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Study of Application Domains of Industry4.0 for an SME in Arunachal Pradesh

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Abstract—*India is the sixth largest industrialized country in the world. Manufacturing comes under secondary sector and generates large income and employment as well in the Gross Domestic Product (GDP) of India. Micro Small and Medium Enterprises (MSME) contribute to 40% of production in India. Small to medium enterprises (SME) consist of 96 % of total industries. Most of the SMEs are operated on manual or semi-mechanized system. The fourth industrial revolution (Industry4.0) marks a major turning point in history of manufacturing in 2013. Advent of new intelligent technologies like Industry4.0 which is based on Internet of Things (IOT), Cloud manufacturing (CM), Big data and Cyber physical systems (CPS) for industries in general and SMEs in particular revolutionized in the manufacturing system globally. These will enhance productivity, quality and profitability of the organizations. In India many of the SMEs are not employing the emerging technologies into their manufacturing assets, processes and quality systems. Hence, in the present work an attempt has been made to identify and develop application domains for an SME located in Banderdewa, Arunachal Pradesh.*
M/s Satyam Ispat (NE) PvtLtd(SINEL), Banderdewa, Arunachal Pradesh is an SME mainly producing Thermo Mechanically Treated (TMT) bars which are suitable for seismic for zone construction and billets. Capacity of 74, 400 MT per annum for Mild Steel Billets and 67, 200 MT per annum of TMT bars 8 mm to 32 mm diameter. The application domains of industry4.0 and its subsystems are identified for sections raw material storage, steel melting, continuous casting, billet reheats and TMT bar rolling. CPS, IOT, CM and big data subsystems of Industry4.0 for SINEL are considered in the present work and some useful conclusions are arrived at.

Keywords*: Indsurty4.0, SME, cyber physical system, Internet of things, TMT bar.*

1. INTRODUCTION

India is the sixth largest industrialized country in the world. Manufacturing comes under secondary sector and generates large income and employment as well in the Gross Domestic Product (GDP) of India. Micro Small and Medium Enterprises (MSME) contribute to 40% of production in India. Small to medium enterprises (SME) consist of 96 % of total industries. Most of the SMEs are operated on manual or semi-mechanized system. The fourth industrial revolution (Industry4.0) marks a major turning point in history of manufacturing in 2013. Advent of new intelligent technologies like Industry4.0 which is based on Internet of Things (IOT), Cloud manufacturing (CM), big data and Cyber physical systems (CPS) for industries in general and SMEs in particular revolutionized in the manufacturing system globally. [1]

SME: Small medium enterprises define as the investment should be more than twenty five lakhs rupees but not exceeds five crores rupees.[2]

Industrial Revolution: The revolution of industry has been evolved from Industry1.0 to Industry4.0. In first industrial revolution steam power were used in Industries. After first industrial revolution the second industrial revolution changed steam power by mass production with the help of electrical energy. The third industrial revolution introduced the use of electronic and Information Technology (IT) system. Now, at present scenario fourth industrial revolution introduces the use of Cyber physical System.

2. INDUSTRY4.0 AND ITS SUBSYSTEMS:

Industry 4.0 is a name given to the current trend of automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the Internet of things, cloud computing and cognitive computing. Industry 4.0 is commonly referred to as the fourth industrial revolution.[3]

Industry 4.0 fosters what has been called a "smart factory". Within modular structured smart factories, cyber-physical systems monitor physical processes, create a virtual copy of the physical world and make decentralized decisions. Over the Internet of Things, cyber-physical systems communicate and cooperate with each other and with humans in real-time both internally and across organizational services offered and used by participants of the value chain.

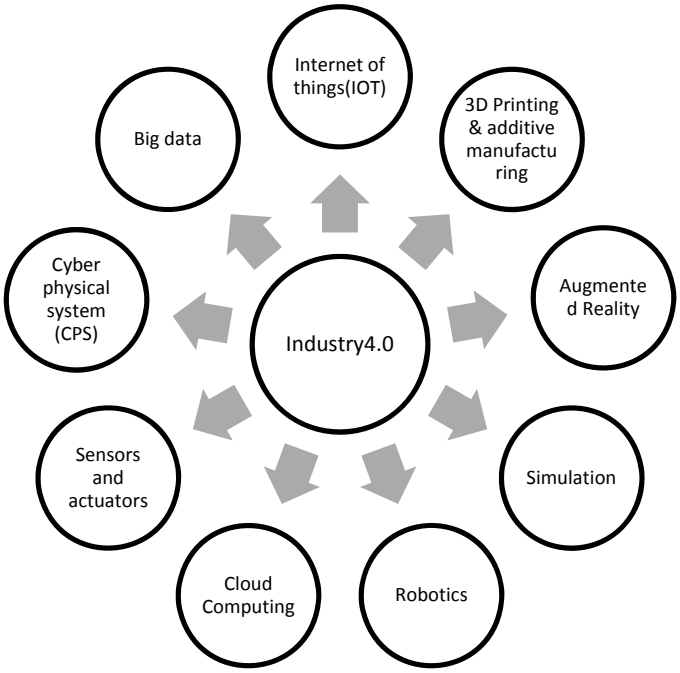

Figure 1: Building blocks of Industry4.0

IIOT (Industrial internet of things):Itrefers to interconnected sensors, instruments, and other devices networked together with computers' industrial applications, including, but not limited to, manufacturing and energy management. This connectivity allows for data collection, exchange and analysis, potentially facilitating improvements in productivity and efficiency as well as other economic benefits. The IIoT is an evolution of a Distributed Control System (DCS) that allows for a higher degree of automation by using cloud computing to refine and optimize the process controls. [4]

CPS (Cyber physical system):Cyber-physical systems (CPS) are engineered systems built and dependent upon the integration of computational algorithms and physical components. Together with the internet, data, and services available online, embedded systems join to form cyber-physical systems. [5]

Big data and Cloud Computing:With the use of big data and cloud computing, the information retrieved through these networks can be used to model, virtualize and simulate products and manufacturing processes. Thesemodels are called digital twins, or device shadows. A digital twin is a computerized companion of a physical asset that enables real time monitoring, diagnostics and prognostics of the asset. [6]

3. STUDY OF INDUSTRIAL MANUFACTURING SYSTEM AND ITS SUBSYSTEMS OF SINEL: A CASE STUDY

M/S Satyam Ispat (NE) PvtLtd, Banderdewa, Arunachal Pradesh is located in Banderdewa and is mainly known for the production of TMT (thermo mechanically treated) bars and billets .ITS head office is located in Guwahati; Assam This factory got the certificate of commercialization in the year 2006. In the year 2006 it got BIS certificate. The ISO certificate was obtained in 2009.Its man power includes 1 manager, production engineer, around 90 technical staff and 260 non-technical employees. The factory has an annual production of 74, 400 MT per annum for Mild Steel Billets and 67, 200 MT per annum of TMT bars 8 mm to 32 mm diameter. Those bars are rolled from billets produced by continuous casting section. The factory owns an area of around 61633 sq m and the built up area for the factory is around 57765 sq m .Its main products include mild steel billets of 10 mm square and 500 TMT bars of 8, 10, 12, 16, 25 and 28 mm diameter. The raw materials used are mild steel scrap, sponge iron, pig iron and cast iron. The Chemical composition of the TMT bar is around: Carbon (0.20 to 0.25% max.), Manganese (0.65 to 1.00% max.), Silicon (0.15 to 0.20 max.), Sulphur and Phosphorus is 0.45% (maximum). The physical properties required by the

finished product include yield stress (450 to 485 N/mm~2), tensile stress (550 to 5800 N/mm~2) and elongation -15% (minimum).The factory is divided into the following divisions:

1) Raw material storage section.
2) Steel melting section.
3) Continuous casting section.
4) Billet reheats section.
5) TMT bar roller section.
6) Thermax section.

Figure 2 shows the proposed cyber physical system layout of SINEL. The factory contains 4 bays. Raw material section, the melting section, laboratory and the concast section is located in the AB bay. The billet stock area is located in the BC bay. The reheat furnace and stock yard is located in the CD bay. The rolling mill, thermax section, the thermax controller and the TMT conveyor are present in the DE bay. CPS1 to CPS8 connecting with the central hub is presented in figure 2.

In Table 1manufacturing application domains of SINEL for various sections and subsections are identified and presented. Industry4.0 application domains are also identified. The industry4.0 application domains applicable for SINEL sections are presented.

4. DISCUSSIONS AND CONCLUSION

In the present research work Industry4.0 and its building blocks are identified for SMEs. A real SME (SINEL) was considered for identifying application domains of Industry4.0. The physical systems of SINEL added to cyber systems for various sections i.e. CPS1 (Raw materal section)**,** CPS2 (Steel melting section)**,** CPS3 (Concast section)**,** CPS4 (Billet section)**,** CPS5 (Reaheat section)**,** CPS6 (Rolling section)**,** CPS7 (Thermax section) and CPS8 (Stock yard). All the CPSs are connected to Central CPS hub. The manufacturing data of various sections are collected and stored in each of the CPS and interconnected to the central CPS hub. All the CPSs are connected to high speed internet systems forming cloud manufacturing systems.

An existing working SME (SINEL) and its manufacturing sub sections are identified for four Industry4.0 subsystem application domains. The manufacturing physical systems (raw material, melting, continuous casting, rolling section etc.) are made cyber physical systems by various hardware, software and high speed internet systems and the layout diagram for CPS is presented for SINEL of Banderdewa, Arunchal Pradesh, India.

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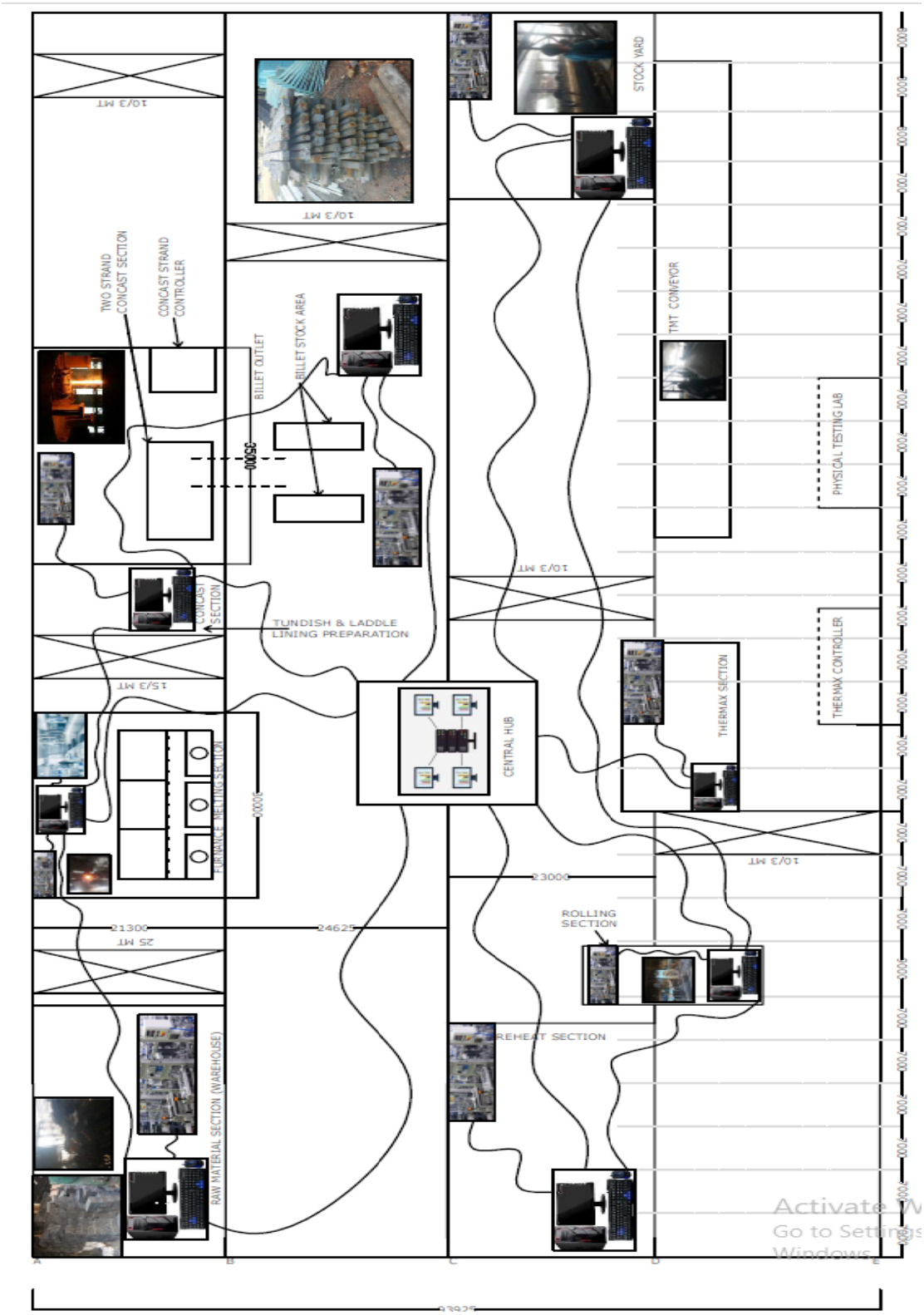

Figure 2: Cyber physical system layout of SINEL.

Table 1. Application domains of Industry4.0 for an SME

SINEL manufacturing sections	Manufacturing subsections	Internet of things(IOT)	Cloud manufacturing	Big data	Cyber physical system
Raw material storage section	Warehouse/ASR	✓		✓	✓
	Load/unload time	✓			✓
	Raw material preparation for metal charging				✓
	Inventory and EOQ	✓	✓	✓	
	Raw material quality		✓	✓	✓
Furnace melting section	Furnace controller	✓	✓		✓
	Furnace cooling system		✓		✓
	Metal charging system		✓	✓	✓
	Furnace lining system		✓		✓
	Molten metal pouring system		✓		✓
	Chemical composition	✓	✓	✓	✓
	Ladle refractory monitoring system				✓
	Metal charge preheating system		✓		✓
Continuous casting section	10T ladle with molten metal	✓	✓		✓
	Tundish		✓		✓
	Continuous casting mould		✓		✓
	Billet concast system		✓	✓	✓
	Billet shearing mechanism		✓		✓
	Strand secondary cooling apron				✓
Billet reheating section	Billet charging system			✓	✓
	Temperature control				✓
	Fuel system				✓
	Soaking time				✓
	Billet removal for rolling				✓
Rolling and Thermax section	Roll speed control system		✓	✓	✓
	Roll die system		✓		✓
	Die lubrication and cooling system		✓		✓
	TMT bar HT system		✓		✓
	TMT bar cutting system and storage system		✓	✓	✓