A Review on Smart Object Based on IOT

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***Abstract*- Nowadays we live in a world, which a period ago would only be described in the science fiction literature. Dayby day things become smart and both scientists and engineers struggle for developing not only new andinnovative devices, but also homes, factories, or even cities. Despite of non-stop development, many of thoseconcepts are still being just a vision of the future, which still desires a lot of effort to become true. This paperreviews the usage of adjective smart in respect to technology and with a special emphasis on the smart factoryconcept placement among modern studies. Due to a absence of a consensus of common understanding of thisterm, a unified definition is proposed. The conceptualization will not only refer to different smart factory visionsreported in the literature, but also link the fundamental characteristics of this emerging manufacturing concept tousual manufacturing practice. Subsequently, the authors discuss the challenges of the potential smart factoryapplications in SMEs, and also propose the future research viewpoint in order to further develop the smartfactory concept.**

***Keywords*-Smart Factory; U-Factory;Real-Time Factory;Manufacturing of the Future;SMEs; adaptive; flexible;automation.**

I. INTRODUCTION

Currently people are surrounded by several things that are called smart. Nearly everybody have a smartphone, some people have smart homes [16], which are related to smart grids [1]. South Korea's government in collaboration with the local industry has even launched the project to form the smart city [6]. In order to produce those large smart systems, smart devices [28] have been used. The label smart (and interchangeably used– intelligent) looks to be abused in many different contexts, because its meaning with favours to objects is yet not clearly defined. Smart, in some contexts, refers to an independent device, which usually consists of following: a sensor, and/or an actuator, a microcomputer and a transceiver [24]. Nevertheless, adjective smart is also normally used to characterize an object that was improved by implementation of further features, which introduce multiplatform communication and increase its computational abilities. The intelligence of such device can be exposed by cooperation in a network of other smart devices, which have the ability to check the system state updates and decide whether to act on them or does not act on system [24]. What is not surprising, such a network is called a smart network[24].One can also find a reference to smart objects, as items having the ability to store the link related data as well as it may offer access to it for a human or machine user[28]. There are also smart products, which are equipped with the memory understood as a sort of product. [28]. In the case of homes, smart is commonly used as a synonym of excessively automated [27] [24]. It can also refers to homes with systems for monitoring and controlling the appliances [1]. Now, what is important, a monitoring function could not be limited to turning devices on and off; devices involved in a smart home should be able to operate semi– autonomously conferring to the predefined patterns or user requirements [27]. The overuse of the adjective smart is frequently faced. Like, some scholars write about smart radio-frequency identification (RFID) tags [3]. Even though RFID tags observe with a number of above mentioned definitions of smart devices, those are characteristic properties of each RFID tag, so adding a RFID tag label smart is a misuse (due to the lack of enhancement of a basic product). It has been observed, that scholars have started to use the term smart factories in describing their apparitions of future manufacturing. Nevertheless, there is no agreement about a clear definition of what smart means in respect to manufacturing facility. That's why, the motivation of this paper is to survey a considerable literature and summarize the smart factory concepts from a combination of altered literature streams in order to simplify the term and develop a uniform definition that will contribute to the future research within this area.

II. SMART FACTORY-VARIOUS VISIONS OF ACONCEPT

The term smart factory is used by both industrialpractitioners and scholars, but there is no consistentdefinition for smart factory. There are some otherterms used in terchangeably: aU-Factory(ubiquitous factory) [15], a factory-of-things [7], areal-time factory [9], or an intelligent factory of thefuture [3]. Smart factory refers as a technology [4],an approach [9][7],or a paradigm [15].

2.1. A conceptual framework of the Ubiquitous Factory

Yoon et al. [15],have expand a conceptualframework based on the product design, recyclingand manufacturing, via so called ubiquitouscomputing technology. Conferring to them, theconventional manufacturing examples, such as flexible-, lean-, holonic-and agile-manufacturingsystems are not actual promising in solving themain contemporary manufacturing problemsexamples, inaccuracy in demand forecasting ortrouble with individualized production control. Theauthors find potential and capabilities in followingthe idea of Weiser [21], who introduced concept ofubiquitous computing technology in themanufacturing. The key features of U-Factory(which they signify as a synonym of smart factory)are to be: information transparency, autonomouscontrol, as well as sustainable manufacturing. Thekey incomes for implementing this vision are saidto be: compatibility with i.a. RFID, UbiquitousSensor Network or Real Time Location System(RTLS) technology [15]. According to vision ofYoon et al., the U–Factory must be ―an innovativefactory combining ubiquitous computingtechnology as an enabler for solving problems onthe shop floor with existing components [15].Hence, they define U–Factory as ―a factory systemin which autonomous and sustainable manufacturetakes place by gathering, exchanging and usinginformation transparently anywhere anytime withnetworked interaction between the man, machine,materials and systems, based on ubiquitoustechnology and manufacturing technology [15].However, the U-Factory concept has not beenunderstood yet. What is more, in order to progress,it is still necessary to develop the ―software andhardware technology, including manufacturingtechnology, information technology and theubiquitous technology, and to combine them‖[15];what is in the pipeline for their upcoming research.This is where we still may be waiting for thetechnology, which is 5-10 years ahead may givedifferent new possibilities to understand the smartfactory vision.

2.2. Smart Factory embedded in wireless communication infrastructure

Additional vision of a factory of the futurehas developed as a collaborative initiative(SmartFactoryKL, Technology Initiative) ofacademic (German Research Center for Artificial Intelligence DFKI) and industrial (Siemens, Bosch,BASF and Endress – Hauser among the others)partners in Kaiserslautern, Germany. It waspresented by DetlefZuehlke on the pages of AnnualReviews in Control [9].The presented aims were: ―the application, development, distribution ofinnovative, industrial plant technologies andgenerate the foundation for their well-known use inresearch and practice‖[9]. Zuehlke, realisticallypoints out that in the recent stage of technologicaldevelopment we are still far away from theWeiser's vision of ubiquitous computing: ―…whentechnology recedes into the background of ourlives‖[21]. Smart factory in Zuehlke's view is away towards a factory-of-things, which looks to bevery much aligned with Internet-of-things (IoT).The IoT in this vision is apparent as an opennetwork of items equipped with sufficientcomputing and communication capabilities to givethem an capability to act individually, withoutdirect human intervention [14]. Differing to Yoonet al., Zuehlke powerfully shows the role of theconventional manufacturing paradigms, namelylean technologies, which helps upcoming smarttechnologies, should lift manufacturing systemsinto additional advanced level. Requirements forthe smart factory described by Zuehlke are: adegree of intelligence embedded in all, even verysmall, coupled devices, while some of the mainfunctionalities should be provided by RFIDtechnology. A smart factory should not only have amodular structure, but also be interconnected by thewireless network, where every single device couldhave its own IP(Internet Protocol) address [9].Zuehlke specifies few very important challenges ofthis unrealistic system - lack of a main standardizedprotocol and compatibility to make devices simplywork together, and regulations allowing processcontrol. Furthermore, before all those devices willorganize to create a smart factory, their safety andreliability desires to be methodically tested. Thenext generation of the manufacturing is also studiedat the University of Stuttgart where, based onWeiser's smart environment method [21], Lucke etal.[7] tried to interrelate a physical (i.e. position ofa tool) and a digital world (i.e. electronicdocuments) [7]. They can define a smart factory as―a factory that context-aware supports people andmachines in execution of their tasks […] bysystems working in background, so-called Calmsystemsand context-aware applications.‖[7].Context-awareness mentions to knowledge ofposition and status of objects of interest, where socalledcalm-systems are its hardware and contextawareapplications are the software [7]. In theiropinion, the key features of such system should be:the ability to enter into a real-time communicationand interaction with its smart environment, wherethe appropriate manufacturing information isdecentralized. In their opinion wirelesscommunication is also essential; Consequently Wi-Fi, Bluetooth, WIBREE or ZIGBEE could be used.Authors have already developed software to beapplied in smart factory: the Nexus Platform [7].Elements used to create a smart factory should setthe main motivation on the execution, maintenance,and education functions of the manufacturingenterprise[7].

2.3. Glocalized Factory

A somewhat different vision of a smartfactory is delivered by Hadar and Bilberg [14],whopropose a decentralized supply of chain setup. Inthis case they can focus more on the factoryfunction and does not define its real design. Insteadof building rare, centralized factories, which wouldbe a part of the global

supply chain they suggest alocal focus setup where a set of intelligent facilities- reconfigurable smart factories- would be able toabsolutely supply a predefined area of market [14].The authors examine manufacturing challenges inWestern Europe, their research focuses on globalDanish companies like LINAK, STRECON, orLEGO, which face problems associated toglobalization and fragmentation of production,which rise supply chain complexity [15]. Aglocalized approach, which they propose can beapplied by large companies that not only operate inglobal markets, but it also have so many suppliers
in different part of the globe [14]. On a supplychain level smart factories are characterized as self-sufficientfacilities, which source the raw materialsfrom the local suppliers. Those local partners andalliances should help in reduction lead time,minimize inventory and at the same increasecustomization and responsiveness of the supplychain, due to proximity both to suppliers andcustomers.

III. SMART FACTORY-A MEANING ANDCONCEPTUALIZATION

All above mentioned concepts and visionsare very capable prospects of upcomingtechnological improvement. Nevertheless, eventhough both engineers and researchers areconstantly functioning on those concept, it stillleftovers just a vision. regardless of of allparticipation and success stories there is a long andtwisting road to go and multidimensional difficultyto solve before we will move the vision of thesmart factory into the reality. Zuehlke estimates theprogress enabling technologies for at least 5 – 10years (from 2010) [9].

3.1. SMART FACTORY FEATURES AND CHARACTERISTICS

Previous to mentioned visions of a smartfactory are missing to provide its clear definition. Itseems that they focal point too much on vagueimages of used technologies like ubiquitous [7]andCalm - systems or context aware applications [4],instead of as long as more general characteristics ofthis solution. Moreover, based on before mentionedvisions, one could have an idea that (alreadyold)Wi-Fi networks and RFID tags seem to be prefundamentals for create or execute the smartfactory effect. It sounds like a significant drawbackto presented theories, mostly due to neglect thepossibilities of other available technologies,underestimating future innovative solutions, andomitting other dimensions (e.g. organizational).There are many technologies which couldbe used in a smart factory set of contacts, butinstead of going into their examine appraisal, thefocus here is on functionalities thatthis factory

should execute. The report about thefuture manufacturing in Europe points out that inthe future, manufacturing companies will dependeven more on flexibility and low cost [13], so anexcellent approach to realize both of those propertysimultaneously, is to work with modules andplatforms[13] .Another multidisciplinary trend, which isunderlined by the Europe an account [13], iscooperation across various types of borders e.g.cultural, geographical, cross-disciplinary etc. Thosecould increase the success rate of problem solvingdue to swap over of knowledge across many levels.Particularly in manufacturing field, those jointexamples are still quite rare, but some have beenreport in make available chain collaboration [12]and in knowledge sharing in shared engineering[5]. Scholars also propose a combination of flexibleand reconfigurable manufacturing systems[12][20][26], and underline importance of alertnessand leanness [13][8]. New emerging developedtrend, which could be very much linked toglobalized factory [23], is an adaptive ortransformable developed [18][10][11].

3.2. SMART FACTORY DEFINITION

Based on an analysis of future developedliterature, features that are wanted for the smartfactory would relate just before being flexible andreconfigurable, low cost, adaptive or transformable,agile and lean. One of the ways to reach some ofthose functionalities would be to apply modularstructure with high opinion to both product/processtechnology and association. Therefore as for aconceptualization we would propose to a meaning as follows. A Smart Factory is a manufacturingsolution that provides such flexible and ad adaptiveproduction processes that will solve problemsarising on a production facility through dynamicand rapidly changing boundary conditions in aworld of growing density. This special solutioncould on the one hand be related to automation,understood as a combination of software, hardwareand/or mechanics, which should lead tooptimization of manufacturing resulting inreduction of unnecessary labor and misuse ofresource. On the other hand, it could be seen in aviewpoint of collaboration between differentindustrial and nonindustrial partners, where thesmartness comes from forming a dynamicorganization.

IV. SMART FACTORY-AN EXTENSION TOSMES

Important common denominators ofvisions discussed at the start of the paper are largecompanies and big organizations, which oftenfunction in global markets. Applications of allAforementioned smart devices in smart factoriesendeavor at solving problems of global players.Those technologies are

believed to solve theproblem of complexity of supply chains, but at thesame time due to technological improvement theymake the setup more complex by themselves.

4.1. SMART FACTORIES FOR SMES

Even after recognition of so far discussedsmart factory visions, would manufacturing smalland medium enterprises (SMEs) be able to affordthe cost of purchasing and maintenance of thissolution? One of the imperative drawbacks of smartfactory visions existing in the literature is the lackof concepts applicable in SMEs. Most of them havea need for automation solutions in the region ofmanufacturing, which could be developed andapplied in order to optimize their currentoperations. Those solutions may not betechnologically as advanced as previously plannedsmart factory visions, but the main characteristicswould be affordability particularly in terms ofpotential financial investment. What is more,previously discussed solutions are in theimprovement by large organizations (like Siemens)or for large organizations (like LEGO). Thusdevelopment of smart automation solutions by

SMEs for SMEs may be much more feasible thanin the case when there is a disproportion of power.Similar observations were also made by Westheadand Storey[22], who point out the uncertainty ofthe environment as well as consistency ofmotivation and actions as crucial distinctive factors between large and small firms.

4.2. AUTOMATION SOLUTIONS FOR SMES

The literature about automation solutionsfor SMEs is very inadequate. Wadhva[25],basingon an action research approach, creates guidelinesfor flexible automation, which could progressfoundries' responsiveness as well as supportinteraction among different collaborative partners.In a research associated to foundries as well,Ribiero et al. developed a methodology forbenchmarking and got as far as to suggest theperformance measurement framework. An attemptto implement a smart factory concept in SMEscould allow for manufacturing numerous differentproducts and at the same time, raise the degree ofmachine utilization, reduce in-process inventory aswell as decrease response time in order to meetcustomer preferences. Additionally, in case ofSMEs, it could also be a great help in the process ofincreasing their competitiveness and productivity.Manufacturing activity represents about 21% of thetotal EU GDP [25]. It provides approximately 20%of all jobs in industry, which are largely conqueredby SMEs [25].

V.CONCLUSION

Much has been written about different smart objects, without a lucid definition of this term. What is more, misuse of the adjective smart is not uncommon. This paper puts focus on the smart label with regard to factory and expansion ofthe concept. Adopting a consistent definition ofsmart factory, and building upon it, would help toaccelerate our understanding of this buddingapproach to future manufacturing. We hope thatour collection of existing smart factory visions,together with grounding it in the traditionalmanufacturing theories, will help us move in thisdirection as a community of scholars. Thus far thesmart factory is just a great exposure of futuredevelopments in manufacturing facilities. Theconcept still needs to progress before fullyattainment its practical application in an industrialproduction set up. In terms of solutions for largecompanies, most of the technologies are not yetfull-grown to serve the realization of smart futuremanufacturing vision. As for research focused onSMEs in the field of automation andmanufacturing, due to a limited attention given tothis group as well as partial understanding of theirfuture production prospects, new research would beessential to fill up this gap.

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