

SMES Challenges Adopting AI Technology

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1. Introduction

The European Commission considers artificial intelligence (AI) the most crucial technology in the fourth industrial revolution, particularly for SMEs. This essay aims to explain what artificial intelligence is and how it relates to SMEs. In Europe, SMEs make up 99% of all companies, and it is essential to understand why they are lagging in the adoption of AI as a means of improving, evolving, and surviving amidst new challenges. These challenges include developing sustainable businesses and facing unforeseen crises, such as those caused by a pandemic (Hervás-Oliver, Parrilli et al. 2021).

The Covid-19 lockdown caused numerous small and medium-sized enterprises to shut down because of production halts, cancelled orders, disrupted supply chains, shortage of raw materials, and limited working hours. This had a significant impact on companies with lower technological capabilities, making it difficult for them to adapt and sustain their business or process models while striving for growth (Lu, Wijayaratna et al. 2022). AI technology will be examined from ethical, moral, and humanistic perspectives because of the absence of regulations and the significant concerns that arise when handling a technology that can surpass the controls imposed by developers (Siau, Wang 2020).

Into the digital transformation definition, it will discuss the difference between digital and smart manufacturing because many people mistakenly use these terms interchangeably.

It is crucial to comprehend the concept of Lean Manufacturing (LM) to ensure the successful implementation of new technologies. Failure to understand or utilise LM can result in the unsuccessful adoption of the new process. Companies that have already incorporated this process

have a higher chance of success in selecting and implementing new improvement processes that generate favourable returns in the short term (Cardenas-Cristancho, Muller et al. 2022).

2. Literature Review

2.1 Digital Transformation in Manufacturing Industry

Digital transformation (DT) surrounds the changes in manufacturing companies driven by digital technologies, with the final objective of improving operational productivity, structure, processes and culture. This company's enhancement also could be moved to achieve a better customer experience, service, final product, and social or environmental impact (Vial 2019).

The leading digital technologies used for DT to permit process reduction and real-time information are the Internet of Things (IoT), data analytics, autonomous robots, artificial intelligence (AI), and cloud computing (Pihlajamaa, Malmelin et al. 2021).

(Pousttchi, Gleiss et al. 2019) has categorised the main activities of the digital transformation into ten groups that, individually or mixed, can have enormous effects directly or indirectly that can be seen in the short or long term.

1. Process Alignment (visibility, speed, efficiency, automation, efficacy, integration)
2. Staff (recruiting, safety & health, creativity, skill shortage)
3. The utilisation of Data (digital twins, monitoring, real-time data, customer data, information gain, key performance indicators)
4. Networks (networking, cooperation, platforms)

5. Business development (business model adjustment, core business, organisational structure, outsourcing, third-party dependency, structural dependency, resource dependency)
6. Product development (product innovation, product creation, product integration, aggregation, design, customisation, cost & reduction, quality, interoperability, add-ons, digital enabler)
7. Customer behaviour (customer attitude and decisions)
8. Customer relations (user experience, pre-sales & after-sales, customer support, retention, and community building)
9. Channel management (customer interface, channel development)
10. Marketing (brand and marketing mix)

Digital transformation can offer many options for companies, but it can also be complex to implement without proper understanding. This is due to the various processes and activities involved. Another essential point is understanding the difference between ***Digital Manufacturing*** and ***Smart Manufacturing***. For many people, these two terms can be the same, but the reality is that they are not. As presented previously, a company can integrate digital manufacturing processes without being a smart factory. However, considering that a business has a smart manufacturing process in place, this needs to have the digital processes already integrated. Due to this, the smart manufacturing industry is occupied with producing smart products through smart manufacturing processes with smart factories and the smart communication of the entire supply chain. Additionally, the digital twin 3D model virtualisation, big data processing and analytics, advanced robotics, the connected supply chain, and

eliminating hazards and inefficiencies in the workplace can be considered the main features of smart manufacturing (Group 2021).

2.2 Lean Manufacturing

The Toyota Production System (TPS) became more popular as the Lean Manufacturing System (LMS) around 1988, after having experienced a revolution in the manufacturing industry due to the crises caused by the Second World War. The creation of this new system was showing to other manufacturers that high-quality products also could be achieved at the same time by reducing inventories and having more flexibility. Toyota became an improved version of what Ford's system had implemented, pushing them to be leaders for a long time.

Cost and time reduction through the analysis of value-added and non-value-added used by companies to manufacture their products is the main idea of Lean Manufacturing (LM)

(Cardenas-Cristancho, Muller et al. 2022)

(Feld 2000) presents manufacturing flow, organisation, process control, metrics, and logistics as the leading five primary elements for LM and can be described as:

1. *Manufacturing Flow*: Design and physical changes affected
2. *Organisation*: Identification and designation of training required and employees' roles/functions
3. *Process Control*: Ways used to identify, control, and stabilise processes to be improved
4. *Metrics*: Performance measurements, team recognitions, and targeted improvements
5. *Logistics*: Flow material management through mechanisms and operating rules

Even though these elements can be implemented individually and appropriately, if the final objective is to have a healthier company move forward into a new success level, the full

implementation of these five elements interacting with each other will be required. The aim of having these five elements working together is to have a consistent, predictable, flexible, and responsive production operation system well established.

2.3 Artificial Intelligence

There are multiple definitions for Artificial Intelligence (AI); in this situation, it is more defined as a process than a concept. The continuous computer development based on human intelligence capable of addressing and making complex resolutions can be used as an AI definition.

Numerous research shows controversy when defining the term intelligence coming from machines because they say these are learning machines with an advanced digital computing system instead. Almost all companies or managers who want to work with AI need to consider these concepts: autonomy, learning and inscrutability. **Autonomy AI** can work without human intervention and occasionally without human knowledge. **Learning AI** is the ability to improve automatically through the data managed and own experiences. **Inscrutability AI**, because of its autonomy and learning capacities, can have or generate understandable or incomprehensible algorithms for humans, plus the complexity and diversity results (Berente, Gu et al. 2021). According to (Handelman, Kok et al. 2019), it is necessary to mention *Machine Learning* (ML) when discussing complex logarithms and its ability to learn from experiences and analysed data. Subsequently, it is necessary to understand the key elements to have a complete AI system, and it should be noted that these elements must work together, interacting with each other.

1. Machine Learning is an AI application that does not require a particular program to improve and learn automatically
2. *Deep Learning* uses a network of algorithms to interpret the data received within the ML

3. *Neural Networks* are computer systems based on the neural network used by the human brain that allow deeper learning

4. *Cognitive Computing* is in charge of recreating, imitating and improving the interaction and understanding between machines and humans and transferring it to a computer model

5. *Natural Language Processing* (NLP) is the tool that reproduces human language using computers after understanding, interpreting and recognising it.

6. Computer Vision is the one that interprets the images, tables, graphs and videos using pattern identification and deep learning (Kanade 2022b).

Some of these elements could be removed from the system depending on the objective to be achieved.

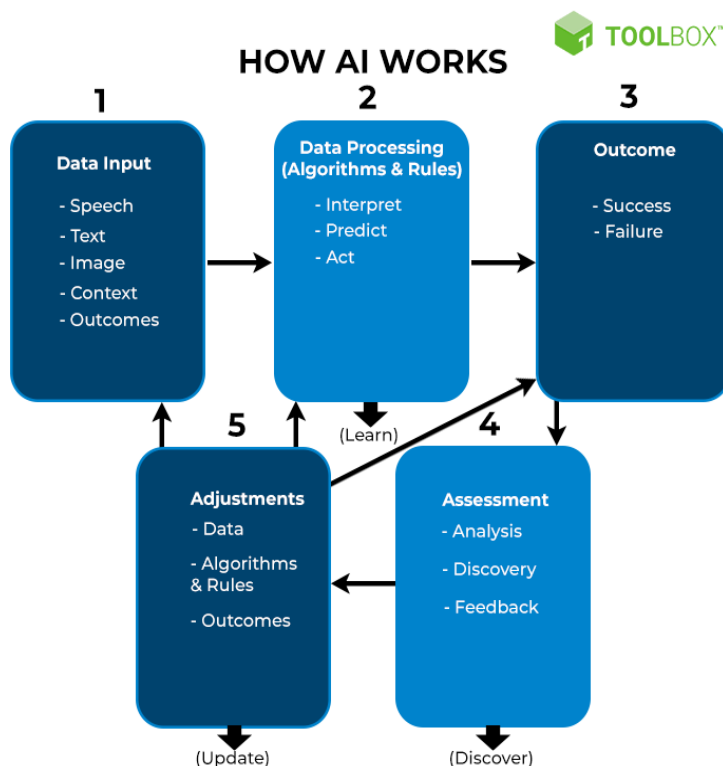


Figure 1. How AI Works (Kanade 2022a).

There are two main groups to divide the types of AI, which are divided by advanced performance and limited functionality. The three ones in the first group are artificial narrow intelligence (ANI), artificial general intelligence (AGI), and artificial superintelligence (ASI). The second group is split into four and is defined by the thinking capacity: reactive, limited memory, theory of mind, and self-aware.

Artificial Narrow Intelligence (ANI) is an AI system that can do things better and faster than humans, but due to its programming, it can not do anything that it has not been programmed for.

Artificial General Intelligence (AGI), the AI system, can act as a human because it can understand everything completely.

Artificial superintelligence (ASI) is where AI comes out ahead of any human because it can replicate many facets of human intelligence and be smarter, sharper, and faster using the information taken from AGI.

3. AI into SMES

Artificial intelligence can help any company regardless of size, and the SMES should enter into a race for the application of this technology to improve their processes like:

Industry standards & compliance regulations, AI has the advantage of obtaining this information instantly and reviewing compliance with regulations in a faster way.

Precise error analysis, identification and solution of manufacturing problems in a short period thanks to the deep analysis of the previously collected data.

New efficiencies identification & blocker remover reduce time and cost by introducing new solutions once the inefficiency has been identified.

With *better supply chain management*, AI improves inventory planning and reduces supply chain costs by controlling waste and material stock (Factor Eye 2022).

The field of AI involves developing intelligent machines that can perform tasks requiring human-like intelligence. Its objective is to create machines that can perceive, reason, and act like humans. All these AI services that help companies reduce process times and dependency on employees were the ones that SMES began to seek the most after the recent pandemic experienced with COVID-19. In 2019, about 99% of manufacturing companies in Europe were small and medium-sized enterprises (SMEs), highlighting their significant role in society. However, there is concern about why this group of companies is lagging in adopting new technologies. Many papers were reviewed to verify the benefit that companies in the maintenance, assembly line, energy management, quality, production planning, marketing, cybersecurity, robotics, business assistance, and material handling sectors can benefit from artificial intelligence. However, these were the most common limitations found:

Lack of management strategy and involvement, managers should have more understanding of the benefits and feasibility of adopting AI.

Lack of skill/knowledge, lack of experience in this field, employee ages, insufficient training, and the lack of advanced IT and AI knowledge.

Data problems, knowing that AI tools are based on data analysis, and most SMEs need help collecting, sharing and having the quality required for correct interpretation of data due to the lack of infrastructure.

Solutions, even if AI technology was installed, a qualified person should handle the interpretation of the data to put the results into practice.

Lack of budget, Small and medium-sized enterprises (SMEs) often have limited funds for technology investments. Additionally, they may believe that the cost of implementing technological solutions is prohibitively expensive, although this is not necessarily the case.

Unfortunately, there is currently a dearth of resources available to help SMEs accurately evaluate the cost-to-benefit ratio of artificial intelligence (AI) and machine learning (ML) applications (De Simone, Di Pasquale et al. 2023).

4. Discussion

For a while, it was still determined how emerging technologies and lean manufacturing would work together to revolutionise manufacturing companies. Some thought that Lean Manufacturing would be replaced in the industry. However, studies and experiences have shown that not only will LM not be replaced, but it will also be a crucial tool to aid in the implementation of new technologies. In fact, it is a requirement for many of these technologies. Studies have found that companies that have already implemented LM have seen the most significant improvement in operational and cultural performance when digitising. It is worth mentioning that the integration of LM with digital technologies is not only beneficial for the industry's performance but it also brings significant environmental advantages. By reducing waste and optimising the use of resources, companies can achieve a more sustainable production process. Additionally, the use of digital tools such as predictive maintenance and real-time monitoring can help prevent

equipment failure and improve energy efficiency, contributing to the greener manufacturing industry (Buer, Semini et al. 2021).

4.1 Organisational Concerns and SMES main blockers

It is essential to change the mentality of the companies and stop seeing the LMS as a goal to be achieved instead of processes to improve things and the way of thinking. Once the company has decided to implement the LMS, it is crucial to simultaneously implement performance indicators to evaluate the pros and cons of these implementations with a high-frequency level to guarantee successful implementation in a short or long time of LMS. These indicators are necessary to reduce the high percentage of failures and frustrations companies are experimenting with during the LM implementations (Cardenas-Cristancho, Muller et al. 2022).

Why are performance indicators challenging to implement in manufacturing companies?

- Finance

Digital technologies are not easy to embrace by SMES companies because they are more restricted from a financial point of view, and their technical structure or resources, most of the time, are not convenient to upgrade (Peillon, Dubruc 2019).

Another critical point is to understand what type of technology is required and that it can also be sustained in the long term from a good point of view because what it does not want is for the company to acquire expenses that it cannot afford due to the mere fact of wanting to update and enter the digital age, and ended up closing (Lu, Wijayaratna et al. 2022).

- Human resources (existing and new ones)

Manage the existing employees or even integrate the new ones needs to be highly well addressed by companies when the integration of a new technology is going to be planned or executed. It is important to create a good atmosphere, and especially with the existing employees due to some of them probably changing tasks that they have been doing in the same way for many years. The management team will play a critical role here, because they will need to stimulate and develop the new employees or the current ones to minimise any possible resistance that can block or slow down the new changes. Equally important is to try to keep as many employees informed or involved as possible from the beginning of the plan, and not create walls or divisions between them or with the new technology (Pihlajamaa, Malmelin et al. 2021).

Lack of digital knowledge between many SMES employees these days can create a barrier to introduce these digital technologies, because this will push these businesses to the necessity of new employees qualified with high pay salaries (Peillon, Dubruc 2019).

4.2 Environmental drivers to implement new technologies in SMES companies

Pressure from competitors or business partners

The business environment for European SMEs has undergone significant changes due to technological advancements and globalisation. These changes have put pressure on SMEs to compete in international markets and face various challenges, such as driving digital transformation, accessing finance, and discovering skilled employees. It is important for SMEs to overcome these challenges and enhance their international competitiveness to ensure

economic growth and employment in Europe. To assess the position of European SMEs in international competition, we surveyed SMEs in France, Germany, Poland, Spain, and the UK. They were asked to compare themselves with their competitors in various aspects, including factors such as product quality, pricing, location, transport, digital infrastructure, political stability, availability of skilled employees, and external finance. This survey aims to identify the strengths and weaknesses of SMEs and potential areas for improvement. As a result, implementing the new technologies is a critical tool to allow SMEs' subsistence in the coming years (Abel-Koch, Jennifer Al Obaidi, Leath El Kasmi Sabrina, Fernandez Acevedo, Miguel Morin, Laetitia Topczewska 2019).

Customer expectations

In today's consumer-focused world, companies prioritise the customer experience and adapt their products and services to meet the constantly evolving expectations of consumers. Even manufacturers are transforming into customer-centric organisations.

By offering customizable products, companies are able to cater to a broader range of customers with varying needs and preferences. This not only helps retain existing customers but also attracts new ones who may have previously overlooked the company's offerings. Additionally, this approach allows for greater flexibility in production and inventory management, as there is less need to stockpile large quantities of a single product. Overall, the trend towards customization in manufacturing is a smart move for companies looking to stay competitive in today's ever-evolving market (Child 2021).

The implementation of AI in companies has been raising more concerns for the last few years from an ethical point of view based on the continuous developments in autonomy, learning and inscrutability. Years ago, introducing new automatisms into manufacturing companies introduced fear in many people, thinking that the new mechanisms would take away their jobs. However, other people with more skilful jobs were more focused on economic benefits and with their minds set on a society insatiable to consumer demand. So they thought that there would be more jobs available for those whom automated machines have already replaced. These days with artificial intelligence, it is no longer just the less skilled workers who are worried about their future. This technology is also replacing mental functions, so the concern has spread to all levels of society (Berente, Gu et al. 2021).

4.3 Humanistic side of AI

Numerous scientists and relevant people in society are warning that although artificial intelligence is changing the way large industries are operating and the way society is evolving, on the other hand, it is opening the door to what could be the end of the human race for not being able to have complete control of what artificial intelligence can do or how it could evolve since the language of algorithms is more complex to understand for human beings than for artificial intelligence. Facebook already had to shut down an artificial intelligence engine for having developed a unique language that humans could not understand (Bradley 2017).

The definition of Roboethics and Machine ethics is essential to understand ethics in technological developments related to robots and artificial intelligence.

Roboethics is the moral part of human behaviour by working with the design, development, use, and interaction of AI agents and robots with humans and society. It is also responsible for the interaction between the same technological agents.

Machine Ethics focuses on the ethical conduct of Artificial Moral Agents (AMAs), which is a research area that aims to develop artificial agents with moral capabilities.

The rules and values that should guide the development of new technologies, including AI, need to catch up to the rapid progress in these fields. Ideally, it should be the other way around. While some governments and corporations are attempting to establish ethical standards for creating and applying artificial intelligence, reaching a universal consensus can be challenging due to competing interests among parties seeking to dominate the market.

The social impact from the point of view of workers is also changing as more companies become involved in the technological revolution, where in some parts of the world it is already seen that job offers for highly qualified people are increasing in comparison to the decline in new opportunities for the less qualified. Furthermore, this is due to the new type of skills required to manage this new technological world (Siau, Wang 2020).

5. Conclusion

It can be argued that there is a lack of understanding and fear when many SMEs hear concepts like digital transformation, smart factories, artificial intelligence, VR/AR, IoT or lean manufacturing. All these concepts are related to many, even without starting to dig into what they are. What are they for? Or How can they be implemented? It is crucial to have experienced individuals who are well-versed in these concepts to assist companies in leveraging their existing resources and translating this knowledge into practical steps. This is the only way to transition successfully into the current technological age. The correct use of lean manufacturing will reduce risks and bring a high percentage of success to SMES companies to benefit from their technological innovation if this can be seen as a process to develop the company processes and not as an objective. Equally important is obtaining information on how SMEs can use government funds to deal with high uncertainty risks during new technologies implementation. In the same way, the humanistic side is essential to manage the employees and keep them connected with the company's vision on these new changes. Subsequently, managers in SME businesses need to possess good skills to identify individuals who can be trained for new opportunities or recruit new qualified personnel (Pihlajamaa, Malmelin et al. 2021).

As AI becomes more integrated into our daily lives, we must consider its impact on society. While AI has the potential to revolutionise industries and improve our quality of life, we must also be mindful of how it can perpetuate biases and inequalities. It is our responsibility to ensure that AI is developed and used in an ethical and beneficial manner, taking into account all stakeholders and potential consequences. To fully benefit from AI and reduce its potential risks,

it is necessary to take specific steps, like considering the data used to train AI algorithms, as partial data can lead to unfair and harmful outcomes.

6. References

- ABEL-KOCH, JENNIFER AL OBAIDI, LEATH EL KASMI SABRINA, FERNANDEZ ACEVEDO, MIGUEL MORIN, LAETITIA TOPCZEWSKA, 2019-last update, The Challenges Facing European SMEs. Available: https://www.british-business-bank.co.uk/wp-content/uploads/2019/11/going-digital-the-challenges-facing-european-smes-european-sme-survey-2019_2.pdf [June 01, 2023].
- BERENTE, N., GU, B., RECKER, J. and SANTHANAM, R., 2021. Managing artificial intelligence. *MIS quarterly*, **45**(3),.
- BRADLEY, T., Jul 31, 2017-last update, Facebook AI Creates Its Own Language In Creepy Preview Of Our Potential Future. Available: <https://www.forbes.com/sites/tonybradley/2017/07/31/facebook-ai-creates-its-own-language-in-creepy-preview-of-our-potential-future/> [May 26, 2023].
- BUER, S., SEMINI, M., STRANDHAGEN, J.O. and SGARBOSSA, F., 2021. The complementary effect of lean manufacturing and digitalisation on operational performance. *International Journal of Production Research*, **59**(7), pp. 1976-1992.
- CARDENAS-CRISTANCHO, D., MULLER, L., MONTICOLO, D. and CAMARGO, M., 2022. Toward a holistic understanding of performance in Lean Manufacturing: a discussion on the relevance of its indicators. *International Journal of Lean Six Sigma*, **13**(5), pp. 1025-1057.
- CHILD, G., December 07, 2021-last update, How are changing customer expectations driving change in manufacturing? . Available: <https://www.oneadvanced.com/news-and-opinion/how-are-changing-customer-expectations-driving-change-in-manufacturing/> [June 01, 2023].
- DE SIMONE, V., DI PASQUALE, V. and MIRANDA, S., 2023. An overview on the use of AI/ML in Manufacturing MSMEs: solved issues, limits, and challenges. *Procedia Computer Science*, **217**, pp. 1820-1829.
- FACTOR EYE, June 02, 2022-last update, Why should SME manufacturers invest in AI and machine learning?. Available: <https://factoryeye.magicsoftware.com/blog/why-should-sme-manufacturers-invest-in-ai-and-machine-learning/> [May 24, 2023].
- FELD, W.M., 2000. *Lean manufacturing: tools, techniques, and how to use them*. CRC press.
- GROUP, S., August 31, 2021-last update, Smart Manufacturing Vs Digital Manufacturing: How To Unlock Industry 4.0 Benefits. Available: <https://stefanini.com/en/insights/news/smart-manufacturing-vs-digital-manufacturing> [May 20, 2023].

HANDELMAN, G.S., KOK, H.K., CHANDRA, R.V., RAZAVI, A.H., HUANG, S., BROOKS, M., LEE, M.J. and ASADI, H., 2019. Peering into the black box of artificial intelligence: evaluation metrics of machine learning methods. *American Journal of Roentgenology*, **212**(1), pp. 38-43.

HERVÁS-OLIVER, J., PARRILLI, M.D., RODRÍGUEZ-POSE, A. and SEMPERE-RIPOLL, F., 2021. The drivers of SME innovation in the regions of the EU. *Research Policy*, **50**(9), pp. 104316.

KANADE, V., 2022a. *How AI Works* .
<https://www.spiceworks.com/tech/artificial-intelligence/articles/what-is-ai/#lg=1&slide=0> .

KANADE, V., March 14, 2022b-last update, What Is Artificial Intelligence (AI)? Definition, Types, Goals, Challenges, and Trends in 2022 . Available:
<https://www.spiceworks.com/tech/artificial-intelligence/articles/what-is-ai/> [May 26, 2023].
LU, X., WIJAYARATNA, K., HUANG, Y. and QIU, A., 2022. AI-Enabled Opportunities and Transformation Challenges for SMEs in the Post-pandemic Era: A Review and Research Agenda. *Frontiers in Public Health* , pp. 1079.

PEILLON, S. and DUBRUC, N., 2019. Barriers to digital servitization in French manufacturing SMEs. *Procedia Cirp*, **83**, pp. 146-150.

PIHLAJAMAA, M., MALMELIN, N. and WALLIN, A., 2021. Competence combination for digital transformation: a study of manufacturing companies in Finland. *Technology Analysis & Strategic Management* , pp. 1-14.

POUSTTCHI, K., GLEISS, A., BUZZI, B. and KOHLHAGEN, M., 2019. Technology impact types for digital transformation, *2019 IEEE 21st Conference on Business Informatics (CBI)* 2019, IEEE, pp. 487-494.

SIAU, K. and WANG, W., 2020. Artificial intelligence (AI) ethics: ethics of AI and ethical AI. *Journal of Database Management (JDM)*, **31**(2), pp. 74-87.

VIAL, G., 2019. Understanding digital transformation: A review and a research agenda. *The journal of strategic information systems*, **28**(2), pp. 118-144.