Industry 5.0: Engaging Employees in Smart Factories [1, 2]

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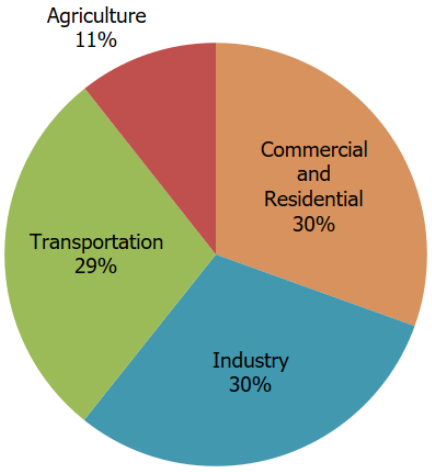
Abstract

In today's increasingly eco-conscious world, smart factories have a vital role in minimizing industrial operations' carbon footprint. While technological advancements have enabled these factories to become more energy-efficient, employees' active involvement and commitment truly drive down greenhouse gas emissions. Currently, factories are responsible for producing the largest amount of greenhouse gases (29%). The European Commission (EC) has determined that to achieve this goal, we undergo an industrial evolution, which the EC is calling Industry 5.0. Industry 5.0 will focus on sustainability, resilience, and human-centricity. However, bringing these factories into existence requires employee engagement, and it can be challenging for factories when employees show little interest. This topic aims to explain how smart factories are changing and how there is a direct need for people in factories to bring forward Industry 5.0.

The smart factories leverage advanced technologies such as the Internet of Things (IoT), artificial intelligence (AI), and robotics to enhance productivity, efficiency, and connectivity. However, amidst all the excitement surrounding these advancements, it is crucial to recognize the importance of engaging employees in this new era. According to a recent global Gallup poll, only 23% of employees feel engaged in their work. With a new workforce and factories dealing with evolutional change such as the "Great Resignation," transformation is hard.



U.S. Environmental Protection Agency (2023). Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2021

Smart factories of the future will use advanced technologies like IoT, AI, and robotics to improve productivity, efficiency, and connectivity. They must

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produce more with less to reduce greenhouse gases and meet the 2050 net zero goal. The US industrial sector currently contributes 30% to greenhouse gases (US EPA, 2021).

The European Commission determined that meeting this goal requires a new industrial revolution - Industry 5.0, built on sustainability, resilience, and human-centricity. However, achieving these factories requires employee engagement. This topic will explore the changes in smart factories and the direct need for people to bring forward Industry 5.0.

Keywords: Industry 5.0, Sustainability, Resilience, Human Centric, Smart Factory, Engagement, Motivation, Transformation, Diversity, Equity, and Inclusion (DEI)

Introduction

Today's advances in factory technology, digitalization, and enhancement in flexibility have turned factories into smart factories, also known as Industry 4.0. However, the supply chain is embarking on a challenging time as businesses are seeing the push to reduce greenhouse gases through government and corporate initiatives (Jafari et al., 2022). As Ivanov (2022) suggests, smart factories are changing practices by bringing the resilience of Industry 4.0 to drive sustainability within the industries, seeing the need to engage the smart factory workforce to drive sustainable solutions to reduce greenhouse gases. The concept of Industry 5.0 was developed by the European Commission (EC) in 2021 as the EC was determining how countries could meet the Paris Agreement to be "net zero emissions" by 2050 (United Nations [UN], n.d.). The EC (2021) determined that a three-part approach around sustainability, resilience, and human-centricity would need to occur to create a framework for the rapid development of innovation within the value chain.

Figure 2

The concept of "net zero emissions" refers to balancing the amount of greenhouse gases emitted into the atmosphere and the amount removed from it. The idea of net zero can be achieved through various means, including reducing emissions, increasing carbon removal through natural processes like afforestation and reforestation, and technological solutions such as carbon capture and storage.

Several countries, regions, cities, and corporations have committed to achieving net zero emissions by a certain target year, typically by 2050 or earlier. This commitment involves significant efforts to transition to renewable energy, improve energy efficiency, adopt low-carbon technologies, and implement policies to reduce emissions across various sectors such as energy, transportation, industry, and agriculture (UN., n.d.).

Problem

In the face of organizational maladaptation, motivation, process industry discipline, workplace stress, and social exchange contribute to why employees disengage in the process industry (Schwartz, 2018). A recent global survey of individuals found that only 23% of employees felt engaged at work (Gallup, 2022). With low engagement, the process industry and other workplaces must evaluate what is driving the data and determine the best course of action to transform the workforce (Ahmad et al., 2022; Schwartz, 2018). Neglecting employee engagement can negatively affect various aspects of a business, including employee morale, staff turnover, process industry productivity, and overall business performance (BebiToğlu, 2023). Prioritizing employee engagement can lead to a thriving and successful organization (Ingsih et al., 2021).

Since the First Industrial Revolution, factories have had an association with a grueling work environment; employees work long hours, where injuries and deaths are rapid, and employees have limited say in these matters (Stroup, 2020). Much has changed in today's process industries; however, the workforce still has little voice in matters (Matošková et al., 2023). The transformation from Smart Factories to Industry 5.0 requires a skilled employee needing continuous training and the will to keep up with the demands of the factory's new technologies (Matošková et al., 2023; Kim & Lee, 2021). However, while technology is moving fast (Barata et al., 2019), today's workforce struggles to keep up with technology and retain talent as innovation is deployed (Horvath & Szabo, 2019). Losing human capital will lead Smart Factories to struggle to engage their employees through slow results (Matošková et al., 2023). As Kim and Lee (2021) suggest, a skilled employee is pivotal in ensuring smooth operations in the complex landscape of smart factories. These professionals are responsible for the operations and upkeep of sophisticated machinery, identifying and resolving technical issues, and implementing proactive running strategies (Razavi et al.,2022). Industry 5.0 represents a significant shift in the manufacturing sector, with smart factories evolving into more advanced and interconnected systems (Matošková et al., 2023; Kim & Lee, 2021). This transition necessitates a highly skilled employee adept at troubleshooting and repairing complex machinery and systems. Continuous training is essential for these workers to stay current with the latest technologies and advancements in the industry (Jafari et al., 2022). The future employees must demonstrate a strong dedication to keeping up with the demands of the factory's evolving capabilities, ensuring optimal performance and efficiency of the production process. Adaptability and a willingness to learn and adapt to new technologies are crucial factors in successfully navigating the transformation to Industry 5.0 (Ivanov, 2022).

In a recent survey acknowledging the issue of employee engagement, 83% of the companies surveyed globally have employee well-being as important and are actively constructing strategies to address the problem (Aon, 2023). Not addressing employee engagement can cause high absenteeism, turnover, theft, safety incidents, and quality drops (Due et al., 2022). The phrase "Quiet Quitting" has become popular following the Pandemic, particularly with the Generation Z community (Gallup, 2022 p4). The term is defined as rather than workers quitting jobs, employees are quitting the idea of going above and beyond. Unhappy with some aspect of their current company or role, the employee chooses only to complete the bare minimum" (Ford, 2023, p2). When polled, 59% of employees acknowledged disengagement with the job and seeking new work(Gallup, 2023, p4). While employee engagement is a clear call to action, some barriers slow facilities to act (Ahmad et al., 2022). The drawbacks include the financial commitment to support change, the current cultural barriers, management commitment, and legality that inhibit the facility's ability to create positive change, which leads to a process industry business leader's unwillingness to invest (Matošková et al., 2023). However, many facilities see a direct link between employee engagement and being more reliable, sustainable, and productive, which drives many facilities to reconsider their strategies (Materi & Renna, 2021).

Engaging facilities employees is an Organizational Transformation process, a term used to drive change (Ahmad et al., 2022). However, for companies that have decided their facility needs a change, only about 30% of transformations are successful (Viana Vargas et al., 2020). The common reasons are employees' resistance, management engagement, and support or limits to budget or resources in the budget for change (Bodell, 2022, p.1; Ewenstein et al., 2015). Industry Transformation is shown to be difficult as a whole; however, within the different industries, data has shown that the pace of transformation is 76% faster in process industries than that of industry peers such as Government, Education, Retail, or Health/Medical Services (Viana Vargas et al., 2020). As industries are hesitant to embark on a transformation (Ewenstein et al., 2015), there is a clear call for improvement, as estimates suggest that the global economy is impacted by $8.8 trillion annually and that the companies that are working to improve employee engagement have seen a 21% increase in productivity against the standard (Gallup, 2023).

History

To understand Industry 5.0, it is important to understand the previous industry revolutions.

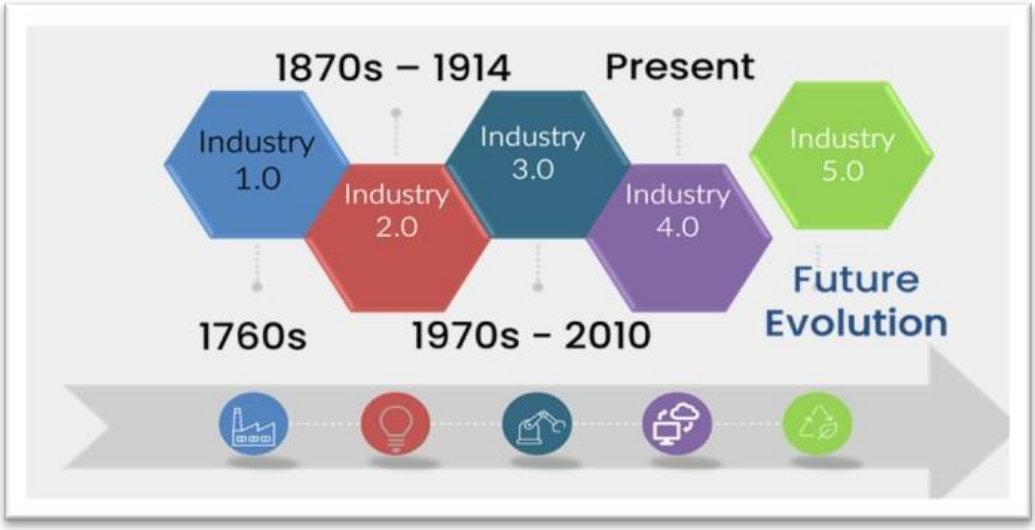

FIGURE 3

Industry 1.0

The Industrial Revolution, Industry 1.0, started in the late 17th and early 18th century and allowed mass production and distribution. New manufacturing processes that used steam power and coal made this possible. This period saw the rise of automation, with inventions such as the weaving loom and steam engine in transportation.

Industry 2.0

Industry 1.0 utilized steam and coal, while Industry 2.0 introduced electrical energy, which led to mass production with sophisticated machines capable of assembly.

Industry 3.0

In the 1970s, Industry 3.0, or the "Digital Revolution," emerged. It introduced computers, PLCs, and electronics, leading to further automation. Integrated circuits and transistors increased production accuracy, speed, and quality. Today, this technology is still prevalent in many factories, including robotics and continuous flow assembly.

Industry 4.0

Industry 4.0 is still pertinent, and it has made Industry 3.0 more substantial and more effective. It enhances the competitiveness and efficiency of Information Technologies by connecting every resource (data, people, and machine) in a supply chain. Industry 4.0 is primarily about continuous monitoring, processing of large data sets, and mobility in handheld devices.

Industry 4.0 can be divided into 9 pillars of technology (Akman & Karaman, 2021).

- Industrial Internet of Things
- Big Data and Analytics
- Horizontal and Vertical System Integration
- Simulation
- Cloud Computing
- Augmented Reality
- Autonomous Robots
- Additive Manufacturing
- Cyber Security

How to Drive the Change

Throughout the author's career, he has always been excited about engaging employees in manufacturing. The idea is to build a perspective the employees support and work together to self-improve their workplace. However, transformation is difficult, with a roughly 70% failure rate. Much can be attributed to the scope and time of the project because while factories can apply new technologies, they fail to meet the expected results if they do not engage the workforce. The problem is that the workforce often resists change and wants to continue as they always have. The key to Industry 5.0 is the ability to drive change for sustainability and adopt technology from 4.0 (EU, 2021) in a Human-Centric approach. As Matoskova et al. (2020) suggest, engaging employees in smart factories requires determining the workforce's needs so that employees can see and contribute to the results. This article will discuss principles that help drive positive change in smart factories and why they are important. Beginning with the idea of transformational change, motivation, Expectancy-Value Theory, Goals, and influencing motivation.

Transformational Change

Transformational Change can also be referred to as Transformational Learning, as this article will cite the research in the workplace. However, applying the process in a classroom or a factory floor is similar to building a case for change and involving others. Working on a factory floor can be challenging, as the work environment is often designed with something other than the employee's comfort in mind. However, those working in factories exhibit remarkable determination and perseverance worthy of admiration. Adults spend significant time at work or engaged in work-related activities, making the workplace an important context for formal and informal learning. Although it may not always be planned for, the workplace can also be a place for transformative learning. According to Marriam and Bierema (2014), addressing inequalities and oppressive practices in the workplace requires workers to critically examine their role in perpetuating such practices. This process requires a significant amount of reflection and can be challenging, given the enormity of the task at hand.

The idea of Transformative change can be introduced in the factory workplace in several ways, either through peer learning (Brookfield, 2009), storytelling and dialogue (Tyler, 2009), coaching (Fisher-Yoshida, 2009), or action learning conversations (Marsick & Maltbia, 2009). Success can sometimes hinge on hegemony beliefs (Marriam & Bierema, 2014). For example, if the workforce believes that management does not care about their well-being and safety, they will be less likely to engage in and support new ideas. It is important to assess where the factory is as far as business maturity is concerned.

Motivation

Motivating employees to be engaged in their work is crucial for the success of any organization. There are several effective strategies that employers can implement to encourage employee engagement. Providing clear and achievable expectations to achieve their goals can give employees a sense of purpose and direction, motivating them to be actively involved in their tasks. Regular communication and feedback, such as performance evaluations and constructive criticism, can help employee engagement by letting them know their work is valued and helping them improve. Creating a positive work environment where employees feel appreciated and supported promotes engagement.

Offering opportunities for growth and development, such as training programs and career advancement, can further motivate employees to be engaged in their work by providing them with a sense of progression and the chance to enhance their skills. A culture that values teamwork and encourages employee collaboration can significantly increase engagement. By implementing these strategies, organizations can create an environment that motivates employees to fully engage in their work, resulting in higher productivity and overall success.

Expectancy-Value Theory

The Expectancy-Value theory by Atkinson (1957) is a crucial framework that can be applied in various contexts, including psychology and related fields. It suggests that an individual's motivation to pursue a certain behavior or goal is influenced by two key factors: expectancy and value.

- Expectancy refers to an individual's belief in their ability to successfully perform a task or accomplish a specific outcome in the workplace. It is determined by their perception of the likelihood of success based on their past experiences, self-confidence, and perceived task difficulty. A higher expectancy increases the likelihood of an individual engaging in the behavior.
- The term "value" refers to the perceived significance or desirability of the outcome or goal associated with a particular behavior. This includes intrinsic value (such as personal enjoyment or satisfaction) and extrinsic value (like rewards, recognition, or social

approval). Individuals who assign a higher value to the outcome or goal tend to be more motivated to pursue the behavior.

According to the Expectancy-Value Theory, motivation can be calculated by multiplying expectancy and value:

$$\boldsymbol{Motivation = Expectancy\ x\ Value}$$

In simple terms, this theory proposes that an individual is more likely to engage in a behavior or strive to achieve a goal when they have a high belief that they can succeed (high expectancy) and perceive the outcome as valuable (high value). On the other hand, low expectancy or low value decreases motivation. While this can be tied to most individuals and workplaces, the theory plays an important part in understanding how people in the workplace can be motivated. Consider the following: if they value it, they are motivated to work at it. If they are motivated to work at it, they are likely to set goals that will lead to the next area of engagement.

Goals

Setting clear goals in a factory workplace can be crucial in engaging employees and improving overall productivity. When employees have specific objectives to work towards, it provides them with a sense of purpose and direction. This clarity fosters motivation and increases their commitment to achieving those goals. Additionally, goals create a framework for performance evaluation and feedback, allowing employees to track their progress and adjust as needed (Ormrod, 2020). This structured approach helps enhance individual performance and promotes collaboration and teamwork within the factory, as everyone works towards a common goal. Ultimately, having goals in place not only benefits the employees by providing a sense of accomplishment and fulfillment but also contributes to the overall success and efficiency of the factory.

Self-Determination Theory

Self-determination theory is a well-known motivational theory in the field of psychology (Deci & Ryan, 1985). This theory suggests that three intrinsic needs: autonomy, competence, and relatedness drive individuals. In a factory setting, implementing practices that give employees a sense of control over their work, opportunities to develop new skills, and positive relationships with colleagues can lead to a more motivated and engaged workforce. By understanding and applying the principles of Self-Determination Theory, factory managers can create a work environment that promotes the well-being and productivity of their employees.

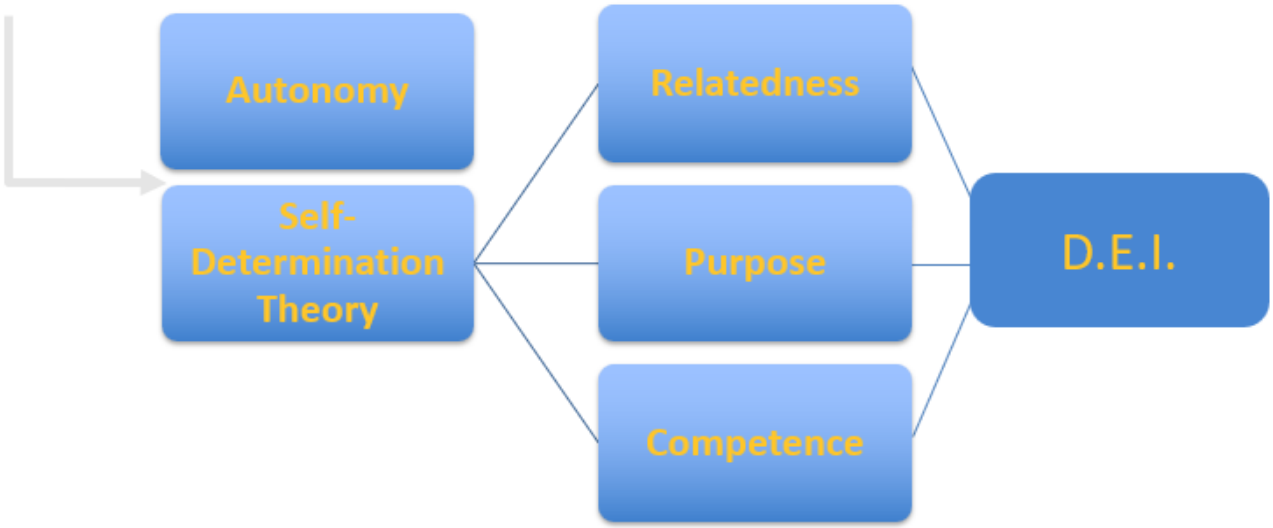

Figure 3

Autonomy

Employees having autonomy can greatly benefit the factory workforce by increasing productivity, boosting morale, and promoting innovation. When employees are given the freedom to make decisions and take ownership of their work, they are more engaged and motivated to perform at their best. This sense of autonomy can lead to a more efficient and effective production process, as employees are able to make quick decisions without needing constant approval from supervisors. Allowing employees autonomy can also lead to greater job satisfaction and a positive work environment, as workers feel valued and trusted by their superiors. Overall, autonomy can empower employees to take initiative, think creatively, and ultimately contribute to the overall success of the factory workforce.

Competence

A competent manufacturing workforce refers to employees with the necessary skills, knowledge, and ability to perform their assigned tasks effectively. A competent workforce can increase productivity and profitability, as competent employees produce high-quality products efficiently and accurately. Furthermore, competent employees can easily handle complex challenges and problem-solving tasks, leading to smoother operations and fewer errors or delays in production.

Relatedness

In a factory workplace, relatedness refers to the connection and camaraderie among coworkers, creating a more cohesive and supportive work environment. Positive relationships among employees lead to effective communication, collaboration on projects, and mutual assistance when needed. This connection between workers can also lead to increased job satisfaction and a greater

sense of belonging within the workplace. In summary, having relatedness in a factory setting can help improve morale, productivity, and overall job performance.

D.E.I.

Social heterogeneity refers to the diversity of people's values and their level of acceptance towards different ideas, beliefs, and lifestyles. It indicates that individuals within a society may hold contrasting views and attitudes, which can affect their social dynamics and interactions. A workplace that values and appreciates diversity thrives on inclusivity and equal opportunities for everyone. Employing individuals from different backgrounds, cultures, and experiences creates a diverse workforce and fosters a stimulating and innovative atmosphere (Banks & Banks, 2020).

Recognizing Diversity, Equity, and Inclusion in an organization opens up transparent conversation and helps bridge the gap in having a social and justice workplace (Bell, 2007). However, the workplace can have an invisible force that shapes the perception of others, often without realizing biases (Gorski, 2018; Mantsios, 2013). Implicit bias exists within each of us, influencing how we interact and make decisions daily (De Houwer, 2019). Developing sustainable solutions that engage the workforce requires understanding the importance of diversity and why certain cultures may be more dominant(Bonilla-Silva, 2015; McIntosh, 2006). However, racial and cultural diversity offers complications due to cultural suppression, lack of access to knowledge, stereotypes, poverty, or a lack of emphasis on academic and professional development (Apple, 1992; McLaren, 2003). This report seeks to understand the embedding problem of behaviors within individuals that can hinder prosperity and stifle organizational growth.

Embracing diversity, promoting equity, and including others as equals in an organization entails fostering an inclusive environment where individuals from various backgrounds, cultures, and abilities feel valued and respected. "It refers to reconstructing society in accordance with principles of equity, recognition, and inclusion" (Bell, 2007, p. 34). The main question this report seeks is how to begin to unpack and address DEI in the workplace. As many organizations focus on profitability and purpose, businesses can fall short if people are not part of the plan.

Conclusion

While Industry 5.0 at the core has many complexities, today's smart factories have the challenge of applying new technology and determining how to do more with less. The human aspects of Industry 5.0 may carry most of the burden as people are the key to sustaining the new practices. Appling diligence and willingness to involve those is a challenge for a factory manager who is often more concerned about the day-to-day than working on long-term plans to transform the workplace and reduce waste. Industry 5.0 refers to a human-centric approach that is needed to drive sustainability and resilience. Often, different theories and practices are introduced to engage a human-centric approach.

Transformational change in smart factories involves implementing new technologies and processes to increase efficiency and productivity. This change can motivate employees by providing them with tools and resources to perform their jobs more effectively. Setting specific goals within the organization aligns employees towards a common objective, allowing them to track their progress and stay motivated. Expectancy-value theory suggests that employees are more likely to engage in their work if they believe in the outcomes' value and expect success. Self-determination theory emphasizes the importance of autonomy and self-motivation in the workplace, encouraging employees to take ownership of their organizational roles. When these theories are applied effectively in smart factories, employees are more engaged, improving performance and overall success.

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