# Chapter 11
# The Challenges of Industrial Engineer Management Skills in Industry 4.0

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## ABSTRACT

*Industrial engineering and management (IEM) is considered a softer type of engineering. IEM professionals have been slow in implementing many changes that have occurred in production, ranging from mass production to mass customization paradigms embedded in Industry 4.0. This chapter introduces and discusses the role of IEM professionals in dealing with all the changes required for the implementation of these paradigms. This chapter discusses the training of these professionals that demands more applied research, and, at the same time, it seeks to instigate their curiosity and creativity to generate new solutions based on fundamental research. A semi-systematic literature review was used. The results indicate that an IEM professional needs a strong leadership style and ethical sense to lead multidisciplinary teams and should also be a systems, lean, and sustainability thinker, who has the technological, digital, and transversal skills to face the current and future challenges of the successive industrial revolutions.*

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## INTRODUCTION

Industrial Engineering and Management (IEM) has been evolving from Mechanical Engineering Elsayed (1999), growing and making space for itself in the complex world of engineers. Nevertheless, the creation of goods has existed since humanity started making objects to cover its skin or killing animals to survive. With the advent of machines, mechanical production replaced handicraft production with one-of-a-kind style and customized design. The role of the human being was as important as before, although probably not to perform the job but to organize it. The second and third industrial revolutions were dominated by machines, energy, computers, and information and communication technologies (Kaya, 2019) that enabled the high production of one-fit all products (mass production). Consequently, high consumption patterns developed, endangering the planet's capacity to restore the resources. Currently, the fourth industrial revolution is dominated by IoT technologies (Chou, 2018), where mass customization (Tien, 2020) and niche production (Rolfes et al., 2019) are the production paradigms. Indeed, the shift from mass production to customized production opens new entry opportunities for latecomer firms aimed at niche production, which are less dependent on scale economies (Corrocher et al., 2020). Increasingly, the mass market is turning into a mass of niches (Anderson, 2008; R. Armstrong, 2008) despite few examples presented by Elberse (2008) in the same entertainment (video and music) industry.

Nevertheless, producers face the challenges to ensure sustainable production and more efficient production systems that "do more with less", as Lean production of the Toyota Production System teaches us. At the same time, production needs to be flexible and agile to provide a new value proposition that customers expect with different way of organizing companies' resources to solve their problems and eliminate waste. Being the organization skills the core of an IEM professional this issue will be discussed in this chapter. Also, knowing that the main challenges for them in an industry 4.0 context is their education to provide them with the suitable skills, this issue will be also addressed.

In the literature some authors (e.g. Mourtzis and Doukas (2014)) discuss the challenges faced by an IEM professional in an industry 4.0 environment, starting with the evolution from handicraft production to Industry 4.0. Thus, this chapter sought hereby to identify the current and future skills required of an IEM professional in the context of Industry 4.0. Although there is some published literature on the skills required of professionals in general, and, engineers in particular, evidence of the skills required of IEM is scarce (Sackey & Bester, 2016). Santandreu-Mascarell et al. (2011) analyzed the skills proposed as ideals for an IEM degree and identified them in the current study plans implemented at Spanish universities. Also, Pais-Montes et al. (2019) analyzed the employability traits of engineers (computer engineers, naval engineers and industrial engineers) who had recently graduated and concluded there is a significant gap between the skills learnt in higher education and those needed at the workplace. None of those studies focuses on the new industrial era. Finally, Piwowar-Sulej (2021) addresses this topic from the perspective of IEM professionals in Poland.

Another contribution of our research is related to the role that Higher Education Institutions may play in the development of the skills mentioned previously. In that regard, Gowripeddi (2021) studied the role of advanced and collaborative learning practices in the education of future construction engineers and researchers in the fields of data-driven technologies. Moreover, Bonnaud and Bsiesy (2020) address the topic from the perspective of microelectronic engineering.

Furthermore, Hadgraft and Kolmos (2020) discuss the topic of engineering education from the point of view of the emerging learning environments. In the area of IEM, some recent contributions can be found, such as Tan et al. (2020) and Gupta et al. (2019) who focus on the learning factory concept, and