Ambient-Intelligent Decision Support System (Am-IDSS) for Smart Manufacturing

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INTRODUCTION

Competitiveness among companies and nations is forcing decision makers in companies to strategically re-creating manufacturing processes and supply chains toward smart production. The goals of smart manufacturing include: 1) optimizing production and increasing profitability and innovation, 2) responding to market changes faster and with agility, 3) better-informed decisions, and 4) more flexibility in physical processes, cf., Clemons, 2018. Smart manufacturing can create dynamic, competitive operations, and global supply chains by using intelligent computerized control, advanced information technologies, the Internet of Things (IoT) technologies, and flexible manufacturing systems.

Research in the broad area of smart manufacturing and its challenges for encompassing IDSS into the production process appeared in a wide range of topics and methodologies. For instance, Simeone et al. (2019) investigated the requirements for cloud manufacturing platform for making a sharing platform in the smart manufacturing network. Weber (2018) introduced effective stakeholders in measuring key performance indicators (KPIs) for the smart production process in the high-tech industry. Meng et al. (2018) considered the smart recovery decision-making process for sustainable manufacturing purposes. Latorre-Biel et al. (2018) designed a Petri net model of a smart factory regarding the Industry 4.0 paradigm as virtualization for decision making support. Avventuroso et al. (2017) introduced a networked production system to implement virtual enterprise and product lifecycle information loops. Preuveneers et al. (2017) reviewed the emerging trends on the smartness of manufacturing, including the relevant research challenges and opportunities to shape an IDSS. Brodsky et al. (2014) investigated the decision support system for reusable components, including knowledge, data, control variables, and decisions, for leading the environment to the smartness. However, there is a lack of a good snapshot of quantitative modeling approaches and trends based on system engineering design, emphasizing system requirements analysis and specification, the use of alternative analytical methods and systems' evaluation.

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The purpose of this article is to introduce an IDSS based on AmI technology for smart manufacturing landscape, emphasizing on design and structure of AmI technology and covers the technological foundations of smart manufacturing. To build essential knowledge around AI technology and its role in influencing Am-IDSS platform, we are focusing almost exclusively on issues relevant to understanding, constructing, and analyzing the different challenges of smart manufacturing from the system engineering point of views based on human-centric computer (HCC) interaction design.

Our approach is to explain the basic principles of Am-IDSS structure in the area of smart manufacturing. First, we address the new and rapidly growing role of the internet and high-tech computing in manufacturing. Other topics include the definition of smart manufacturing, smart DSS, AI potentials for smart manufacturing, and the necessity for advance Am-IDSS in smart manufacturing. Thereafter, problems of coordinating the advanced robotics, Cyber-Physical systems (CPS), IoT and admitting the big-data, machine learning, and cloud and cognitive computing in industrial development will discuss. Following these topics, the structure of Am-IDSS including component of collaborations, services and logical issues in Am-IDSS, infrastructural layers of Am-IDSS such as physical, functional, integrated, and human-computer layers, architecture of human-centered DSS, components of database module, information collection components, components of knowledge management (KM) module, decision making process components, and user-interface components will be reviewed. The system engineering design of each model implements the role of AI in different segments of Am-IDSS. Models and applications of Am-IDSS for smart manufacturing will be explored, including (not limited) the advanced manufacturing processes, rapid prototyping, collaborative virtual factory (VF) platforms, advanced human-machine interaction (HMI), machine-to-machine (M2M) communication, and open manufacturing. The development and future trend of IDSS for smart manufacturing such as HCC and Information architect (IA) will discuss.

The study will be concluded by providing recommendations for further research and align our mindset for the next step. From the gap in the literature, we propose some areas for further investigation, for those who are interested in walking into the field of IDSS for smart manufacturing.

BACKGROUND

AmI is becoming an interesting emerging topic after the birth of the fourth industrial revolution and smart manufacturing. In a manufacturing environment with AmI setting, human's senses and their actions, machine and materials, temperature, etc. are becoming feasible; therefore, creating a platform or software to interpret and act on data from sensors in real-time is a significant problem. In this sphere of influence, several studies have been done to show how AmI can bring impact for decision makers in different fields, such as transportation (Ocalir-Akunal, 2016), healthcare (Tawfik & Anya, 2015), and disaster management (Fersini et al., 2017). However, only limited works consummated in this sphere for smart manufacturing.

A unified structure of an integrated expert system and DSS for designing an IDSS for the first time was discussed in the late 80s by Teng et al. (1988). Later, after the birth of AmI in the late 1990s and increase of interest in user-experience and user-evaluation, during the revolution from mass production to mass customization, Kim et al. (2004) were among of the first researchers who integrated the human-centered knowledge into the IDSS. Following them, Filip (2008) designed the IDSS for large-scale complex systems with the perspective of advanced IDSS, including the AI-based techniques, the concept of the AmI, and mixed-knowledge IDSS approach. Marreiros et al. (2009) invented the augmented DSS