LITERATURE SURVEY ON SMART MANUFACTURING IN INDUSTRIAL INTERNET OF THINGS (IIOT)

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Abstract- Smart Manufacturing (SM) uses the blending of next generation Operations Technology (OT) and knowledge Technology (IT) to know significant untapped market opportunities. A fourth technological revolution is propagated in global manufacturing. It supported the introduction of Internet of Things and Servitization concepts into manufacturing companies, leading to vertically and horizontally integrated production systems. Smart manufacturing is taken under consideration as a replacement paradigm that makes work smarter and more connected, bringing speed and adaptableness . The target of this paper is to depict a landscape of the scienti�c literature on the concept of the 'Smart Manufacturing', which in recent years is gaining more and more attention from academics and practitioners thanks to signi�cant innovations within the assembly systems within the manufacturing sector.

Keywords: Internet Of Things(IOT), Industrial Internet Of Things(IIOT), Characteristics, Applications, I4.0

I. INTRODUCTION

Internet of Things (IoT) may be a computing concept describing ubiquitous connection to the web , turning common objects into connected devices. The key idea behind the IoT concept is to deploy billions or maybe trillions of smart objects capable of sensing the encompassing environment, transmit and process acquired data, then feedback to the environment. It's expected that by the year 2021, there'll be around 28 billion connected devices[1]. IoT is typically depicted because of the disruptive technology for solving most of present-day society issues like smart cities, intelligent transportation, pollution monitoring, and connected healthcare, to name a few.

Industrial IoT (IIoT) covers the domains of machine-to-machine (M2M) and industrial communication technologies with automation applications. IIoT paves the way for better understanding of the manufacturing process, thereby enabling efficient and sustainable production[1]. IIoT in manufacturing means all of your plant equipment can ask you by giving necessary data and by presenting insightful data for your action. Your plant equipment can ask one another and present insightful data points and concepts to enhance your productivity.

IIoT for Smart Manufacturing

Smart Manufacturing in Industry 4.0 implies usage of • Connectivity

• Data handling and processing

•Artificial Intelligence and Machine Learning • Platform & App Access

• 24x7 Cloud Access

• Consists of top-down approach wherein llоT can directly have a positive impact on the business[4]

II. CHARACTERISTICS

A.CONTEXT AWARENESS

Context awareness is the ability of a system or system component to collect information about its environment at any given time and adapt behaviors accordingly. Contextual or context-aware computing uses software and hardware to automatically collect and analyze data to guide responses.

Identity: An SMS should have a unique identity. As an SMS often operates in a digital environment, we may say that an SMS should have its own digital presence, thus providing a unique identification in the digital world, for example, a network interface address[5]. *Location:* It is used to describe the physical location of the system itself or subsystems within.

Status: this is often wont to describe this state of the activities that are being carried within the SMS. Asset self-awareness will also mean that the SMS should be able to know about its present state[6].

Time: The SMS should be ready to define its timely priorities, and it'd even have to consider the civil time .

B. MODULARITY

Modularity is the property of a system by virtue of which a unit is often decomposed into components which will be combined to make different configurations[5]. Composability is the property of the system when it might be developed from its subsystems[7].

C. HETEROGENEITY

Heterogeneity considers the range and dissimilarities within the units and components. However, it doesn't consider the mixture of units like modularity, and as a result, it should be considered as a separate characteristic[5].

D. COMPOSITIONALITY

Compositionality is that the property that deals with the understanding of the entire system supports the definition of its components and therefore the combination of the constituents[7]. As neither modularity nor heterogeneity affect the system or component definitions, compositionality should be considered as a separate characteristic.

E. INTEROPERABILITY

Interoperability is that the characteristic thanks to which, system units would be ready to exchange and share information with one another,[5,7] With the assistance of networkability, systems are ready to collaborate in several process-related aspects, and for this collaboration, they need to permit one another to share and exchange information.[5] Therefore, networkability and distributed characteristics of systems are covered by interoperability. Information appropriateness describes that information is out there, accessible and understandable when needed; this could be a characteristic of data to be shared, otherwise the knowledge are going to be of no use.[6] Integrability is the characteristic thanks to which different units are often integrated, but two units are integrated as long as they need access to every other's information. Therefore, this characteristic of integrability is included in interoperability.[6] Decentralized is that the characteristic by virtue of which SM are often operated by other attached units, and consequently it's going to be considered as a part of interoperability. However, integrability is different from modularity because modularity physically combines the systems leading to a replacement configuration, whereas integrability is inclined toward the exchange of data between two systems and thus it's a neighborhood of interoperability.

F. TECHNOLOGY CLUSTERS

1. Intelligent control:

An important characteristic of producing systems is the speed of response to events. Responsiveness could also be considered because of the ability of an SMS to speedily provide the specified products to the purchasers. Agility is the ability of a system to reply to external influences; in SMS, this might be the response to plug changes[8]. Scalability is taken into account because of the property by which it can easily handle the fluctuations in load,[5]. Adaptability describes the power of the system to make a decision about its own diagnosis, prognosis and thus the best system performance even when it's uncertain information[9]. The systems are often considered to possess a high level of robustness when it can perform well under uncertain conditions[6], and it possesses flexibility when it can adapt to changes within the external environment[11]. Reliability is that the ability to perform activities needless to say , and thus it also makes the results predictable[8]. Accuracy is that the ability to supply the result exactly or very on the brink of the particular result. With the assistance of intelligent technology, a system is in a position to vary its action and support its own experience[12], and if it possesses intelligent control technology, it can make use of, for instance , AI techniques to regulate its mechanisms[12] and is in a position to be reliable and accurate. A producing unit possesses autonomy and has two parts (a) it can adapt with feedback and pursue its activities to realize the target[5] and (b) the unit wants the feedback mechanism to figure . it'll need the technology of intelligent control; therefore, autonomy should be a neighborhood of intelligent control. A system is claimed to be fully automated if it can do its own work completely, but the extent of automation may vary from system to system. For a system to be fully automated, it'll also need some intelligent control mechanisms. Therefore, this characteristic should even be covered by intelligent control. Proactivity is the characteristic which will help units eliminate failures before they happen by sensing things[6]. As this characteristic considers sensing and controlling the mechanisms of the system, it'll need intelligent control mechanisms. Therefore, we will consider it as a neighborhood of intelligent control. However, proactivity senses this situation which may involve data, so this characteristic could be involved within the data analytics cluster also.

2. Cyber security:

Data should be secured from cyber threats. As SM is essentially supported by digitization and data-based services, cyber security is an integral technology for SMS[12]. Albeit this characteristic also involves data, it should still be considered break away interoperability because interoperability is about data sharing and availability, whereas cyber security is about data privacy and security.

3. Energy saving/efficiency:

Products and processes are said to possess sustainability if they're reusable and cause minimum environmental footprints[6]. Thus making the products and processes more economical, social and environment-friendly. The importance of energy cost savings through SM has been discussed frequently, and energy saving is among the most drivers for SM [13]. A sustainable SM process for extracting vegetable oil has also been proposed[14]. Energy saving/efficiency is that the technology thanks to which the energy required to supply a product and repair are often reduced. Various studies are done to decrease the utilization of energy in manufacturing systems[15]. If a system can reuse its products, then the quantity of energy required will decrease in most cases. Thus, sustainability can arguably be seen as a part of energy saving. Although researchers have considered energy saving/efficiency on par with the opposite technologies, it's going to be considered as a necessity for any manufacturing system and not only SMS.

III. APPLICATIONS

A.Application Scenarios & Use Cases

The selection of application scenarios was made to present a broad variety so as to spotlight the wide scope of the initiatives. The appliance cases range from technical initiatives implementing CPS in SME intralogistics[17], over human robot interaction at the shop-floor level using sensors and image recognition[18], to new business models around product enhancing services supported lifecycle [19].

B. Safe Human-Robot Interaction

Smart Manufacturing is different from the pure automation focus of previous initiatives. For a sensible robotics' factory within the context of I4.0 and IoT, where high productivity is demanded by the market, collaboration between human workers and robots is the key. Human workers are essential in their role of either supervisor, collaborator and for jobs robots aren't trained or capable of. These so-called co-bots(collaborative robots)[3] are a fanatical area of research and a number of other companies have already brought forth their vision of such systems. Within the I4.0 initiative, the presented application research focuses on new ways to a) make sure the safety of human workers and b) limit the restrictions of a divided workspace. The core of this robotic factory CPS development is the integration of dynamic characteristics of the individual components. The individual protection components register the context, situation and standing of the worker, machine, plant and process and activate protective mechanisms before a hazard, e.g. collision, can occur. Symbiotic human–robot collaboration[2] is defined for a fenceless environment during which productivity and resource effectiveness are often improved by combining the pliability of humans and therefore the accuracy of machines. Robotic CPS can enable such human–robot collaboration with the characteristics of dynamic task planning, active collision avoidance, and adaptive robot control. Humans are a part of the CPS design, during which human instructions to robots by speech, signs or hand gestures are possible during collaborative handling, assembly, packaging, food processing or other tasks. The approach is to exhibit safe intermediate Human- Robot Collaboration (HRC) with no fencing. so as to understand this, extra safety and protection measures got to be implemented for CPS. The human component is well connected through different adaptor technologies, e.g. human position tracking, and safety distance parameters are important considerations for worker safety within the robotic CPS. The robotic CPS may be a highly automated system because it removes the boundaries between the composite elements and supports their operational interactions.

C. Video Surveillance as a Service:

The company may be a vendor for the aviation sector, which offers fully integrated solutions for surveillance systems. This Aircraft Security Video System (ASVS) is an integrated, video- based infrastructure. As a modular solution, the system consolidates several components, all of which are required by a universal closed-circuit television for aviation. The main target of the utilization case is on the Cabin Video closed-circuit television (CVSS), which helps flight attendants to watch the cabin area while the aircraft is on the wing. It generates video streams, which are stored on a memory cartridge within the Central Video Unit (CVU/DVR). These systems are customized, individual turnkey solutions, certified consistent with aviation standards and approved by aviation authorities. Customers are airlines, which retrofit their aircraft with the customer furnished surveillance solutions from the seller . Generally , the planning , manufacturing, operation and maintenance of aircraft and (airborne) aircraft equipment are strictly regulated by authorities (mainly EASA, FAA and native authorities), which suggests that within the case of changes the system has to be recertified, which may be a long and expensive process. The thought is to rework the bottom Station into a CPS that interfaces with the CVU/DVR to supply a web-based service which archives the video data automatically and offers access to the video data of an airline on demand via the web . Additional automatic analyses of video streams and logging data are often added within the future to supply even more services for the customer also as system status data for maintenance The challenge for the corporation to develop an appropriate CPS is on the one hand to switch and newly assemble the bottom Station for the proposed service. Additionally, replacement software is going to be required to handle the proposed actions for the service. As service engineering has not been the core competence of the corporate so far , especially support in managing the service life cycle, from ideation over Requirements Engineering and testing, is required. Customer feedback has got to be collected so as to enhance the service; this information also can be fed into the ideation phase for extra services. A serious change for the corporation is the transition from selling their video surveillance solution to providing video archiving and analysis services. so as to form an innovative, but safe shift from a pure product supplier to a product-service provider, there's a requirement to spot if the service is going to be accepted by the market, possibly also in other sectors (e.g. train surveillance). Thus, a business model innovation is required to supply the improved functionality to the customer.

IV. RESEARCH ISSUES:

A.TECHNICAL RESEARCH ISSUES

1. Data quality:

While Big Data and other data analytics research streams gain significant attention, the difficulty of knowledge quality is similarly important [16] . With the increasing amount of producing data available, it presents a challenge to ensure the integrity and quality of the captured and communicated data. inferiority data may cause results that are endangering the info based optimization and monitoring systems. Automated data quality monitoring algorithms have to be developed and evaluated during a manufacturing environment to support the human users and help to enhance the trust in data based decisions. Another aspect of knowledge quality is the heterogeneity of producing data, especially when watching the entire lifecycle of a product. The annotations of the info entities are very diverse and is an increasing challenge to include diverse data repositories with different semantics for advanced data analytics. Systems just like the Semantic Mediator[20], applied within the CPLS case must be developed further and included within the standards mentioned before.

2. Standards/interfaces:

Within the global economy, supply networks are formed within the majority of cases by a variety of heterogeneous entities. Heterogeneous during this case includes different dimensions like, e.g., company size, location, but also the used software solutions[21]. While some companies might choose proprietary solutions available on the market, others might prefer (or are forced to shop for , e.g., economic means) self-developed or open-access solutions. When companies with different systems prefer to work together, interoperability may be a major issue that must be addressed to enable Smart Manufacturing. This is. reflected within the CPLS use case, where machines, transport systems and human interface devices from different vendors need to collaborate. The dynamic and sophisticated nature of producing a 'one of a kind' integration won't suffice but commonly respected standards are needed to facilitate formation and operation of successful Smart Manufacturing supply networks.

3. Data analytics:

Data analytics or Big Data are a core component of the info based Smart Manufacturing and I4.0 initiatives[22]. Data analytics are essential to attach the captured sensor (and other manufacturing/supply chain related) data and therefore the humans within the loop. The increasing degree of automation of Smart Manufacturing Systems with real-time data availability and automatic monitoring and control depend upon strong algorithms supporting human decisions.

B.METHODOLOGICAL RESEARCH ISSUE 1. Requirements Engineering:

Inadequate Requirements Engineering (RE) is one among the most sources for the failure of development projects and culminates in exceeding budgets, missing functionalities or maybe the abortion of the project[23]. Therefore, within the context of Smart Manufacturing, adequate Requirements Engineering is additionally the key to success or failure of each CPS. Ensuring communication and consistency of requirements for CPS may be a challenge thanks to the variability of stakeholders from different domains involved. Furthermore, viewing CPS as a system of systems, the independence of its elements and their evolutionary nature are challenging. This results in exceptionally distributed RE activities with isolated RE approaches. Within the aircraft surveillance case, the new service engineering department was initially organizationally separated from hardware and software engineering. This complexity leaves requirements fragmented among many disciplines and sometimes conflicting, unstable, unknowable or not fully defined. RE processes have to be ready to handle competing stakeholder demands and dynamically answer continually changing requirements. Finally, the properties of the CPS aren't the sum of the properties of its elements. Rather, they emerge from the cumulative interactions of the only systems. Therefore, RE methods and tools need to be ready to manage emergent effects with predictable results[24].Geisberger and Broy[25] emphasize the central role of Requirements Engineering for CPS development, integration, maintenance and evolution. consistent with their research agenda, main topics during this area include involving users and other stakeholders from different domains actively into CPS development from the start , adaption of CPS to needs, habits and competences of the users, specification of formal requirements models, detailing of requirements and mapping them to system elements, integration of engineering models with digital models from software and systems engineering for the collaborative description of requirements, also as their implementation, validation, evolution and communication between stakeholders from different disciplines. Penzenstadler and Eckhardt[26] introduce a RE content model for requirements elicitation and documentation at different levels that might need to be adopted by all stakeholders involved. Wiesner et al.[27] propose tongue Processing (NLP) as how to translate non-formal requirements to formal descriptions in several disciplines, thus enabling automated information science

2. Visualization:

Visualization is grouped under methodological issues but is additionally strong when writing specifications, transforming requirements in tongue into discipline specific models[28]. Visualization is a crucial vehicle to speak the complex results of knowledge analytics to the stakeholders, like the recorded video streams and operational data from the aircraft surveillance case. It's challenging because the stakeholders have very different foci and requirements towards the visualization and granularity of the presented results. Visualization offers for instance the various levels, from very detailed, e.g., machine level, to a summary. Research and industry got to work together on driving visualization research because it is a critical part of Smart Manufacturing acceptance in the real world .

3.Service/app marketplaces:

It has been mentioned multiple times that Smart Manufacturing is an interdisciplinary field, with strong ties between engineering and computer science. App/Service marketplaces gained significant attention in recent 35 years as they offer flexibility, transparency and (in 36 some cases) accreditation/security features[29].Flexible app/service marketplaces that offer a set of core apps and allow users or independent third parties to develop customized apps focusing on certain issues in the Smart Manufacturing realm are desired by industry and research. User- developed apps can range from granular scheduling apps to advanced supply chain wide data analytics apps. The aircraft closed-circuit television provider plans to supply advanced video analysis services, a number of which could even be developed by third parties. There is a significant overlap with research issues in interfaces/standards, visualization, data analytics, data security and reference models etc.

C.Business Case Issues:

1.Privacy issues:

Privacy issues are strongly related to data security issues. However, in this case it was decided to separate the two areas. Whereas data security issues focus more on the technical ability to guard and preserve sensitive (manufacturing) data, privacy issues during this case describe challenges regarding the exchange of information and/or knowledge within the company itself and within the supply network[38]. With the dawn of Smart Manufacturing and therefore the connected company, detailed manufacturing data is out there for advanced analytics. However, this presents a major thread for the core competencies of specialized manufacturers. By obtaining precious data, competitors are able to not only 'reverse engineer' the products but, even more problematic, derive the underlying knowledge and capabilities. On the other hand, within supply networks, companies may work together which are competitors in a different segment of the market[40]. E.g. Video data from aircraft surveillance belongs to the airline, is stored by the service provider and is regulated by passenger privacy, with laws differing between countries. Within the supply network, the sharing of information is beneficial for multiple reasons, e.g., quality improvements[30].

2. Servitized Business Models:

In the manufacturing industry, Business Models (BM) have traditionally focused on the fabrication or assembly of more or less customized (physical) products and have generated revenue from their sales. The therefore required machines, materials and qualified personnel cause high fixed costs, so supply chain organization and efficiency have had a high influence on competitiveness[31]. However, these traditional BMs have come under pressure with the global harmonization of technological standards and the reduction of trade barriers. Many researchers have suggested that manufacturing firms in developed economies should expand their role within the value chain by extending their products with services in order that they don't have to compete solely on cost [32,33]. Neely et al.[34] published a study that shows five fundamental developments: “(1) the shift from a world of products to a world including solutions, (2) outputs to outcomes, (3) transactions to relationships, (3) suppliers to network partners, and (5) elements to ecosystems.” The results are called Product-Service Systems (PSS), a framework describing the integrated development, realization and offering of specific product-service bundles as a solution for the customer[35]. This is fully in line with the idea of Smart Manufacturing, where CPS provides the solution for a certain problem through the outcome of their application. Instead of one-off sales transactions, CPS built relationships with other systems and their environment. For example, access to lifecycle data may allow the manufacturers to enhance their processes and offer additional services around their core product, as within the case of aircraft video surveillance. Gorldt et al.[36] have coined the term “Cyber-physical Product-Service System” (CPSS) for the integration of the PSS concept and Smart Manufacturing. A manufacturing enterprise that changes from the fabrication of products to offering CPSS solutions and transforms its supplier base into an ecosystem of network partners will have to analyze and adapt various elements of its BM to stay profitable and competitive [37]. According to Osterwalder and Pigneur[39], these elements comprise not only the new value proposition, but also different customer relationships, distribution channels, key resources, and activities , as well as a changed cost structure and revenue streams.

V. CONCLUSION

This article identified, discussed and clustered characteristics, technologies, applications and research issues which may be wont to define SM and thus provide a foundation for a future comprehensive SM ontology. These characteristics, technologies, applications and research issues may additionally be wont to classify a producing system as smart. Several application scenarios were presented that have highlighted the wide scope of Smart Manufacturing.

One application case focused on a cyber-physical logistics system for intralogistics that would reduce Kanban cycles and distances. The third use case gave insights within the application of video streams and operational data from an aircraft cabin closed-circuit television to supply new and enhanced archiving and analysis services through an innovative business model. The three use cases from different domains present alittle selection of the various applications and challenges I4.0 and Smart Manufacturing need to affect on the one hand, and what huge potential lies in these new initiatives. This might be an opportunity for researchers who haven't had much interaction with applied research in their field to collaborate with researchers of supplementing fields and industry to ascertain their work getting used in real world applications.

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