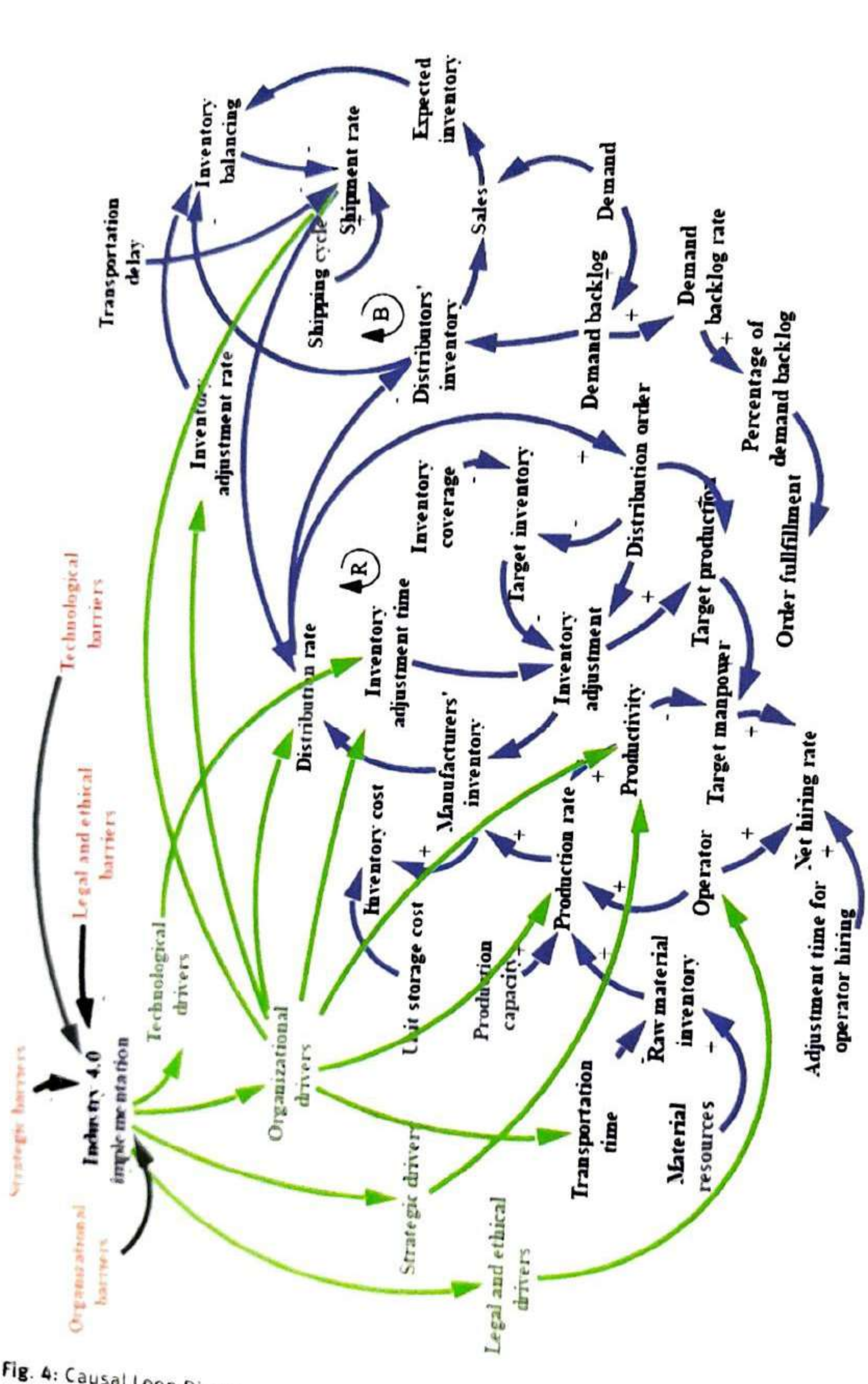

Fig. 4: Causal Loop Diagram.

RFID tags, the findings demonstrate better inventory levels and lower inventory costs than the previous system. The standard SC model exhibits an oscillating curve in the manufacturer's inventory because of process instability caused by poor inventory management. Because of the constant flow of information from demand and order to shipment and production output via RFID and cloud technologies, the inventory is stabilized. Data can be used to improve operational efficiency through the use of both technologies. SCs that are flexible, agile, durable, and sustainable can be built using Industry 4.0 technologies, which enable a greater degree of visibility and adaptation. RFID may also be used to monitor the entire SC (a prerequisite for IoT). All

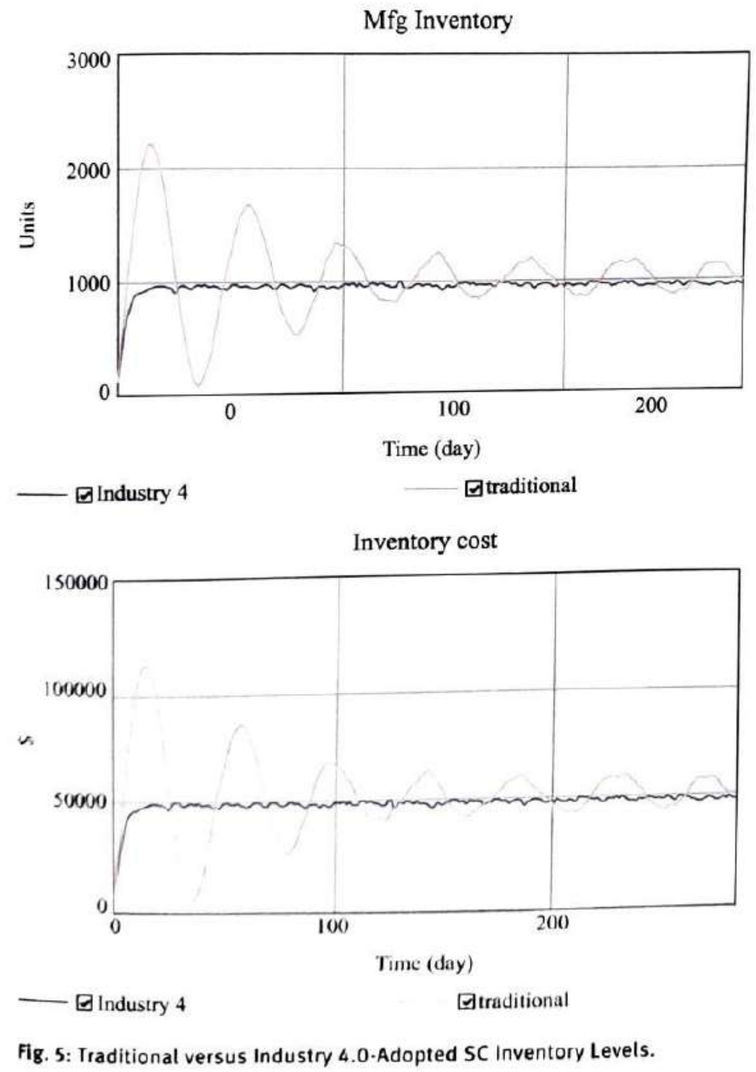

Fig. 5: Traditional versus Industry 4.0-Adopted SC Inventory Levels.

members of the SC will be able to access real-time data for forecasting, production planning, and logistics strategy formulation using RFID tags applied to all products.

Transparency with all stakeholders is provided via real-time data feeds into the cloud system, eliminating the bullwhip effect and creating a transparent system. Figure 5 depicts the randomness and poor customer service that arise from a lack of communication and feedback on demand backlog, as shown by the variability in order fulfillment rates. Order flow is now more transparent and easier to follow due to the introduction of cloud-based information exchange and RFID-based tracking based on data and response to workplace interruptions. Higher SC efficiency brought by Industry 4.0 technologies will lead to increased customer satisfaction.

To avoid the "bullwhip effect" and create an open system, real-time data feeds into the cloud are used to provide transparency to all stakeholders. A lack of communication and feedback on the backlog of demand causes order fulfillment rates to fluctuate, as depicted in Fig. 6. Data exchange and monitoring using RFID have made order flow more transparent and easier to monitor. Using Industry 4.0 technology, the SC can make better decisions based on data and be more responsive to interruptions, which improve customer satisfaction.

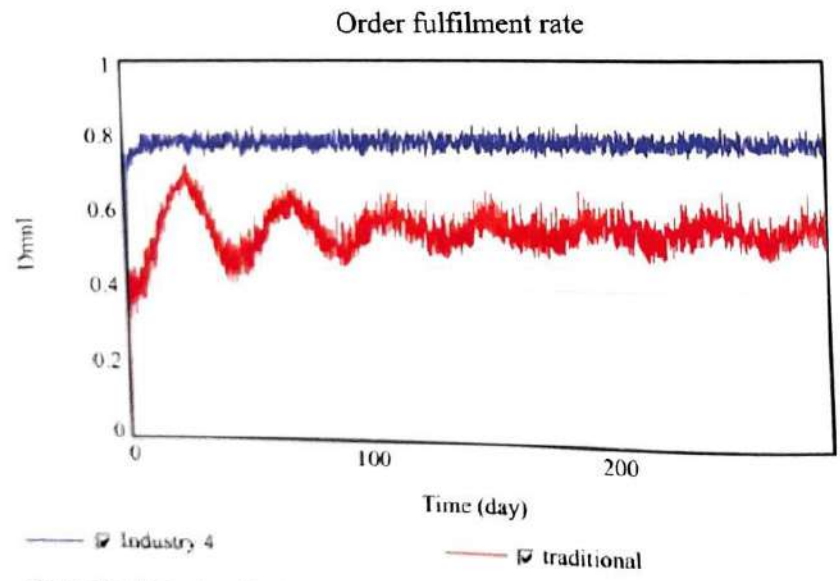

Fig. 6: Traditional and Industry 4.0-Adopted SC Have Different Order Fulfillment Rates.

We must evaluate the advantages and disadvantages of Industry 4.0 platform adoption and upkeep. Simulated findings show that Industry 4.0 technology can significantly alter SC characteristics. A thorough discussion of Industry 4.0's motivations and benefits in the context of SC, which is still in its infancy, is essential. A conceptual framework for the implementation of Industry 4.0 in a supply chain network has therefore been established. Digitalization and network transformation are part of the framework we've put out so far. Since Industry 4.0 and digitization have become more common, corporate networks have undergone significant transformations. As a result of these advances, the culture, processes, business models, and linkages between and within organizations all change.

When comparing an old-fashioned SC with an Industry 4.0-enabled one, the outputs of the SD model can reveal a wealth of valuable information. A cloud-based RFID system reduces and stabilizes inventory levels and costs, improving operational efficiency. The SC's capacity to track and transmit real-time data is partly responsible for the increased inventory management. This shift in agility and flexibility will have a positive impact on the entire organization. Forecasting, production planning, order fulfillment, and response time can all be enhanced through the use of modern technology by making real-time information more visible and accessible. The impact of Industry 4.0 on business operations can be measured at the state level. In this study, the benefits of Industry 4.0 were shown to be comparable to those previously reported. Despite this, the outcomes of the SD modeling are crucial in estimating the total impact of SC adoption of Industry 4.0.

A wide range of industries, including automotive, defense, and electrical, are embracing the fourth industrial revolution. Recent research has mapped many SC processes to various IoT devices; robotics-enhanced decision-making is possible because of IoT devices, cloud computing, and RFID tags and sensors are used for real-time vehicle monitoring. A network of interconnected physical items has emerged as a result of the SC's digitalization and automation. Because of this, extensive policies and frameworks at the federal and state levels will be needed to make the most of the digital transformation. Organizational culture, network infrastructure, and management techniques must be changed for SCs to implement Industry 4.0.

6 Conclusion and future scope

The fourth industrial revolution, called "Industry 4.0," will incorporate a wide spectrum of cutting-edge technologies. CPSs and RFID are two examples. This next revolution will be aided by the use of cloud computing and BDA. A wide number of industries are being transformed by the Industry 4.0 paradigms, including automotive, logistics, aerospace, and defense. Academic research on Industry 4.0 technology and implementation issues has increased. A huge shift in the SC has occurred as a result of the digital transformation. The findings of the study show that traditional SCs must quickly adapt to fast-changing markets by implementing Industry 4.0 concepts. Companies are stepping outside the SC to adapt to and welcome the new revolution. However, even though experts have recognized the significance of researching the Industry 4.0 transformation from a SC network perspective, it remains a somewhat unusual method. Examine how

Industry 4.0's challenges, drivers, and impediments are all addressed in this study to fill this vital demand.

A four-phase strategy for implementing Industry 4.0 in SCs was devised based on the model's findings. For a successful implementation of the framework, there are four phases you must follow. Industry 4.0 research on SC systems has never been done before utilizing the SD method. Technology and design concepts for Industry 4.0 have been the subject of earlier studies. Industry 4.0 and SC dynamics can be quantified utilizing the SD-based technique that has been presented herein in quantitative detail. SCs can use Industry 4.0 as a framework to develop a new digital reality in the digital world now.

Logistical and supply chain management will be drastically altered as a result of this paradigm shift. Companies can expect to learn about the advantages of Industry 4.0 modifications and the best techniques for implementing them in supply chains through the envisaged implementation framework. Future scholars can put to the test the paradigm given in this paper. System dynamics can be used to optimize supply networks and their interactions with Industry 4.0 equipment and processes. Identifying hurdles to Industry 4.0 adoption is the goal of the study, which aids practitioners in their efforts. Using the generated SD models, businesses may better comprehend the impact of Industry 4.0 on their operations.

Several limitations are present in this study, as is the case with most studies of this kind. No empirical data was used to test the SD models in this study. For the sake of clarity, several assumptions were made during the simulation. In addition, due to the SC's complexity, only a few Industry 4.0 elements (RFID and Cloud) were taken into account throughout the construction and evaluation of the model. Model results and discoveries can be confirmed with primary data in the future. Extending the model across the value chain is necessary for evaluating additional performance metrics.

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