Internet of Things (IoT) for Manufacturing Logistics on SAP ERP Applications

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Abstract—**Logistics activities and production reporting are the important areas that are becoming the determinants or factors affecting the key performance Index (KPI) in evaluating the logistics business performance monitoring (BPM). Inventory management and manufacturing production processes are the activities that provide important information. These information or data are usually captured and updated in the normal computerized system in such module "SAP ERP" software. The integration and the linkage of the focus areas by the enterprise resource planning (SAP ERP) that champions the supply chain value are much relied on internet. The move of logistics operations in the internet economy actually shifted the traditional logistics to E-logistics. The internet of things (IOT) enhanced the logistics operation performance providing the real time update that influence the management making decision related to time and costs saving as well as improved operation's efficiency by connecting those unconnected activities as the enhancement for the issues addressed in manufacturing logistics. It benefited the related parties, especially the manufacturers and consumers.**

Index Terms—**Internet of Things (IOT); SAP ERP Application Software; Supply Chain Value.**

I. INTRODUCTION

Logistics production environment and its related system would be wirelessly communicated with an internet of things (IOT) system. It is connecting the unconnected to the normal system, which enhances the production performance [2]. The system includes the updating and interfacing multi-application of different task or focus area onto the system or the mainframe which will be transmitted to the respective person in the organization [3]. Warehouse management system and the inventory system are the examples that provide a lot of data and the involvement towards the production, especially the manufacturing activity, which generates the cost of production report. Any issues or problems faced during the production at the real time situation must be rectified and solved instantly with quick decision-making by the respective department or the authorized person. It improves the quality of investigating and analyzing [8].

Faster decision-making would reflect such daily performance monitoring in logistics production. Inventory management and manufacturing activities managed by the team led by the warehouse manager and production manager should be highlighted with their information or data at every moment of the production, and with this internet of things (IOT) connection, every single issues is sent to the respective personnel for verification and immediate action. Since SAP R/3 (Release 3) introduced the 1st edition in July

1992 and the ERP version ERP central Component (ECC)1 in year 2004, it has been integrated within the computers of the authorized personnel, and has been extended to the respective person's personal contact mobile device or smartphone. This is the simple basic of IOT function without using other additional special equipment. This is the 24 hours linkages and preset instant reports and messages sent relating to any matters related to the production. Supply chain management and initiatives can be achieved by implementing this method of connection as the focus area can be monitored and investigated or the root causes be ascertained accordingly. Therefore, the IOT, which can be implemented or aligned through the SAP functional area will be discussed in the SAP description and related application.

II. SAP - SYSTEMS APPLICATIONS AND PRODUCTS (SAP ERP)

Software named as the "System, Applications and Products" that interacts businesses and operation activities, integrates the focus area of the manufacturing logistics activities linkages to the supply chain management (initiatives) through the enterprise resource planning (ERP). SAP is a "software" that allows business to "track customer (related parties) and the business interactions". Originally, the idea is to provide users with the ability to participate or communicate within the focus operational area on the same platform (database) with various range (comprehensive) of applications. SAP ERP makes many organizations or companies to successfully operate their business operation. SAP in general provides the "management" of finance, assets & cost accounting, factory or plants, manufacturing, material and personnel. SAP R/3 (release 3) system operates on many platforms, such as Windows 2000 and users server model. "Comprehensive Internet-Enabled" is the latest product that uses IOT (Internet & Wi-Fi) to make the mobile or hand held devices possible in logistics operation or the manufacturing logistics.

In its latest development, SAP introduced a product that is operated under a comprehensive Web interface, called mySAP.com, and added new e-business applications, including customer relationship management (CRM) and supply chain management (SCM) [1].

Figure 1 shows the linkages between the focus areas and enterprise resource planning (ERP) that functions as the dashboard or the performance indicator or the business performance monitoring (BPM) applicable to any business activities. Logistics is part of the supply chain management.

Internet of things (IOT) can be implemented in many areas to support the enhancement in the production.

Standard reports or results from SAP with the value added of IOT can be ascertained at real time as it can highlight any errors found in the production. This is one step further contributing to the efficiency and accuracy as compared to the normal SAP ERP reporting. The implementation of IOT with the value added features in the logistics activities will be later discussed in detail, emphasizing its advantages, safety productions and contributions towards the management decision on analyzing performances as well as cost savings and cost control.
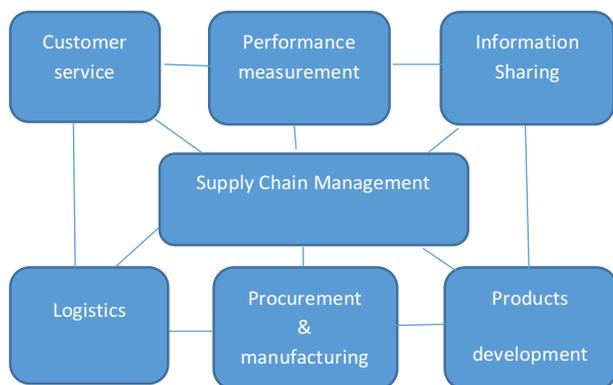

Figure 1: Logistics and Supply chain Management Linkages [2]

A. SAP Business Process - Logistics

Material management in SAP is called "SAP MM", where the role in manufacturing logistics is related to the "Procurement Management" that administers the purchasing for the organization. This function is very important to manufacturing logistics, which works on information sharing that can be processed and updated to the main system. Material and inventory management in "SAP MM", allows proper recording and monitoring of the administration, especially for statistical as well as for "Economic Order Quantity" (EOQ) purchasing. Costing method can be applied for stock or inventory management, for example the valuation of stock method, such as the "Last in First Out" (LIFO). "SAP MM" works smarter with material management and procurement (E-Procurement) and the administration of "Vendor Management System" (VMS) which includes purchase requisition (PR), purchase order (PO) and invoice verification (IV). It is a complete activity or production recording and report within the SAP system.

Logistics activities usually are the outsourced jobs by other organizations which were professionally done by the third party logistics (3PL) service provider , which may benefited with the SAP software. Warehousing, manufacturing, transport consolidating and transportation and the detail production activities would adopt the mobile services as the means to manage and monitor the processes. From operation to asset management, real time information can be highlighted to respective person in charge or the management.

Some of the Internet of things (IOT) functions are to automate certain processes, distribution of central control to sub unit or of small self-organized units and etc. IOT is about "connecting the unconnected", "sensing & sense making" in the logistics operational efficient and effective. The powerful of internet and the Wi-Fi technology is the platform that allows every information to be shared for a

common purpose and even for automation instruction process as the right first-hand information to the right qualified person at the real time.

III. INTERNET OF THINGS (IoT) IMPACTS ON MANUFACTURING LOGISTICS

Technology, especially the information technology (IT) is pushing the jobs and works activities faster and to have efficient management as to a high level standard or good decision making. Through internet or "connected the unconnected", performance monitoring becomes fast and efficient. ERP concept is championing the supply chain function and the management. IOT benefits across the entire logistics value chain through the warehousing operations, freight transportation and the consolidation and movement of goods in the intermodals transportation. The benefits can be realized as the impacted areas, such as operational efficiency, safety and security and customer relationship experience. Maximizing usage (utilization) of assets will result in good operation activities (efficiency). In manufacturing, the machines (machineries) play important role in production, sometimes technology (equipment) may need replacement for better or efficient production. That is one of the factors besides having 'sensor' (IOT) to improve the administration or analyzing performances. For example, IOT can be implemented IOT in the car manufacturing plant or operations to gain efficiency.

Resource and energy monitoring involve costs. IOT and sensors really helps in monitoring the resources and consumption, especially in petrol and other utilities such as energy (electricity and water). Companies that replaced the workers (labor) with a smart-technology solution and advance technology are actually aiming to increase efficiency and profitability. Respective managers will know the situation and the condition (environment) at the manufacturing workplace when being connected through this IOT that are related to machine performance, usage of energy and the standing (status) or material or inventory management.

Safety and health or even any hazards affecting the assets and workers is the main target whether the standard operating procedure (SOP) on production safety or occupational safety compliance as provided and guided in the factory machinery act (FMA) and the occupational safety and health act (OSHA). Any issues for not complying the rules and regulations may face difficulties in claiming such insurance covers. Sensors can be upgraded to check compliance matters in the operation and to detect or to forecast any possible errors that may lead to damages or accident. Improving efficiency may derive from anticipating the factors of equipment (tools) optimization level analysis, warehousing or storage guidance on robotic assistance for customers (users) on the activity or the transaction recording (Scanner, Bar Coding and Radio Frequency Identification - RFID).

IOT output and results will prioritize the problems, such as difficulties in the operation areas and any business issues for getting solutions or new methods. It promises a substantial impact, for example monitoring condition of assets, goods and people at the actual situation throughout the value chain. Analyzing asset performance comparing standard and actual, automate business processes is the elimination of manual operation. It improves quality and

forecasts performance as well as lowers costs by coordinating activities of people or worker, systems and assets together. Through research and analysis, we can identify areas of improvements, opportunities and the best practices. IOT in logistics is about "connecting the unconnected" for better and efficient manufacturing and production activities. IOT enables "Capabilities". Business performance monitoring (BPM) is the process of measuring, controlling, automating, optimizing and learning or findings for which management is looking for the cost benefits and creating values to the customers. Due to the increase in the sales, marketing and customer's demands on internet based, web based and e-commerce or e-market, logistics activities or the logistics service provider have to adopt IOT in their business operation.
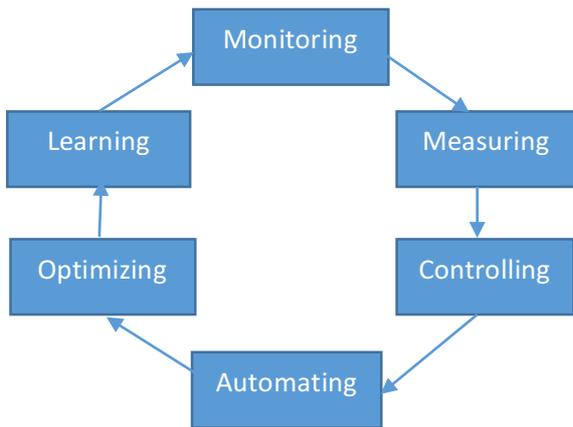

Figure 2: IoT-enabled Capabilities [2]

Figure 2 shows the IoT business performance monitoring process, which implements IOT at the area that applies the "sense and sense making", where "connecting the unconnected" [2].

The IOT impact on manufacturing and logistics is related to the network control, the management and the administration of manufacturing equipment and machineries, in which the situation might be benefited for "Lean manufacturing" or "Just In Time "(JIT) concept [10]. The IOT system provides fast information and instruction process to production (demand), actual time production and aligns machineries under the control of one system. Automatic process control by which operator tool and equipment and the system are within the IOT. "Measurement", "automated controls" "plant and machinery optimization", "health and safety management" and other functions are some of the areas that use network sensors and programmed IOT that will enhance the efficiency of the production. IOT and the internet is connecting "People, Process, Things and Data" [8].

IV. LOGISTICS AMONG THE FIRST TO ADOPT MOBILE OR WIRELESS CONNECTIVITY

Mobile and hand held devices have great benefits for paperless or replacing the "paper based" system or process for the drivers or the forklift drivers in the warehouse logistics. It promotes economic benefit, such as lowering the cost when the platform internet and Wi-Fi connected. IOT allows the logistics and the 3PL company to move forward by simply making the existing processes simpler and better in which it involves the tracking vehicles and the moving

cargos. The IOT can include connected intelligence that is the high technology or interface to sophisticated software or IT application at different elements of logistics infrastructure. IOT can be implemented in the transportation modes, especially the land, sea, air transportation. Vehicles or motorized transport for inland and sea transport are users of IOT in logistics with the latest design and technology of vehicles or transportation equipment will have the "sensor" installed and for the "wireless" connectivity [10]. It is also suitable at sites, where the movements of vehicles and containers involve many places or locations, including ports, yards, depot or hub centers, warehouses and distribution centers. Additionally, it can also be used to track equipment at site including forklifts, tractors, container handlers, mobile cranes etc., gantry cranes, conveyor belts, automated storage and the retrieval systems [11].

Sensors can be installed in the equipments such as at dock (doors), depot or yard and exit or the outbound, light poles, embedded in floors or under pavement, attached to ceiling and other structures [8]. It has also been installed at roads and or involving movement through lanes, implying that such intelligence is starting to be built into roadways, railways, canals/locks and other transportation connecting points. Future benefits of using IOT in logistics and transport is that it contributes to an efficient logistics activity. Internet is the platform for IT application and software that is being used in the activity processes of logistics. Examples of equipment are "The intelligent box" which communicates with people and machines, smart and energy self-sufficient air freight containers that sensor data to monitor shipment status, sensor monitoring, trigger alarms for smart air freight cargo, smart wooden pallet with innovative radio frequency (RF) and IT infrastructure, as well as cellular transport systems at vehicles parking bay or vehicles used in warehouse movement goods or rail guided inside storage. The IOT and the internet service is modeling a new world of logistics environment of activity and process.

IOT and Cloud computing for logistics is a virtual place for logistics and IT applications as a service center for business processes, software, platform and infrastructure. It changes the usual way of doing things, from the application-centric processes, such as warehouse management system (WMS), enterprise resource planning (ERP) and others to service-oriented processes. It is a field of innovation logistics-by-design (Standard) where standardized structures called "Business-Objects" for the definition and modeling of logistics services and objects. Cloud-based tools are used for the integration and development of logistics services, such as, the "Logistics-on-Demand" (Tools) support for the creation of flexible business processes. Logistics-as–a-product (Market place) it is a virtual market place for custom-made logistics processes ranging from a single service to complete software solutions. Logistics processes are recognized as tradable products or goods.

V. CONCLUSIONS

Warehousing, the adoption of pallet and item-level tagging using devices such as radio frequency identification (RFID) will pave the way for IOT-driven that is smart inventory management [7]. The usage of wireless readers captures the data transmitted from each pallet as the data arrive through the inbound areas. In this case, information

on products or raw materials size, volume and the dimensions which could be aggregated and sent to the warehousing management system (WMS) for processing [7]. This would eliminate the time consumed to complete the task activity of manual accounting and the volume scanning of pallets. The closed circuit television (CCTV) or cameras attached could be used for detecting damages by scanning the imperfections pallets. Pallets that are moved to the right place or location tags transmit the signals to the WMS at a real time and visibility to the inventory levels, preventing out of stocks situations [8]. If any stock has been misplaced, sensors will trigger the warehouse manager [2] who can track the exact location for corrective action plan. It is also, where such situation if temperature or humidity threshold to be compromised.

At the outbound delivery area, pallets are scanned through the outbound to ensure the right product items for the right order for the delivery to be shipped or sent correctly. Here, the stock levels are then automatically updated in the WMS for accurate inventory control [7]. IOT also promotes "Optimal Asset Utilization", where warehouse manager will highlight the machines (machinery) and the vehicles that are connected to the system. Alerts are all in the "Real Time" situations (behaviors). Over and under (utilization) of assets will be notified and those assets having or left idled should be emplaced to do other job or task. Many sensors equipment installed for monitoring the assets in the production either idle assets or its performance. Rectifying and verifying such asset about their capacity and task will be made known to the respective personnel or managers.

Forklift sensors and bar codes installed at the warehouse (ceiling) and the warehouse management system (WMS) application form an indoor (in-house) global positioning system (GPS) to inform the forklift drivers regarding the exact location and direction about the pallets. Report to the dashboard for managers will be transmitted and the information will be delivered to observe the presence (visibility) of the stocks or products, actual time (speed), correct location as well as the production efficiency of the whole fleet. Future inefficiencies on the production standards or operational standards might be reviewed for the normal automated processes [9].

Connecting assets in a warehouse also enable predictive maintenance for the warehouse in-house transport system [2]. Sensor will detect the machine in action which has the level of physical stress by measuring throughput or the temperature of the machine and any detected package damage will be informed to respective staff and personnel [9]. Data and combined analytics will determine maintenance appointments or for the new periodical maintenance and the new forecasted expected lifespan of the machines [10]. Health and safety of operation or the occupational safety can be monitored through sensors and actuators with radar or the CCTV relating to the operational and occupational safety as well the air quality [9].

The Internet of Things (IOT) will improve the operational environment having accurate and efficient decision making process. By connecting the previous activity or operational situation not connected, it creates potential benefits for logistics operation to improve the speed, accuracy and right decision on processes through the analyzed and digitalized information. It enables dramatically faster cycles time, highly dynamic processes, adaptive customer experience or improved customer relationship management (CRM)

through the location of people (ecosystem) and technology, the potential pathway for breakthrough performance gains and the "Technology push" and the need for logistics solutions [2]. Mobile computing is growing steadily with more phones expected in the year 2020. Due to customization of information technology (IT), sensor technology has greater in use and affordable to be used for industry purposes in logistics. Upgrading the powerful internet, wireless communication will give higher level of connection(transmitting & interfacing) with the involvement of "cloud computing" and bigger data technologies that enable possible usage data-based services.

Supply chain considerations regarding the FIVE (5) R's the "right product", "right quantity", "right time", "right condition" and the "right cost" representing perfect information. Customers and users will be provided with real time tracking and the transparency for the detailed shipment. Business customers are requesting for integrity control especially on dangerous or sensitive goods. "Third Party Logistics" (3PL) or the service providers should practice "transparency" of networks and assets performance on the "Utilization" and "Optimization" especially in inter-modal or multi-modal transportation. Effective and efficient warehouse operation activities can be achieved through the smart ventilation to hazardous heavy item loading and the inbound and outbound activities [9].

Technology-driven strategy as the big data and the IOT implementation and the possibility of cloud computing with smarter technologies will be replacing the existing system of processing and communicating method. Connectivity standards between different industries, logistics business for land or road transportation usually involves volume and numerous providers that provide different scales of operation, including the standard either local or international, especially the "multi-modal" transportation that binds the international rules relating to international common terms (Incoterms) and the "International Maritime Organization" (IMO) for sea freight transportation [3].

To achieve a successful implementation IOT in logistics operation requires strong collaboration, high levels of participation between different participants and the competitors [2]. Requirements for the implementation of IOT in logistics need greater involvement and participation of many parties as well as the competitors. Some of the important factors require the achievements in the initiatives as listed below [2]. "Right Approach" using special "identifiers" or "tags" for the right assets in the industries. "Capability & Capacity" of the sensor equipment in transmitting the information. Data "Safety & Security", the sensitive issues of IOT within the supply chain. IOT "Design & Characteristics" should be objective. Adopting new "Landscape & Platform" of business vision and mission upholds the potential of IOT.

Internet of Things (IOT) and the internet services as the platform modeling a new world logistics operation environment with the cloud computing infrastructure will definitely projecting a dynamic future of the logistics industry [13].

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