

# Challenges Facing Adoption and Usage of Information and Communication Technology (ICT) in Small and Medium Scale Industries (SMI) in Nnewi, South East Nigeria

Fidelis C. Obodoeze<sup>1</sup>, Lois Onyejere Nwobodo<sup>2</sup>, Ifeyinwa Nkemdilim Obiokafor<sup>3</sup>

<sup>1</sup>Department of Computer Engineering Technology, Akanu Ibiam Federal Polytechnic, Unwana, Afikpo, Ebonyi State, Nigeria

<sup>2</sup>Department of Computer Engineering, Enugu State University of Science & Technology (ESUT), Enugu, Enugu State, Nigeria

<sup>3</sup>Department of Computer Science & Technology, Anambra State Polytechnic, Mgbakwu, Anambra State, Nigeria

**Abstract**—This paper investigates the challenges facing the ICT automation (adoption and usage) among Small and Medium Scale Industries (SMIs) in the manufacturing and logistics sectors in South East Nigeria. The paper identifies about seven key ICT components or tools that are required to ensure successful industrial automation. The researcher visited and sampled about 25 manufacturing and logistics firms based in Nnewi Anambra State to determine their level of ICT adoption and usage of the major ICT automation components or tools. Questionnaires and structured interview were employed as data collection instruments to reach some of the targeted firms. Twenty-five firms out of 33 filled and returned the questionnaires distributed to them. The paper discovered that the major challenges facing ICT adoption and usage in South East Nigeria are epileptic and unreliable power supply, high cost of internet bandwidth and network unavailability, lack of corporate interest for ICT automation and usage, lack of budget for ICT acquisition, lack of skilled manpower to drive ICT automation and usage, lack of quality training on technical manpower and lack of good existing ICT models to adopt or copy by upstart firms. The paper concludes by suggesting various solutions to these identified challenges.

**Keywords**— ICT, automation, RFID, sensors, computer, actuators, robots, factory, control, process, software, SMI, SCADA, information system, industrial operations, epayment.

## I. INTRODUCTION

ICT automation involves the use of information and communication technology (ICT) based systems such as computers, information systems, robots, sensors, actuators and control software solutions to automate or change manual industrial operations so that they can be driven and controlled automatically with little or no human interventions.

Computer-controlled manufacturing has revolutionised the way products are made. Modern factories are full of robots; everything is automated. In a modern factory the only people you will see are a few engineers who are responsible for keeping the robots and other machinery running smoothly. This is very different to old factories, where everything was done manually by human workers.

## II. COMPONENTS OF INDUSTRIAL AUTOMATION

Industrial ICT automation requires the complete application and deployment of several components. They

include Robots, Sensors, actuators as well as the computers or process control software.

Industrial production and operations need to be automated so that minimal or no human/manual interventions will be required. Robots, sensors, actuators and computers (processors or control software) are needed in most cases to control industrial operations and productions. Sensors gather input data from different sources and send them to the computer or processor to process. Thereafter, the computer or processor sends the result or output of the processing to the actuators to take action without human intervention as depicted in Fig. 1.

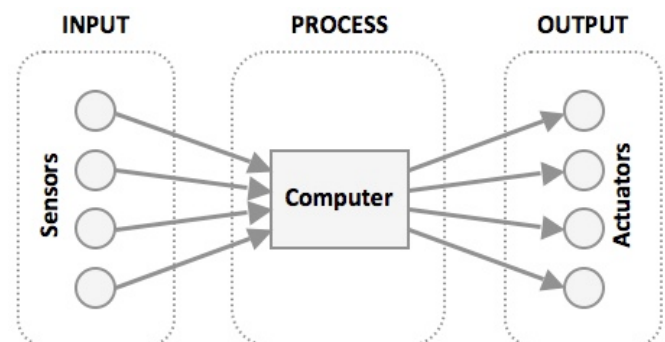


Fig. 1. Basics of computer controlled industrial automation [1].

### A. Robots

The robots used in factories are very expensive. Many of the larger ones can cost as much as N100,000,000.00. Most of the robots are not produced locally in Nigeria but are imported from overseas in foreign currencies. And some factories have dozens of robots while some do not have any at all due to its prohibitive cost and lack of technicalities required to operate them. Fig. 2 shows a typical industrial robot deployed in production lines in manufacturing factories.

### The need for Robots in industrial automation:

There are a number of reasons that robots are used. According to [1], they include the following:-



Fig. 2. Industrial robots in action [1].

1. Robots can work 24 hours a day, every day, with no breaks.
2. Robots don't need to be paid a wage or salary (so money is saved).
3. Robots are extremely accurate compared to humans, so product quality is high.
4. Robots can perform tasks more quickly than humans, so more products can be made.
5. Factories with robots don't need to be heated or even have the lights on, and they don't need food (so lower day-to-day costs).
6. Robots can work in very dangerous / unhealthy conditions (e.g. with dangerous chemicals).
7. Robots don't get bored / hate their job.

**Demerits of Robots:**

There are some downsides to the use of robots in factories:

1. Robots cannot easily adapt to unusual conditions like a human can (e.g. if an item on the line is not in the correct place, a human worker would notice and correct it)
2. People are made unemployed because robots are doing their jobs (however some new jobs are created - looking after the robots - and some employees can be retrained)
3. People are deskilled (this means that, because the robots are doing the complex, skilled tasks that the people used to do, the people are left doing simple, boring jobs).
4. The robots are very expensive, and it can take several years to pay for them.

**B. Sensors**

The Sensors (inputs to the computer) detect what is happening on the production line, and send data to the computer so that it can decide what to do.

Examples of sensors include the following:-

- *Switches / buttons* - detect if something is touching them
- *Pressure sensors* - detect if something is pressing down on them or there is a leakage in the pipeline
- *Light sensors* - detect if something is present (blocks the light)
- *Temperature sensors* - detect if items are hot/cool enough
- *Liquid level sensors* - detect how much liquid is in a container
- *Cameras* - detect the shape / colour of objects

Fig. 3 shows the typical industrial sensors used in production lines.



Fig. 3. Industrial sensors used in production lines [1]

**C. Process or Control Software or SCADA**

The control software running on the computer is the process. It takes the data from the sensors, checks if anything needs to be done, then turns on/off various actuators to make things happen. This control software can be monitored via a web interface on the internet or intranet. It is sometimes called SCADA (Supervisory Control and Data Acquisition). For example, as depicted in Fig. 4, in a soft-drink factory, the production line involves filling bottles with fluid (drink!). Fig. 5 shows a typical industrial automated process using the computer.



Fig. 4. Soft drink automated production using process or control software [1].



Fig. 5. Computer in process control automation [1].

The computer would make sure that a bottle was in place (using data from a pressure sensor, a light sensor, or a camera) and then turn on the fluid control valve. The data from a fluid level sensor would be checked to see if the bottle was full. When it was full, the computer would turn off the fluid control valve. These steps would then be repeated for the next bottle, and so on. In a typical production line, there will be hundreds of sensors and dozens of actuators, all connected to computers (often a large network of computers).

**D. Actuators or Actors**

Actuators (outputs from the computer) are the devices that make things happen on the production line: robots picking things up, conveyor belts moving, etc.

Examples of actuators include the following:

- Motors - used to make almost everything move, from the joints of robot arms, to the motion of conveyor belts.
- Valves - to turn on/off the flow of paint, etc.
- Relays (electrically operated switches)- turn on/off devices like welder.

Fig. 6 depicts the industrial actuators that make things to happen.



Fig. 6. Industrial actuator [1].

**E. Other ICT Tools in Industrial Management**

The Apart from robots, sensors, actuators and computer process or software, these ICT tools are germane to successful industrial automation and management. They are as follow:-

*Company website* – Company websites are needed to project the company’s brand or products and services to their targeted customers and members of the public.

*Corporate Network or Intranet*- This type of corporate network or intranet sometimes called Local Area Network (LAN) enables the firm to tie-up all their automated processes, data and computers together to ensure seamless and smooth integration and this raises productivity level.

*CCTV cameras*- CCTV or Close Circuit Television cameras are security or surveillance cameras needed to provide 24/7 security and surveillance to company’s workers and assets.

*RFID*- Radio Frequency IDentification (RFID) is specialized smart device used to track and tag various industrial processes to detect anomalies and raise alarms or alerts when needed.

*Wireless sensors*- These are micro and battery-powered wireless devices used to track and monitor various industrial processes and to provide security to company’s remotely installed assets wirelessly.

*Corporate database*- This is used to organize and streamline company’s data asset to enhance and improved decision making.

*GPS tracking devices*- Global Positioning System (GPS) is a satellite communication receiver devices used to track or monitor whereabouts of moveable assets such vehicles, ships, persons, animals, etc.

Smart objects such as Close Circuit Television (CCTV) cameras, wireless sensors, Radio Frequency IDentification (RFID), Global Positioning System (GPS) tracking devices can be used to provide security, monitoring and control operations needed to safeguard industrial investments and operations.

Fig. 7 depicts a scenario of the adoption/usage of RFID, corporate network and Database systems to monitor and control the type and amount of medicine given to a patient by a Doctor or caregiver to ensure that the right treatment is given to a particular patient without mistake. The RFID detects a particular patient via his/her RFID tag and ensures that he/she receives the correct treatment in terms of dosage and type. Any mistake or error is detected immediately by the RFID system in the network and an alarm is raised.

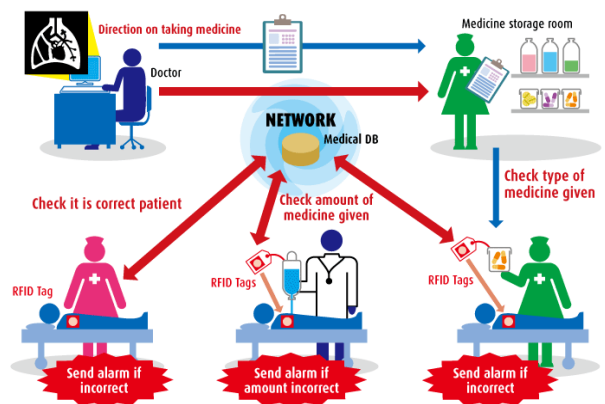


Fig. 7. Use of RFID to monitor and control levels of parameters used in industrial production [2].

**III. THE GOAL OR AIM OF THE RESEARCH**

The aim of this research is to investigate the level of compliancy of manufacturing and logistics firms based in South East Nigeria to ICT automation (adoption and usage) to various industrial processes and operations.

**IV. MATERIALS AND METHODS**

The materials used in this research include the use of questionnaire and structured interview to collect data from sampled manufacturing and logistics firms in Nnewi, Anambra State, South East Nigeria. The methods involved random sampling of about twenty-five manufacturing and logistics firms using questionnaire and structured interview of some staff and management of the firms.

**V. SELECTED ICT TOOLS OR SYSTEMS BY THE RESEARCHER**

The researcher used the following ICT tools/sub-systems to determine the level of compliance in industrial automation



(adoption and usage) of about twenty-five manufacturing and logistics firms based in industrial town of Nnewi, South East, Nigeria. The researcher used questionnaire and structured interview to collect the data.

1. Internet Connectivity or data services and communication softwares with SCADA.
2. Inventory/Customer Management software systems e.g. ERP, CRM, etc.
3. Database systems e.g. MS Access, MySQL, Oracle, MS SQL Server, etc.
4. Spreadsheet and word processing systems
5. Payroll System
6. HRM – Human Resources Management System
7. Wired/wireless sensors/monitoring system
8. Robotic equipments to control industrial production
9. Security monitoring systems such CCTV, environmental wireless sensors, GPS autotrackers, RFID, etc.
10. Robotic devices to control industrial production and operations
11. Automated Control systems
12. E-payment options e.g. POS, Mobile Payment, InterSwitch etc.

VI. THE SELECTED RESEARCH LOCATION

The selected research location or case study is the industrial town of Nnewi in Anambra State, South East, Nigeria. The geographic coordinates of Nnewi is Latitude 6.020 N and Longitude 6.910 E.

The map of Nnewi on Google Map is depicted in Fig. 8.

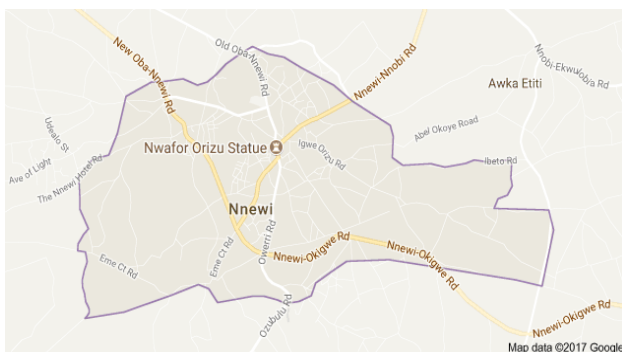


Fig. 8. Nnewi industrial town on Google Map [3]

Nnewi is the home to several small and medium scale industries ranging from manufacturing, maintenance, service, logistics as well construction firms. Nnewi is the home to popular Innoson Motor manufacturing factory. It also houses several motorcycle assembly plants, plastic companies, tools fabrication companies, oil and gas plants, chemical industries, pharmaceutical industries, construction firms, etc. Nnewi is the biggest industrial town in South East Nigeria apart from Aba in Abia State. Nnewi also houses the third biggest market in West Africa.

VII. RESULTS

Table I depicts the result of the ICT adoption and usage compliance level amongst the selected twenty-five manufacturing and logistics firms in Nnewi in percentages.

TABLE I. Respondents’ frequency and percentage.

Item No	ICT automation tool adopted and utilized	YES (adopted and utilized)	NO (not adopted and utilized)
1	Robots, sensors, RFIDs and actuators	10(40%)	15(60%)
2.	Company website/portals	8(32%)	17(68%)
3.	CCTV cameras	10(40%)	15(60%)
4.	Database Systems	5(20%)	20(80%)
5.	Computers connected to a Local Area Network LAN with special control software and web (i.e. corporate intranet) i.e. SCADA	11(44%)	14(56%)
6.	Specialized software systems e.g. CRM, ERP, HRM, Inventory systems, etc.	5(20%)	20(80%)
7.	Internet Access/Connectivity	14(56%)	11(44%)
8.	Epayment options e.g. Point of Sale (PoS) terminals, Mobile Payment, QuickTeller, VoguePay, Remita, etc.	15(60%)	14(40%)

VIII. DISCUSSION

From the table I, it is shown that about 40% of the industrial firms visited adopted and used Robots, sensors, RFIDs and actuators in their industrial operations and management while the rest (60%) did not.

Similarly, the adoption and usage of Company website/portals, CCTV cameras, database systems, use of computers with corporate intranet, use of specialized software systems, Internet access/connectivity, and epayment options respectively recorded 32%, 40%, 20%, 44%, 20%, 56%, and 60%.

From these data, it shows that the majority of the firms visited have not adopted and used the major ICT automation tools and software in their industrial operations and management except in adoption of Internet access/connectivity and epayment options that have improved significantly.

Likewise, even though epayment options have become popular in other regions in the country, up tp 40% of, the firms visited still rely on cash receipts/payments or bank deposits even though POS and mobile transfer are very easy, affordable and available. Allowing customers to have various epayment options to make payment will readily increase sales and turn-over.

Figs. 9-16 captured the above information graphically using bar charts.

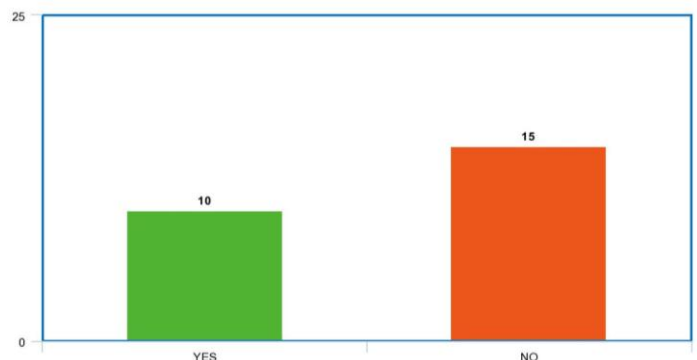


Fig. 9. Adoption and usage of robots, sensors, RFIDs and actuators (green color is YES, Red is NO).

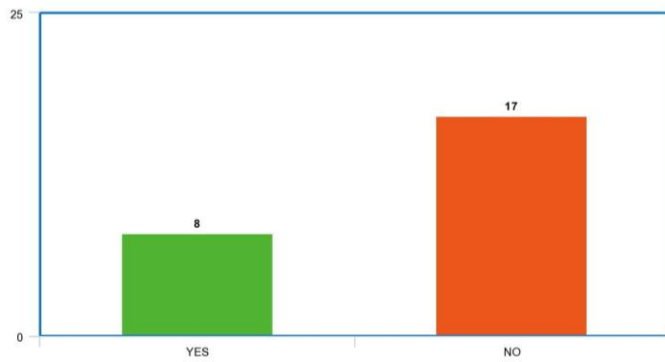


Fig. 10. Adoption and usage of company website/portals (green color is YES, Red is NO).

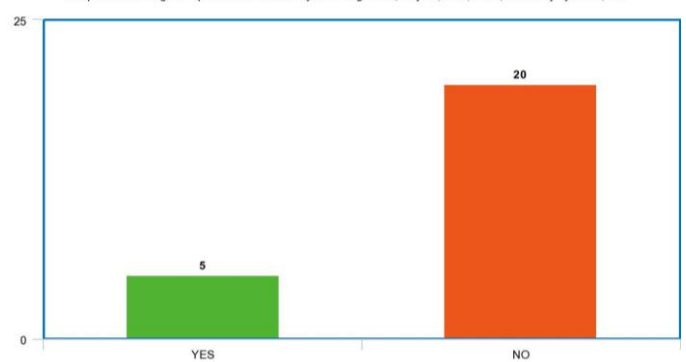


Fig. 14. Adoption and usage of specialized software systems e.g. CRM, ERP, HRM, Inventory systems, etc. (green color is YES, Red is NO).

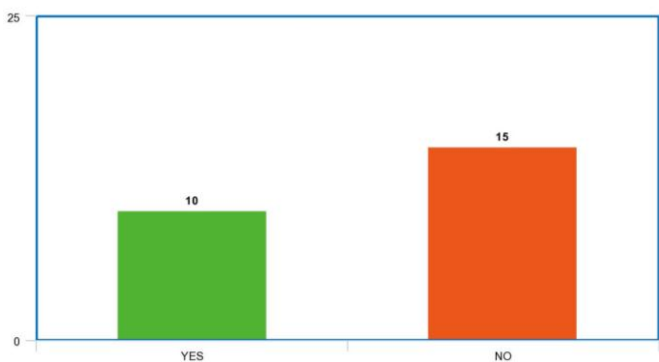


Fig. 11. Adoption and usage of CCTV cameras (green color is YES, Red is NO).

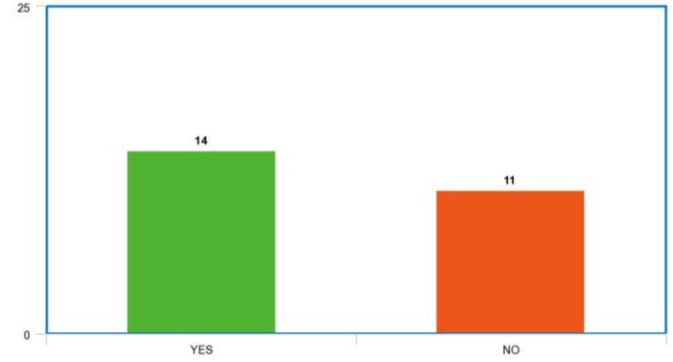


Fig. 15. Adoption and usage of internet access/connectivity (green color is YES, Red is NO)

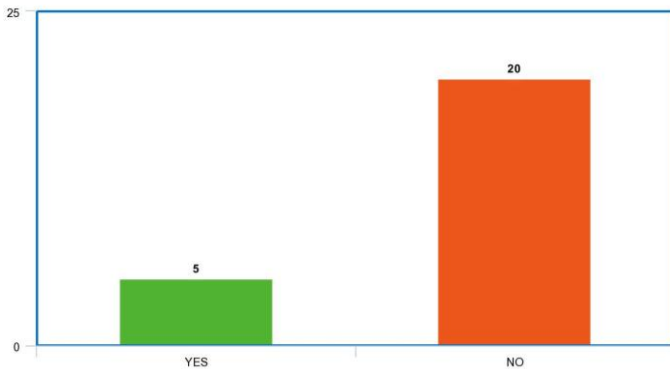


Fig. 12. Adoption and usage of database systems (green color is YES, Red is NO).

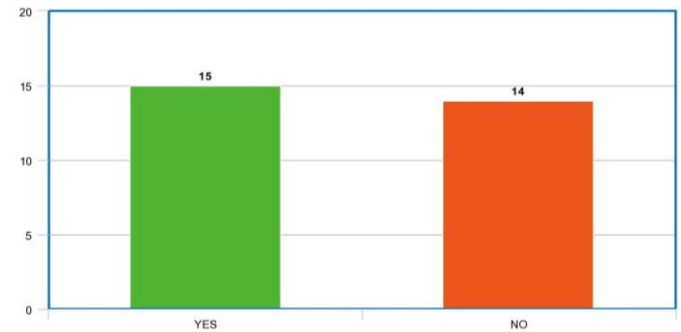


Fig. 16. Adoption and usage of Epayment systems such as Remita, Interswitch, VoguePAY, Interswitch, etc (green color is YES, Red is NO).

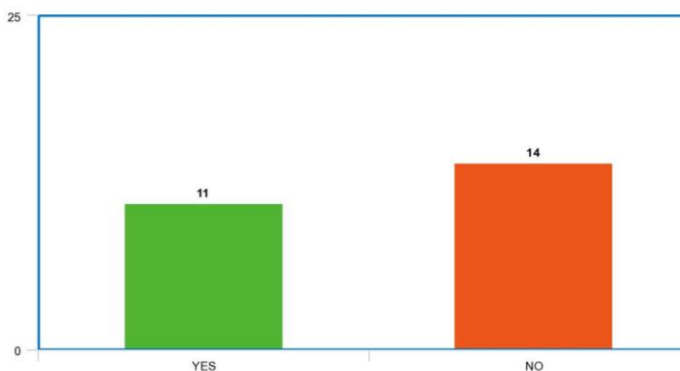


Fig. 13. Adoption and usage of computers connected to local area network (LAN) with control software (SCADA) (green color is YES, Red is NO).

#### IX. CHALLENGES FACING ICT ADOPTION IN INDUSTRIES AND SOLUTIONS

From the findings from the research, it was discovered that the major challenges inhibiting the adoption and usage of ICT in industrial sector in South East Nigeria are as follow:-

1. *Elliptic power supply*: There are constant power outages in major locations of the factories especially in the rural areas. Even in some urban centres the power distribution companies (DISCOs) distribute skeletal power supply to the industries and factories; these discourage investments in ICT by industry owners since ICT requires uninterrupted power supply to thrive.

2. *Lack of broad band internet/data services*. Internet connectivity to broad band or data services is still very low in Nigeria, especially in South east Nigeria. The cost of acquiring

and subscribing to high internet/data bandwidth required for industrial activities/operation is still very high and prohibitive. Most remote locations such as rural areas do not have high penetration of 3G and HSPDA connectivity. Some even do not have access to voice talkless of 3G or 4G networks for data connectivity.

3. *Lack of access to appropriate ICT equipment and software systems.* Many manufacturing and logistics firms lack prerequisite ICT facilities and information systems software required to drive ICT automation. This is because of several reasons. High cost of ICT equipment procurement and subscription is the major reason while lack of skilled manpower to run them is the second reason.

4. *Lack of time for training, exploration and preparation.* ICT automation requires cutting-edge technologies; cutting-edge technologies require high IT skills to drive the technologies. Many of the industrial firms set up some form of ICT automation without having the required manpower, skill or technical knowhow. Some do not even have time to send their technical staff overseas for training on automation because they set up the firm in a hurry without adequate preparation and planning.

5. *Lack of models of good practice in ICT.* Some upstart industrial firms do not even have a working ICT model to copy from or adopt in setting up their ICT automation in their factories. This wastes a lot of time and further discourages the adoption and usage of ICT in industrial operations.

6. *Negative attitudes towards ICT adoption in industries by Managers/Owners.* Most Industry managers in Nnewi, Anambra State and some other South Eastern States believe that ICT adoption is not cost effective and impactful in their industrial operations. They tend to believe that manual operations are much cheaper, better and reliable in industrial operations and management. Some of them have the erroneous believe that ICT exposure will make their products to compete with rivals and push their inability to meet up to demands from customers. Some of them believe that is better to maintain their existing customer base than to try to cover more. The problem is lack of proper knowledge on the benefits of ICT adoption to industries and the problem can be corrected by adequate sensitization and education.

7. *Lack of adequate budget for ICT acquisition.* Because of these negative misconceptions on ICT adoption and usage, industry owners/managers do not provide budget or adequate budget for ICT acquisition for their firms.

#### X. SUMMARY AND CONCLUSION

This research paper explored the level of compliancy amongst twenty-five manufacturing and logistics firms in Nnewi, Anambra State, in South East, Nigeria, in adopting and using ICT automation tools in their industrial operations. The researcher discovered that ICT adoption and usage is still low in South East region of Nigeria. ICT automation is very critical to successful industrial operations and management anywhere in the world. Manual system is not the way to go

especially in this modern era where technology is the key to industrial growth, expansion and profitability. Manual system cannot bring about expansion, automation and smooth management. Many factors such as epileptic power supply, high cost of internet bandwidth, lack of access to appropriate ICT equipment and software, lack of time for training, lack of time for training, exploration and preparation, lack of models of good practice in ICT to copy from, Negative attitudes towards ICT adoption in industries by mmanagers/owners amongst others factors contribute to the inability of industry owners and managers to adopt and implement full ICT automation in their industrial operations in South East Nigeria. However, these challenges can be surmounted if there are concerted efforts by the major stakeholders – the government, ICT vendors and the industrial firm owners/managers to tackle some of the problems.

#### XI. RECOMMENDATIONS

The researcher suggests the following recommendations to encourage and sustain the adoption and usage of ICT to automate and manage industrial operations.

1. The government should tackle the challenge posed by epileptic power supply by looking at different power solutions. Solar option should be encouraged; Inverter systems should be adopted by companies to reduce cost of buying diesel and petrol to power their generating sets.
2. The use of locally made software should be encouraged so that the cost of procurement of software will be reduced. Importing software from India, USA or Europe is expensive because of high foreign exchange rate.
3. Companies should provide some fund (budget) to invest in ICT automation. The initial cost will be recovered after the successful setup and operations.
4. The high level of tariffs, license fees, royalties and taxation charged on telecommunication firms and Internet Service Providers (ISPs) should be reduced. This will in turn reduce the high cost of internet bandwidth. This will lower the cost of internet subscriptions and encourage more industrial firms to adopt internet connectivity.
5. The government should encourage telecommunication firms in the country to move hinterland to establish base stations so that companies in the rural areas can have access to 3G, 3.5G or 4G HSPDA.

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