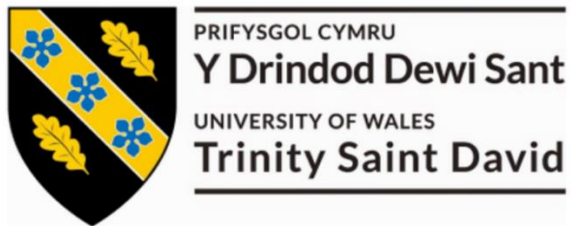


**University of Wales Trinity Saint David.
School of Engineering.**



Name: Matthew Dewhurst

Student Number: 2113040

Date: 10/06/24

**Subject: Manufacturing Systems and Simulation
ACMA 6002**

Title: Applying Lean Techniques

Degree: BEng Manufacturing Systems

Table of Contents

1.0 Introduction	3
1.1 Company Background	3
1.2 Project Background	3
2.0 Define	4
2.1 Problem Outline	4
3.0 Process Wastes	5
3.1 Defects	5
3.2 Inventory	5
3.3 Over Processing	5
3.4 Motion	6
4.0 Customer Analysis	7
4.1 Customer Perception	7
5.0 Process Improvements	8
5.1 Defect Reduction	8
5.2 Inventory Reduction	8
5.3 Over Processing Reduction	8
5.4 Motion Reduction	9
6.0 Implementation	11
6.1 Implementation Costs	11
7.0 Conclusion	12
7.1 Waste Reduction Analysis	12
8.0 References.	13

1.0 Introduction

1.1 Company Background

Aston Martin Lagonda continues to pursue its ambition and vision to be an ultra-luxury car company, crafting the world's most beautiful and accomplished automotive art. Aston Martin is a contemporary, exclusive luxury sports car brand with a unique heritage that is recognised worldwide. Established in 1913 by Lionel Martin and Robert Bamford, Aston Martin is renowned as an iconic global brand synonymous with style, luxury, performance, and exclusivity. The initial Aston Martin vehicles were designed with a distinctive and individual character, meticulously handcrafted to the highest standards, and built to surpass all performance expectations.

1.2 Project Background

In March of 2016, Aston Martin revealed their plans to create the brand's first hyper car under the code name 'AMRB-001' and a year later the project was officially named 'Valkyrie'. The Aston Martin Valkyrie was developed through a collaboration between Aston Martin, Red Bull Racing, and several other expert partners. The design process began with a focus on aerodynamics and weight reduction. Adrian Newey's input was crucial in ensuring the car's design maximised downforce while minimising drag. The car's body was crafted from carbon fibre, and every element was scrutinized to achieve optimal performance. The Valkyrie made its public debut at various auto shows and private events, generating significant excitement and anticipation in the automotive world.

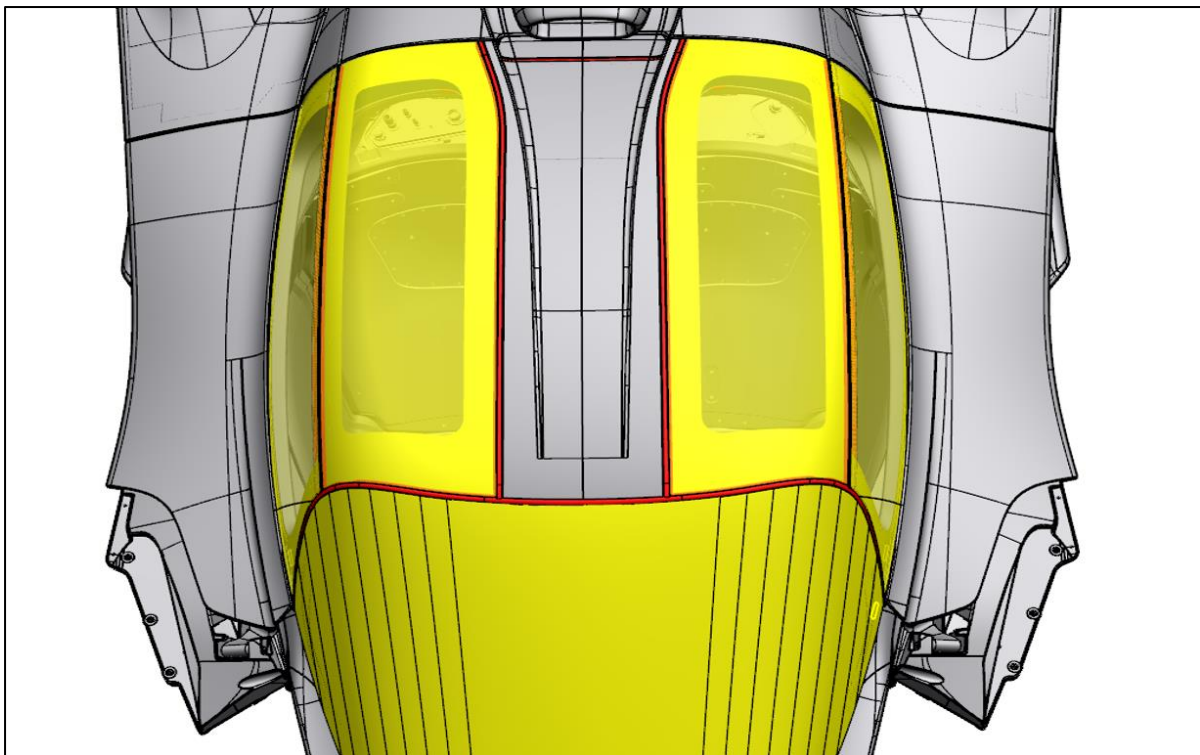
The Valkyrie's development was not without challenges and the complexity of integrating Formula One technology into a road car led to several delays in the production timeline. As well as the complex design work, extensive testing and validation were necessary to ensure the car met its performance targets and adhered to safety regulations for road use. But eventually initial production of the Valkyrie began in late 2021 at the company's headquarters in Gaydon, Warwickshire. Production of the Valkyrie is limited to 150 coupe variants and another 75 convertible variants, each highly customizable by the owners in collaboration with Aston Martin's Q division.

One particularly interesting component of the Valkyrie's design and engineering is the curved windscreen, the curvature and placement of the windscreen ensure optimal visibility for the driver. This is essential for both high-speed driving and precise manoeuvring on both road and track. The design aims to provide a clear, unobstructed view, as this is crucial for a car capable of such extreme speeds. In addition, the windscreen is designed with aerodynamics in mind, contributing to the overall sleek and streamlined profile of the Valkyrie. Its shape helps manage airflow over the car, reducing drag and increasing downforce, which is crucial for the car's high-speed stability and performance. The introduction of the latest Valkyrie variant, the 'Valkyrie Spider', which featured an innovative convertible roof with glass panels and revised windscreen.

2.0 Define

2.1 Problem Outline

With the introduction of the Valkyrie Spider variant, design changes were made to the original Valkyrie model to create a convertible roof section with glass panels. As well as these changes, amendments were made to the windscreen to suit the new roof section, and this created the requirement for revised glazing production processes. Due to the change of design, there is an increased risk of attribute failures such as water ingress, which can be prevented through adequate sealing and bonding. However, during the launch of this model, issues with excess adhesive had become apparent and caused soiling of surrounding interior trim components. The excessive amounts of adhesive being used was a result of the increased glazing processes, in addition to pre-cautious and large adhesive beads being applied to avoid leaks out in the field.



(Figure 1 – CAD data that demonstrates the Valkyrie Spider Convertible Roof Section – Siemens TeamCentre, 2024.)

3.0 Process Wastes

3.1 Defects

As a result of the initial adhesive application on the windscreen in particular being excessive as an act of precaution to prevent water ingress, this resulted in large amounts of adhesive being visible within the cabin. This excessive application of adhesive leads to poor quality and defects, which have a negative impact on process time, cost, and resources. When the windscreen is fitted to the vehicle and the adhesive bead is compressed, excess bond 'spew' is created, and can then fall or leak into the interior of the vehicle. Defects in manufacturing are detrimental to businesses as they lead to product that is not satisfactory to the customer. Another source also explains the additional negative impacts of defects, "These errors could affect several resources, such as time to rework the product to satisfaction, extra materials needed to reduce the product, or a completely defective product that results in total loss of the production materials and time." (Elger, C. (2020)). In manufacturing, defects can lead to additional resources beyond production to fix or replace them and do not add value to the business.

3.2 Inventory

To produce even small volumes of motor vehicles, automotive manufacturers such as Aston Martin consume substantial amounts of adhesive for processes such as glass bonding. Therefore, Aston Martin purchases huge batches of adhesive and delivers those units lineside for manufacturing processes. This substantial stock of adhesive can also be considered a waste as there are hidden costs involved with storage and unused assets. Another negative impact of excessive adhesive application is the large amount of unnecessary waste that is created. Due to the excessive consumption of adhesive for the bonding of the components such as the windscreen, there is physical cost of production that could be considered as waste. In addition, there are hidden costs involved with inventory waste as one source describes, "You also have a host of less obvious costs that are cut directly from your profit, these are areas such as the transportation and movement of this inventory, the space required to store it, the containers to store it in, the administration of keeping track of it, the damage and losses that occur during transportation." (Lean Manufacturing Tools (2013)).

3.3 Over Processing

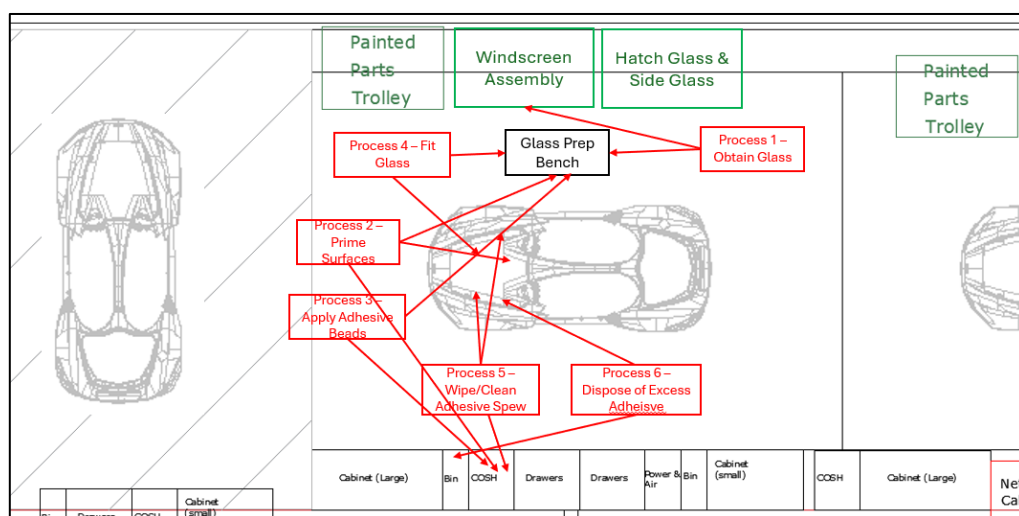
To rework defects related to excessive adhesive application, wipe down processes are required to ensure that any adhesive that could be visible to the customer is cleared away and disposed of correctly. However, a wipe down process can be considered to be excess processing and a non-value-added activity as optimum quality is expected by the customer. Overprocessing can be defined as activities that add unnecessary costs and time to production, without adding value. This is one of the main wastes that Toyota have tried to eliminate, as described by an online source, "This was one of the most prominent types of waste that Toyota eliminated when it created the Toyota Production System, slimming down the manufacturing process to include only the necessary steps – or the steps that directly produced value." (Lean Construction Institute (2024)). To wipe away adhesive and clean the surrounding areas of the cabin prior to bonding activities on the vehicle, process time and labour is wasted which ultimately has an associated cost.

ASTON MARTIN		Desc Rev# Status	PSS_AMRB007_107022 1 Un-Release, 19/7/2023	Released Matthew Dewhurst	ID 92511
Step:		Key point icon	Key point / why:		
Clean Excess Adhesive		 	Ensure any excess PU spew out is removed from around the Windscreen Assembly and tub aperture surface using an IPA wipe and wooden tongue compressor (Fig. 2).		
Safety Quality Critical Knock Environment Sequence					10

(Figure 2 – Adhesive wipe down process for Valkyrie Spider windscreen fitment– EASE, 2024.)

3.4 Motion

A subsequent factor of excess processing to clean away adhesive during bonding activities, is additional unnecessary motion of the technician to walk around the station to obtain equipment and dispose of waste. An online source explains the meaning of wasted motion, “Manufacturing motion waste can include repetitive movements that do not add value to the customer, reaching for materials, walking to get a tool or materials, and readjusting a component after it has been installed.” (Skhmot, N. (2017)). Motion is an example of another waste within the glazing processes of the Valkyrie Spider build, as unnecessary movement is carried out by the technician which does not add value. Unnecessary movement is being demonstrated in more than one instance during the bonding of the convertible roof section, as the technician wastes motion through the movement between the build and their workbench to obtain materials and resources. As well as this, the technician is wasting motion through the cleaning activities of the cabin prior to bonding activities.



(Figure 3 –2D Layout of process mapping for Valkyrie Spider glazing manufacturing processes – AutoCAD, 2024.)

4.0 Customer Analysis

4.1 Customer Perception

Customer value is defined as the worth of products and services to customers. It encompasses systems, processes and mindsets related to customer value, as manufacturers face increasing pressure to meet complex customer demands and expectations. By applying lean principles across a business, companies can enhance customer satisfaction and create improved customer value. Value is determined by the customer and relates to how much they are willing to pay for products and services. This information should then be utilised by the manufacturer to eliminate waste and costs to meet the optimal price that the customer is willing to pay.

From the customer's perspective, value is created through the guarantee of no defects from the glazing fitment processes. The customer expects perfection and no defects when purchasing a vehicle, especially a vehicle from a luxurious brand such as Aston Martin. The importance of lean manufacturing to create customer value is demonstrated by an online source, "Lean manufacturers set targets for perfection, with the idea of complete quality management. This type of management allows manufacturers to systematically remove the causes of poor performance from their processes and have a continuous improvement programme in place." (Davies, J. (2024)). Within the example of the Valkyrie Spider glazing processes, the customer value is also created through the quality of attributes. As the vehicle can reach extremely high speeds and may be used by the customer for track visits, it is of paramount importance that the glazing components offer absolute sealing from water ingress and minimal wind noise to ensure customer satisfaction.

Another value to consider that is perceived as a customer value is on-time delivery, as the customer expects to receive their order within a satisfactory time frame. Many manufacturers experience waste through inventory and production which can have a negative impact on the overall production time. Using the example of Valkyrie Spider production, waste is produced through insufficient quality leading to rework and waste of inventory. These factors ultimately lead to an increase in the production time of the vehicle and a subsequent delay in the delivery to the end customer.

5.0 Process Improvements

5.1 Defect Reduction

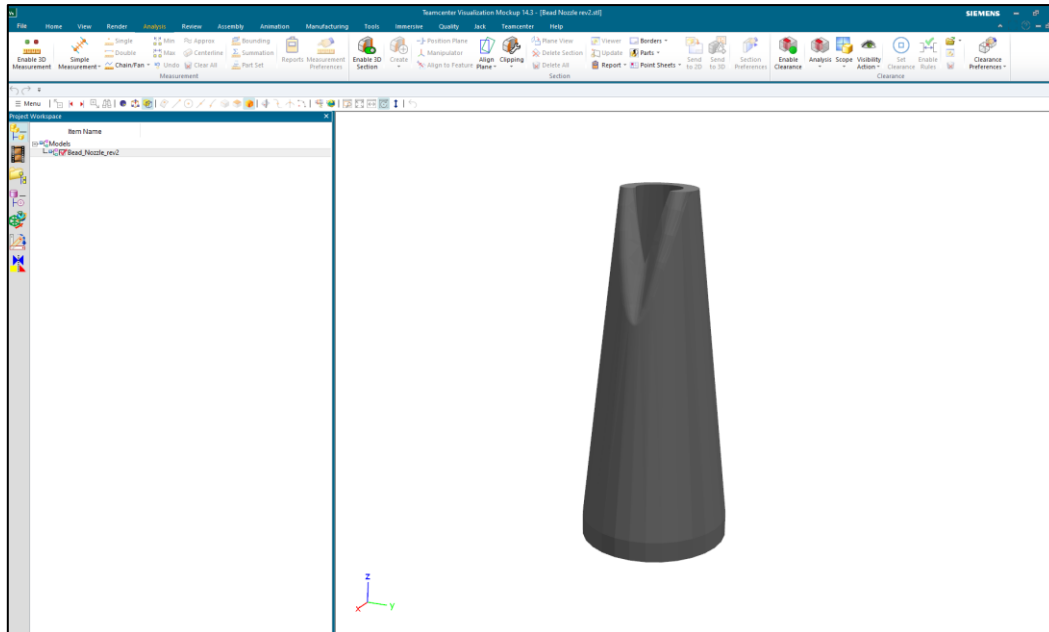
To improve the manufacturing processes of the Valkyrie Spider glazing, the wastes that have been identified must be reduced or eliminated to create a more efficient production line. One aspect of the glazing processes that could be improved is the application of adhesive to the glass panels such as the windscreen. The adhesive beads are applied to the windscreen by hand with an adhesive gun, meaning that there is a risk of the application being uncontrolled. An uncontrolled adhesive bead could be placed in the incorrect positions, this therefore leads to excessive adhesive 'spew' and visible defects to the customer. To overcome this, a visible line could be introduced into the design of each glass panel which gives the operator a guide to follow and achieve a nominal bead position. By ensuring that the position of the bead is correct, the risk of defect wastes such as visible adhesive 'spew' and 'soiling' of interior trim parts are reduced.

5.2 Inventory Reduction

Currently, the adhesive used for all Aston Martin vehicle glazing is purchased and supplied in batches to the production line. This results in large amounts of adhesive stock being stored lineside, which could be considered a waste. "Holding inventory ties up capital, and therefore costs money in addition to anytime materials, parts, assemblies or products are sitting not having value added overhead is being increased." (Worximity (2018)). To reduce this waste, a just in time delivery method could be introduced in which inventory is ordered and delivered to the production line as it is consumed. This will result in a reduction in inventory stock and associated wastes such as the cost and storage of batch orders.

5.3 Over Processing Reduction

To eliminate the requirement of a wipe down process, the amount of adhesive applied during glazing processes should be reduced. In order to achieve a reduction in the amount of adhesive applied, trials must be carried out to gradually reduce the adhesive bead size until there are no visible adhesive bleeds without compromising the vehicles sealing attribute. Therefore, the cut of the adhesive gun nozzle must be amended accordingly, and this can be accomplished repeatably and accurately with the use of a jig or fixture. A jig or otherwise known as a process aid, can be designed and manufactured efficiently utilising software and a 3D printer, creating a 'poka-yoke' process. Once a process aid has been implemented into production and the sealing has been tested effectively, the technician can efficiently and accurately create an adhesive bead that will provide minimal adhesive 'spew' and eliminate the requirement of a wipe down process in order to achieve optimal quality.



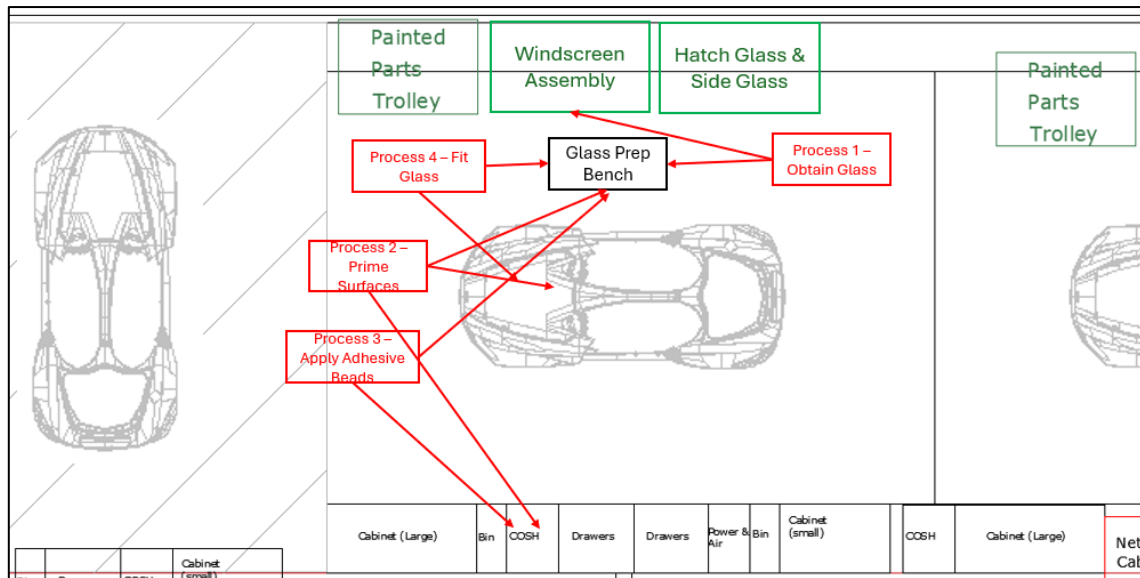
(Figure 4 – Process aid design for adhesive nozzle cutting – Siemens TeamCentre, 2024.)



(Figure 5 – Examples of adhesive nozzle cutting during process – Matthew Dewhurst, 2024.)

5.4 Motion Reduction

With the reduction of wipe down processes and rework requirements, motion waste identified during the manufacturing processes of the Valkyrie Spider glazing will also be reduced. This is due to the decrease in walking and non-value-added processes that the operator has to carry out during production. The wipe down activities and disposing of excess adhesive are considered wasted motion of the operator. By decreasing non-value-added processes such as these, the operator can focus on value-added activities such as fitment of parts with precision. This also leads into the waste of non-utilisation of talent, as the operator is wasting their skilled labour carrying out processes which are unnecessary and to not add value to the customer.



(Figure 6 –2D Layout of process mapping for Valkyrie Spider glazing manufacturing processes with reduction of motion waste – AutoCAD, 2024.)

6.0 Implementation

6.1 Implementation Costs

When introducing improvements to make manufacturing processes leaner, there are associated costs and problems that must be considered. An example of a problem that may occur is the testing and commissioning that is required when the adhesive application for bonding activities is changed. After changes have been made to the adhesive bead size, the first vehicle must be tested extensively to ensure that no water ingress is present and that the sealing of the roof section or windscreen has not been compromised. During this testing, there is a risk that problems could occur and result in leaks or damage to the cabin components. Another consideration that must be taken into account is the time that is required to carry out commissioning, as there is a labour cost for engineers to carry out these activities. Furthermore, these activities may interrupt production and possibly stall the sale of a customer vehicle to ensure that process improvements have been made effectively. As well as the time taken to carry out commissioning, there is a physical cost of the materials that are used such as the adhesive and the possibility of trial parts. This cost can be reduced through calculated actions, considering all factors such as the bead size and the amount of force applied during fitment to decrease the likelihood of failure and resultant re-trials.

In addition, a resultant cost of the process improvements is physical cost of the materials required to produce the process aid or jig. The equipment required to 3D print products can be costly as software and hardware must be purchased, as well as maintained on a regular basis. The cost of the equipment is difficult to reduce but the investment can be worthwhile, as it can be re-used for further process improvements that may be discovered to make other processes leaner. Once the jig has been implemented into the manufacturing process, there is problem of lack of training due to the operator's unfamiliarity with the equipment. This can be overcome through adequate training and instructions; to help the operator understand how to use the process aid effectively and efficiently.

7.0 Conclusion

7.1 Waste Reduction Analysis

Implementing process improvements such as a process aid or visible guide can significantly improve the efficiency of the Valkyrie Spider glazing processes. The introduction of process improvements such as this, helps reduce wastes such as defects, inventory, over processing and motion. This streamlines the manufacturing processes, resulting in a better-quality product and at a quicker rate. In addition, there is an increase in the productivity of technicians, ensuring that the vast amount of talent within the workforce is not wasted.

The importance of process waste reduction and introduction of lean manufacturing is demonstrated by many industrial manufacturing leaders and is highlighted by one source, “Lean manufacturing plays a critical role in reducing waste and increasing efficiency, enabling organizations to deliver maximum value to customers while minimizing resource consumption. By embracing lean principles, businesses can achieve significant cost savings, improve product quality, and enhance their overall competitiveness. Adopting lean manufacturing requires a long-term commitment to continuous improvement and a focus on delivering value at every stage of the production process.” (Persson, J. (2023)).

As highlighted, it is important that lean manufacturing is continued and invested in further to seek new opportunities to reduce waste and improve efficiency across the entire production process of Aston Martin vehicles. The company can benefit from further reductions in wastes and improved cost savings to boost profitability. Companies such as Aston Martin must seek cost saving opportunities where possible, to remain competitive within the luxury automotive sector. Furthermore, some improvements may require investment such as the process aid produced for the adhesive bead application, however the business can benefit from improvements such as this on a long-term basis.

8.0 References.

- Davies, J. (2024) Creating customer value with lean thinking, ERP Software for Manufacturing, Distribution, eCommerce and Retail. Available at: <https://www.winman.com/blog/creating-customer-value-with-lean-thinking> (Accessed: 30 June 2024).
- Elger, C. (2020) The 8 forms of Lean Waste, applied to business: Defects, Ideawake. Available at: <https://ideawake.com/8-forms-lean-waste-applied-business-defects/#:~:text=Defects%20refers%20to%20products%20or,adding%20value%20to%20the%20business.> (Accessed: 24 June 2024).
- Kooijman, S. (2023) Customer value according to lean, Lean Six Sigma Group. Available at: <https://leansixsigmagroup.co.uk/customer-value-and-lean/> (Accessed: 30 June 2024).
- Lean Construction Institute (2024) 8 wastes, 8 Wastes of Lean. Available at: <https://leanconstruction.org/lean-topics/8-wastes-of-lean/> (Accessed: 27 June 2024).
- Lean Manufacturing Tools (2013) Waste of inventory; causes, symptoms, examples, solutions, Lean Manufacturing Tools | Lean Manufacturing Tools, Techniques and Philosophy | Lean and Related Business Improvement Ideas. Available at: <https://leanmanufacturingtools.org/106/waste-of-inventory-causes-symptoms-examples-solutions/> (Accessed: 24 June 2024).
- Persson, J. (2023). The Role of Lean Manufacturing in Reducing Waste and Increasing Efficiency. [online] Medium. Available at: https://medium.com/@johanpersson_38486/the-role-of-lean-manufacturing-in-reducing-waste-and-increasing-efficiency-ebafbc7eedc.
- Skhmot, N. (2017) The 8 wastes of Lean, The Lean Way. Available at: <https://theleanway.net/The-8-Wastes-of-Lean> (Accessed: 27 June 2024).
- Worximity (2018) Types of Waste in Lean Manufacturing: Inventory Waste. [online] Available at: <https://www.worximity.com/blog/inventory-waste-in-lean-manufacturing#:~:text=Among%20the%20types%20of%20waste.>