

# **Unlocking the SME Advantage: Prioritising Optimisation Before Automation for Small-Scale Manufacturers**

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## **Abstract**

In the race to modernize, companies can often neglect foundational principles. With industry 4.0 taking over in manufacturing more and more SME's are automating their processes utilising industry 4.0 technologies. Companies are integrating more automation, data systems and new technologies in a bid to secure their future, become more efficient, productive and reduce costs. This race to change can mean that the basics that have been around for years can be missed. For manufacturing SME's these are techniques and methodologies around lean manufacturing and six sigma practices that can often be as effective in achieving the optimisation goals they set out. The ultimate failure with this approach is that the business ends up automating waste in the race to keep up.

## **Keywords**

Industry 4.0, Implementation Framework, Manufacturing SME, Lean Manufacturing, Lean 4.0

## **1. Introduction**

For many years manufacturing has embraced lean principles and six sigma methodologies as tools for the elimination of waste to help optimise performance and efficiency of operations. From Henry Ford in the early 1900's to the groundbreaking publication of 'Toyota Production System' by Taiichi Ono in 1988 (Ono, 1988) manufacturers have looked to get leaner and reduce waste. The publications in the 1980's really started to pave the way for many western companies large and small to adopt the methodologies outlined.

The conception of six sigma also appeared in the 1980's with the internal Motorola document titled 'The Nature of Six Sigma Quality' by Bill Smith and the development of this methodology is nicely explained in 'Quality into the 21<sup>st</sup> century' (Watson, et al., 2003).

Throughout the 1980's and into the 21<sup>st</sup> century the ideas around lean manufacturing and six sigma have been developed further and further and adopted by more and more by businesses looking to stay competitive and gain an edge on competition. With the introduction of the concepts around industry 4.0 in 2011 (Xu, et al., 2021) manufacturers and engineers have been combining the digitisation of manufacturing with the principals to further eliminate waste and optimise processes.

The combination of these ideas is great for many manufacturers if applied correctly. This paper aims to discuss the method in which these can be applied in small-scale manufacturers and how they should be implemented together as there is currently a risk of technology overtaking the older principals which can result in the costly automation of waste.

### **1.1. SME Challenges**

It is no secret that many large-scale manufacturers within the automotive, aerospace, defence and other industries have been automating and digitising processes for a long time. This is in part due to their ability to do so and having the available resources to invest in unproven technology and get ahead of the curve. (Masood & Sonntag, 2020).

SME's on the other hand have some specific challenges when it comes to resources, knowledge and funding. Without short ROI's many small-scale manufacturers are reluctant to invest. This lack of resource and unproven ROI's leads small-scale manufacturers to fall behind the larger companies and struggle to stay competitive.

In the UK SME's make up 99% of manufacturing businesses (Clark, 2022). This statistic shows how important SME's are to the economy. As well as contributing to the overall economy themselves SME's are the feeder companies for the larger manufacturers.

They supply components into automotive, defence and aerospace companies. When these companies are looking at digitisation it is beneficial for them to consider their whole supply chain for horizontal deployment to automate tasks with ordering and invoicing. If the SME's supplying the larger manufacturers do not have the infrastructure to support these requests or the knowledge to implement them then they can struggle to keep up with their customers. This also limits the digitisation activities of the larger companies.

### **1.2. Lean Six Sigma**

Lean and six sigma methodologies have been around for some time as described in the previous sections. These tried and tested methods have allowed many businesses to relentlessly eliminate waste in their processes reducing cost of manufacture and increasing efficiency.

Some lean and six sigma tools include:

- Value stream mapping: this allows the visualization of the flow of materials and information required to produce a product helping identify areas of waste.
- 5 whys analysis: this involves the repeated asking of the question 'why?' to get to the root cause of a problem quicker and allow for a quicker resolution.
- Kaizen events: this is the idea of a continuous improvement workshop allowing for small continuous incremental changes to a process to eliminate waste and improve efficiency.
- Pareto Analysis: this is the concept of the 80/20 rule that 80% of the effects come from 20% of the causes helping define the most important items to work on.
- Failure mode effects analysis (FMEA): this is a systematic approach to identifying potential failures in a process or system allowing for advanced planning to reduce the likelihood of the event occurring.
- Statistical process control: this involves collecting and analysing data to monitor and control processes.
- 5S: A set of principals focussed on organisation and contributing to efficiency and effectiveness of work areas.

These tools and methodologies have been in practice before companies started to automate and digitise their operations. This means that for many years companies can get more efficient without the costly investment in industry 4.0 and digital transformation initiatives. (Alexander, et al., 2019).

Once these tools have been mastered they can be applied manually without the need for expensive technology to manage the implementation. This is vastly important to SME's as it allows many of the benefits industry 4.0 promises without the large investments it makes necessary.

### **1.3 Benefits of Industry 4.0**

Industry 4.0 encompasses many enabling technologies and ideas such as big data analytics, internet of things (IoT), 3D printing, augmented reality, robotics and many more.

Implementing industry 4.0 technologies allows for many benefits including:

- Increased efficiency though: automation of manual processes, improved data exchange, advanced data analytics to optimise processes and reduce waste.
- Improved productivity by: smart technology and predictive analytics to analyse and reduce errors with higher output.
- Cost reduction: Automation and predictive maintenance help to reduce labour costs and downtime. Reducing the energy consumption and waste.
- Increased Quality: real-time monitoring and control systems allow for consistent product quality and reduction in customer complaints.
- Global competitiveness: Allows an increase in flexibility and complexity of products and customisations allowing for a more attractive product to the end customer making them more competitive.

These top-level benefits align with what lean and six sigma have been promising for many years. This has led to the creation of lean 4.0 and lean six sigma 4.0 (Mayr, et al., 2018). This newer research aims to combine the areas of lean, six sigma and industry 4.0 to supercharge the benefits by digitising the tools and analysis methods as well as utilising new technology to achieve the benefits. (Valamede & Akkari, 2020) highlight the benefits of industry 4.0 technologies when combined with lean six sigma tools.

#### Lean 4.0 Tools:

- Just in Time (JIT) 4.0: Enhanced by Cloud Computing, Big Data Analytics, AGVs, Additive Manufacturing (AM), and AR to ensure real-time data flow and efficient production.
- Kanban 4.0: Improved with Big Data Analytics, AGVs, and VS for automated logistics and inventory control.
- Poka-Yoke 4.0: Supported by AGVs, Cloud Computing, Cybersecurity, and AR to detect and eliminate production errors.
- Value Stream Mapping (VSM) 4.0: Utilizes Big Data Analytics, Cloud Computing, and VS to continually optimize production processes.
- Kaizen 4.0: Facilitated by Big Data Analytics, Cloud Computing, VS, and AR for continuous improvement and enhanced human-machine interaction.
- Total Productive Maintenance (TPM) 4.0: Employs Big Data Analytics, AGVs, Cloud Computing, VS, AR, and AM for predictive maintenance and efficient task management.

## **2. Discussion**

In the above sections it is apparent that SME's face some significant challenges when it comes to industry 4.0 implementation. The key focus of this paper is helping SME's to avoid the automation of waste by utilising lean and six sigma practices before they venture into digital transformation.

The dangers of jumping into digital transformation and industry 4.0 can be that businesses will get excited by the promise of efficiency through technology and start to implement digital technologies into processes that are currently sub optimal.

In the previous section highlighting the crossover of lean and industry 4.0 this can further muddy the water for SME's as they can start to invest in industry 4.0 technologies to get them started on their lean journey which can lead to costly exercises and development when the basics of lean and six sigma can be completed manually and only once the basic steps have been completed should it be enhanced by lean 4.0.

Robotic process automation (RPA) is a good example of this (Antoni Pedro, 2022). The technology around RPA if applied correctly can be very beneficial to businesses as a relatively cost-effective way to automate manual daily tasks that are performed by people freeing them up to do more value add work.

These tasks often consist of manual data entry tasks like customer onboarding and automatic email generation. The danger is that by investing heavily in RPA companies can ignore what should be the first step in automation which is asking the question 'why is this being done'. By skipping this step companies develop RPA over the top of a process that lean on its own would have eliminated.

With RPA being a relatively low-cost option to implement the dangers are often not too damaging to a business. This changes if a business were to invest in more heavy forms of automation such a robotics and fully automated systems.

Considerable investment can be spent on automating physical processes and assembly lines. If the waste is not eliminated at the start up phase of an automation project utilising lean and six sigma tools and methodologies the costs of the automation of waste can be very damaging to a business.

Other examples of poor automation can be the implementation of robotics in sub optimal processes. If a business were to invest in autonomous guided vehicles (AGV) to transport goods from one process to another which is often considered a good investment as waste is commonly identified in wasted movement of people within the process. This issues however when approached from a lean six sigma methodology point of view would suggest utilising tools such as spaghetti diagrams and value stream mapping techniques to identify if there is a more optimal layout of the production process (Ullah Khan & Ali, 2017).

This would then negate the need for AGV's because the flow of product is optimised and production members can have the possibility of being utilised in multiple processes to remove dead time in their operation. This can be achieved through cellular manufacturing if the processes allow. These examples exist to illustrate that there are many scenarios and multiple production methods that can all be optimised through tried and tested techniques.

Some of the key challenges that businesses can face with premature automation include automating inefficiencies and the high costs associated with this. As SME's often operate on much smaller margins than larger companies as they are in a large pool of suppliers and can be squeezed on price by global competition the possibility of considerable investment to become more inefficient has a real risk to business success.

The high costs of automation can be attributed to the lengthy investigation phases, high integration costs and high equipment costs. These combined with lack of knowledge that many SME's possess can lead to very damaging ROI periods where large amounts of cash can be tied up in automation projects that don't allow the business to be as agile as it would usually.

### **3. The Road to Success**

To mitigate these risks it is important for businesses to approach industry 4.0 with a measured caution. As discussed, it is easy to get enticed by the promises of digital transformation and the efficiency and productivity that it promises.

A good method of achieving this cautionary approach can be invest a lot of time in the initial stages of the project. These include the detailed investigation and viability stages and research into all avenues of achieving the desired goal as costly automation is not always the best option.

Tools such as maturity assessments can be utilised to give a good indication of the businesses readiness to implement digital technologies. Within a good maturity assessment will be the opportunity to review current practices and the suggestion that the utilisation of strict and measured lean and six sigma manufacturing principals can often yield good returns in terms of efficiencies with regards to waste reduction (Setianto & Haddud, 2017).

Any manufacturing business should consider investing in a knowledge champion within the area of business improvement, lean manufacturing and six sigma as well as having good knowledge of project management methodologies in order to successfully implement the projects the lean six sigma tools may suggest (Muhammad & Fend chin, 2020).

Only once these initial stages of process optimisation have been completed is it recommended to investigate industry 4.0 technologies and automation projects. A good example of this is if the process has been fully optimised over many iterations of improvement projects and the gains in productivity are reducing then this would be a good indicator that the process is either at the limit of its efficiency or the next step is to automate.

Once the threshold for ROI has been reached with traditional methods investigation into automation is the logical next step. If there is a very manual process that takes many people then often some form of automation can be a good investment.

The flow of data in many traditional manufacturing processes can be very manual. This means that paper travel sheets can be used to flow with the product and any issues manually recorded back into any MES or ERP system. Often even these systems will not exist and many processes can be managed using simple spreadsheets and email communication.

This type of scenario lends itself very well to industry 4.0. The implementation of some form of digitisation of the data flow utilising big data analytics, IoT and others can help reduce any data entry errors and flow of materials can be tracked using barcodes or RFID which are very cost-effective methods of improvement.

On the flipside if the business is not mature enough to have any control over their processes with paper travel sheets and manual processes then this is equally a good place for them to start. This highlights the scenario that every solution needs to be tailored to the business in an achievable and scalable way dependant on their level of maturity.

This is they type of scenario that lean and six sigma tools combined with continuous improvement methodologies, gap analysis and incremental improvements can highlight.

#### **4. Conclusion**

By investing in the education of members across the organisation starting at the beginning with business improvement techniques such as lean and six sigma, utilising tools to identify waste and not jumping straight in at the automation and digitisation stages companies can set themselves up for success.

The need for in depth maturity assessments, gap analysis and good planning in terms of ROI and benefits statements can not be over emphasised. By doing these stages correctly utilising readily available tools and information SME's can optimise processes with little to no cash investment.

Only once the business is sure that the processes it is aiming to improve are as lean as they can be should they consider industry 4.0 technologies. At this stage it is suggested to consult someone skilled within this area such as a facilitator or industry 4.0 expert.

Lean and six sigma tools can be easily learnt through simple training courses or self-lead learning online making them very accessible to SME's at low to no cost. When looking at industry 4.0 technologies this is not so simple as there can be very complex solutions that need to be fully understood as the potential risks increase due to the rise in cost to test implement solutions based around industry 4.0 technologies.

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