Improving Lean Engagement Through Utilising Improved Communication, Recognition and Digitalisation During the COVID-19 Pandemic in JLR's Powertrain Machining Facility

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During the COVID-19 Pandemic, many companies around the world continued to implement and drive adherence to Lean principles. However, there are a number of key challenges each company would face when implementing Lean, one of those main challenges being workforce engagement. One way of measuring the engagement of Lean principles is by assessing adherence. In manufacturing organisations around the world, there are differing motivations, and these can be dependent on a number of aspects, such as culture and organisational structure. Therefore, it is imperative to understand employees' motivations in relation to the adherence to Lean principles. This 3-year study of Lean principles assesses the adherence in Jaguar Land Rover's (JLR) Powertrain Machining Facility. It also examines methods of instigating a new recognition process, developing an improved communication method, and creating digital solutions to training issues. The main achievement of the research is improving the adherence to the Lean principles, improving adherence to standardised working practices, and improving the utilisation of problem-solving and continuous improvement tools.

Keywords: *Lean; Manufacturing; Digitalisation; COVID; Automotive; OEM; Industry 4.0; People Recognition.*

1. INTRODUCTION

Lean Manufacturing's main focus is on the elimination of non-value-added activities, also often referred to as the 7 wastes [1,2]. Lean was previously thought of as a tool to reduce waste and improve production. However, it is not just a tool to reduce waste; it is an all-embracing business philosophy that considers the whole of the value chain rather than the production processes alone [3]. Japanese Manufacturers are often credited with the creation of Lean Manufacturing. For example, Taiichi Ohno, Shigeo Shingo, and Toyoda Kiichiro are three such Japanese Manufacturers who all contributed to the creation of the Toyota Production Systems (TPS) [4,5]. However, American Industrialist Henry Ford was once quoted in 1926, "One of the most noteworthy accomplishments in keeping the price of Ford products low is the gradual shortening of the production cycle. The longer an article is in the process of manufacture, and the more it is moved about, the greater is its ultimate cost" [6]. This quote from Henry Ford demonstrates that the theory of the reduction of waste within the manufacturing process was around prior to the development of the Toyota Production System. The idea of reducing or removing waste in the form of non-value-added activities is the fundamental principle of TPS. However, as already discussed in the previous literature, Lean is now considered an all-encompassing business philosophy, not just looking at manufacturing processes but considering the whole value chain [3]. In JLR, the production systems are predominately designed to support manufacturing processes, but they are also designed to be all-encompassing, supporting the whole value chain.

1.1 Workflow

The authors of this paper form part of the centralised Integrated Production System (IPS) team within Jaguar Land Rover (JLR) and the local IPS team at the Electric Propulsion Manufacturing Centre (EPMC), formerly known as the Engine Manufacturing Centre (EMC). The responsibility of the central IPS team is to create, distribute and provide training on the Lean principles to the localised IPS teams based on the various manufacturing facilities around the World. It is the responsibility of the Local IPS teams to then ensure this production system standard is implemented, understood, and adhered to by the operations teams [7].

This research is a continuation of previous research into "Improving Lean Manufacturing Systems and Tools Engagement Through the Utilisation of Industry 4.0, Improvement Communication and People Recognition Methodology in a UK Engine Manufacturing Centre" [7]. In the previous research article, the authors implemented the improvements in Module 4 Inline Six Cylinder Engine Assembly production area [7]. This

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paper will examine the implementation of the same theory but tailored to the CNC Machining side of the business. Within the Machining production areas, the organizational structure is different; it is substantially more automated than the assembly area, and there was also the additional challenge of implementing these improvements during the height of the COVID-19 pandemic.

The previous research project proved that imple–menting the suggested improvements can provide improved adherence and better engagement in the Lean principles. Moreover, research into other manufacturing industries has proven that transversing manufacturing technologies and methodologies can provide benefits to the organisation [8, 9].

In the previous research project, the authors outlined a 5 staged approach to improving Lean principle adhe–rence, engagement, and implementing Industry 4.0 digital solutions [7]. The reason for this is to reduce the risk of failure by trying to tackle too much across the whole EPMC, as each individual area(s) is very dif–ferent and diverse. There are plenty of documented instances in other companies where technological imp–lementations have failed [10-12]. Therefore, the authors have continued with the staged approach listed below.

- **Stage 1** – Gathering Lean data into one central location utilising digital technology and gathering together information from multiple sheets into one single location. This activity was initially carried out in module 4 engine assembly as a trial [7]. – **Completed**
- **Stage 2** – Take what was learned in the activity carried out in Stage 1 and implement it in the other engine assembly halls [7]. – **Completed**
- **Stage 3** – Taking what was learned in the activities carried out in stages 1 and 2 and implementing them into the machining halls. This, therefore, provides full exposure across the whole of the EPMC [7]. – **Current Research Stage**
- **Stage 4** – Gathering all of the Lean data from the assembly and machining halls into one central location utilising digital technology. This ensures that improved Lean principle adherence, engagement, and recognition are being implemented across the entirety of the EPMC [7]. **– Ongoing**
- **Stage 5** – This stage investigates a total digital solution, as well as gathering all of the Lean principle data into one central location. The data currently collected by Gemba (the place where things happen) walks from paper-based team boards would be collected from a digital solution automatically. Therefore, it provides real-time data on the Lean principles to people with access to a digital dashboard [7]. - **Future Project**

Stage 1 was successfully completed, and the adhe–rence measures improved [7]. The second stage, which implements the same improvements in the 4-cylinder petrol and diesel assembly halls, was also completed. This paper will focus predominately on Stage 3 whilst also examining digitalised training solutions to support the implementation of the Lean principle.

A description of the Lean principles (Integrated Production Systems) utilised in the Engine Manufa–cturing Centre are as follows:

- **Problem-Solving** – Initial problem-solving is car–ried out utilising Concern and Corrective Action Reporting (CCAR). This is followed by Level Zero, which is designed to identify the root cause. Finally, Practical Problem Solving (PPS) is a de–tailed problem-solving methodology used when CCAR and Level Zero have not identified the root cause. At the EPMC, this is the 3 staged approach to problem-solving [7, 19]
- **5S** – Seiri (organisation), Seiton (neatness), Seiso (cleanliness), Seiketsu (standardisation), and Shit–suke (discipline) [13, 14]. In JLR’s EPMC, this process is referred to as Sort, Set, Shine, Standar–dise, and Sustain and supports standardise working.
- **Standardised Work (SW)** and **Standard Work Confirmation (SWC)** – At JLR EPMC, a stan–dardised working approach is used and audited uti–lising the Standard Work Confirmation process. Standardised work forces waste in the work methods to be identified and eliminated [7, 15, 19].
- **Versatility Matrix (VM)** – The Versatility Matrix is a visual management tool that quantifies the capabilities and skill sets of employees at the EPMC [7, 16].
- **Kaizen** – Is a Japanese term pertaining to "continuous improvement" or “change for the bet–ter” and is a hypothesis for a management phi–losophy based on a set of values and principles [17-19]: top management commitment and leadership, focus on process; Gemba improvement manage–ment; non-blaming and non-judgmental metho–dology; people’s participation; standardisation; constancy; discipline; investigation; examination skills; and systemic reflection [19]. At JLR's EPMC, Kaizen is established and utilised throug–hout the workforce. There is a monthly recognition event for the best kaizens implemented in the previous month [7, 16, 19].
- **Process Confirmation** – This is an established coaching methodology on a peer-to-peer basis. It is designed to highlight the significance of the various production systems utilised at the EPMC [7, 16, 19].
- **Team Improvement Circles (TIC)** – TIC is a time-bound team activity. It involves following a 10-step problem-solving methodology [7, 19].

Figure 1 demonstrates how the Integrated Produc–tion Systems tie together in JLR’s EPMC. The overall goal is to have a repeatable, standardised process. Utili–sing a standardised approach allows organisations to identify and reduce waste [20, 21]. At the EPMC, Work Element Sheets (WES) and Quality Process Sheets (QPS) are the key processes followed by the operatives to ensure standardised work is achieved [7]. All of the other processes are designed to support this. For example, 5S is designed to allow anomalies to be easily identified. The versatility matrix and visual factory also support standardisation. Standard Work Confirmation (SWC) audits allow Team Leaders and Process Leaders to identify anomalies and then, if necessary, utilise the problem-solving tool(s) to bring standard work back to the baseline condition. If standard work is stable and at a consistent baseline condition, then again, SWC can also identify improvement, and the Kaizen process can be used to set a new baseline condition.

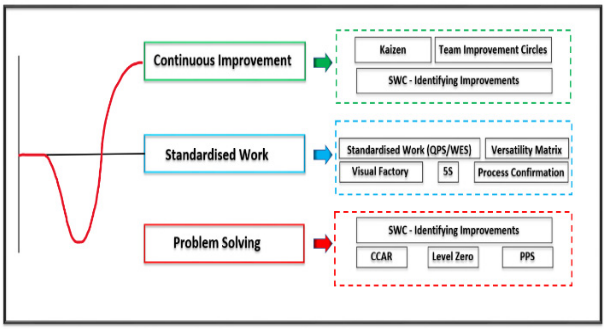

Figure 1. Illustrates the Lean principles utilised at the EPMC and how they fit around standardised work.

1.2 Pandemic - COVID-19

The Coronavirus, also known as COVID-19, was dec–lared a pandemic by the World Health Organisation on March 12th, 2020 [22]. As of January 20th, 2022, it has been estimated to have killed 5.5 million people worldwide [23].

It has also had a huge effect on the automotive manufacturing industry. In particular, car sales in the UK experienced their worst month since 1946 in April 2020 as sales fell by 97% [24]. Organisations have had to start looking at innovative ways to deal with the pandemic [7].

One study undertaken suggests that, within manu–facturing, the coronavirus outbreak has prompted rese–arch into Industry 4.0, applications, and tools. The aut–hors agree that utilising digitalisation, implementing an improved recognition process, and enhancing commu–nication have proven pre-pandemic to improve the adherence and engagement in Lean principles, and it is now, more so than ever, important in ensuring the continued success of the organisation [25].

1.3 Lean Manufacturing Culture

Previous research has identified relatively low success in the application of Lean principles. There was a thesis that examined the utilisation of Lean principles in foun–dries within the United Kingdom which was published in 2015. This research found that 46.15% of the res–pondents stated that they were not utilising Lean to their full potential. In the same research, 69.23% of res–pondents stated that they strongly agree or agree that the implementation of Lean is difficult [10]. Organisational culture is one of the biggest challenges to successfully implementing Lean adherence and, therefore, its subsequent impact on operational performance [10]. Other research undertaken has highlighted the impor–tance of organisational culture for the success of Quality Management Systems and the achievement of the organisation's desired results [21]. Research has also identified that within organisations culture is essential in the role of change management and the challenges related to culture change [27]. Further analysis carried out in 2019 demonstrated that 295 manufacturers within the United Kingdom identified that cultural dimensions were revealed to arbitrate the effect of Lean management on operations performance [28]. In the same study, it was identified that Lean Principles are associated positively with an organisation's culture if that culture is employee orientated, socially loose, structurally open, focused on procedure, rule-driven, and market-orientated [26].

1.4 Motivation, Engagement, and Recognition

Previous research papers have demonstrated the positive use of reward strategies in organisations designed to improve their performance [29].

There is one popular theory on motivation known as Maslow's Need Theory. This theory argues that human beings strive to satisfy the following needs: physi–ological needs, safety needs, social or belonging needs, self-esteem needs, and self-actualisation needs [30-32]. One study examined employees in three European cou–ntries, namely the United Kingdom, France, and Germany. The study identified that employees in Ger–many were more productive with regard to reinforce–ment fixing than their European colleagues in the United Kingdom and France [33]. It was identified that the employees in the German construction industry were paid a salary similar to employees working within scientific or intellectual roles and that they were held in high regard [33].

1.5 Communication and Lean

Previous research has shown a correlation between communication and Lean [34]. The authors of this study investigated organisations that have successfully imp–lemented Lean principles, embedding them into the culture of the organisation. Table 1 lists a high-level description of the management communication practices found in one study [33].

Table 1. Communication Practices [7, 34]

Original Procedure (Observed)	Opposite Procedure (Derived)	High-Level Explanation:
Blending	**Separation**	**Blending** – Manager's communication relates to the worker's situation. Team-based words used when communicating, such as "we" **Separation** – Manager's communication is directive: "you" or "your team," for example
Engagement Positive	**Engagement Negative**	**EngagementPositive**– Manager's communication injects energy and is positive. **Negative Engagement** – The communication utilised by the manager is not rough or abusive. However, it damps down energy by only identifying failure.

Words - Soft	**Words - Hard**	**Words –Soft** Communication by the Manager is always constructive and emotionally positive in execution. **Words – Hard** Communication by the manager is the opposite, i.e., emotionally negative and demonstrates disinhibited behaviour when connecting with colleagues.

The study demonstrated that using communication like soft words, blending, and positive engagement when communicating Lean assisted in the successful embedding of Lean in the organisation. The research was carried out successfully in a Scania facility and 3 individual Toyota facilities. The embedding of Lean failed in facilities at Subaru, GM, Suzuki, and Mazda, where the approach was opposite to the methods utilised at Scania and Toyota [7, 34].

1.6 Industry 4.0

The term Industry 4.0 is used to describe the 4th Indus–trial Revolution. In the late 1700s and early 1800s, water and steam-powered machines were utilised in in–dustry, and this is now known as the 1st Industrial Re–volution. Then, in the late 1800s to early 1900s, the focus was the utilisation of steel and electricity in the industry; this is often referred to as the 2nd Industrial Revolution. Simultaneously, during this time period, the concept of mass production and the moving assembly line were introduced [35-36]. In the 1950s, many manufacturers began to utilise electronic technology; this is often now referred to as the third industrial revolution and is also often referred to as the digital revolution [35-36]. Since around 2011, there has been a focus on Big Data, the Internet of Things (IoT), Augmented Reality, Simulation, Additive Manufac–turing, Cloud Computing, Cybersecurity, Autonomous Robots, and Horizontal and Vertical Systems Integ–ration [35, 37]. These are known as the nine pillars of the 4th Industrial Revolution. The term Industry 4.0 has been utilised as a buzzword in an attempt to describe digitalisation in multiple phases of the value chain within an organisation [38]. Since 2021, there have been discussions of Industry 5.0, which is a more human-centric approach to Industry 4.0, in part due to challenges caused during the COVID-19 pandemic.

This study transverses a number of the industry 4.0 pillars, so that reads pilars namely Big Data, Systems Integration, and Cloud Computing. Through the utilisation of effective communication by using multiple integrated systems and cloud computing, all of the key decision makers can be kept informed on the Lean principles data. A study carried out by the World Economic Forum confirms this, stating that the overall quality of decision-making and collaboration was improved when real-time data was provided to key decision-makers within the business [40].

Moreover, research published in 2021 on Industry 4.0 implementations identified that technology is fun–damental in an organisation's digital transformation journey. However, effective human interactions are also essential in the implementation of Industry 4.0. Orga–nisations should consider the human aspects to support the management and business in order to accomplish successful competitiveness [41].

2. METHODOLOGY

In section 1.1. workflow discussed the various stages of this research. This research examines Stage 3, which is to take what was learned in the Assembly areas of the EPMC and implement it in the CNC machining halls. By doing this, both assembly and machining halls will have implemented the improved Lean principles theory of improved communication and recognition aided by Industry 4.0 solutions. This is a new challenge due to the increased automation, organisational differences, and challenges associated with COVID-19. Figure 2 below shows how the systems and tools fit together.

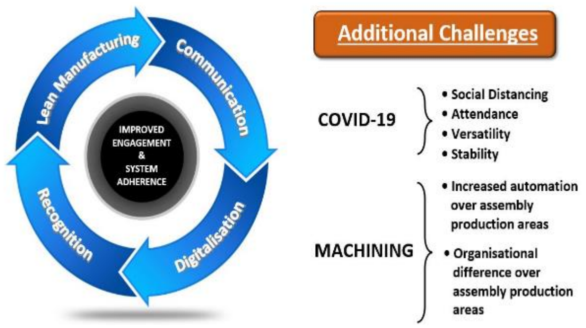

Figure 2. Lean Principles Adherence Process.

This research looks to continue building on the previous research carried out in the assembly production areas within JLR's EPMC, uniting people's engagement with Industry 4.0 principles, centered on motivation, with the goal to improve Lean principle adherence in the CNC Machining areas within the EPMC.

Within this research, a digital Microsoft® Share–Point® page was generated that permitted the 9 mac–hining areas to access and view their performances against the Lean principles. Additionally, the authors created 8x digital training assessments on the Lean Manufacturing systems and tools, which are designed to provide awareness without the need for classroom-based training, which is important during the current pan–demic. The areas within machining are listed below:

Module 1:

- 4 Cylinder Block Machining (Petrol and Diesel)
- 4 Cylinder Head Machining (Petrol and Diesel)
- 4 Cylinder Crank Machining (Petrol and Diesel)
- V8 Cylinder Head Machining (Petrol)
- Parts Measurement Room and Tool Crib

Module 4:

- 6 Cylinder Block Machining (Petrol and Diesel)
- 6 Cylinder Head Machining (Petrol and Diesel)
- 6 Cylinder Crank Machining (Petrol and Diesel)
- Parts Measurement Room and Tool Crib

The SharePoint® site, in this instance, was mainly utilised by the IPS team rather than in the previous paper, where the site was mainly utilised by the Operations team [7]. This was due to the change in the LAM process and because, as part of Stage 4, the IPS teams across the plant were utilising the site to record all of the Lean data in one location.

Every Monday, the Lean data from across the whole of the EPMC is collected and inputted into the SharePoint® site manually by the IPS team. The information then provides the IPS team with the Operations team's performance in terms of Lean adherence to the systems and tools.

2.1 Original Lean Adherence Process

Below is a list that describes the key steps in the Lean principles adherence process at the EPMC.

1. Collect the Lean adherence data from all the technology lines within Module 1 & Module 4 Machining.
2. Update the data in the Information Centres for Head, Block, and Crank in Modules 1 and 4. (Filling in trend analysis charts).
3. The data collected and populated was SWC adherence and actions raised, Kaizens raised and closed, and Process Confirmation adherence.
4. The data would then be analysed and reviewed in a weekly managerial review, which takes place in the area's information centre.

Apart from the Kaizen data, which is kept on a Microsoft Access database, there was no electronic method of tracking, monitoring, and reviewing the Lean data. The data was inputted on a trend analysis chart inside the information centres and archived annually.

There were disadvantages to the Lean principles adherence process. Initially, communication of Lean adherence amongst the Team Leaders, Process Leaders, and Managers, and between the machining lines, was poor. Unless a team member visited an information centre to specifically look at the data, the teams did not know who was utilising the Lean principles or not. They also did not know how each line compared against the others. Secondly, there was a lack of Lean engagement. The tools were being utilised but were not being utilised efficiently, and they were being utilised in a silo when the Lean principles should be utilised together. This raised a number of concerns:

- The data can not be seen by the Team Leaders, so they are unaware of how they are performing on a week-by-week basis.
- There is no visibility of the Lean data against other machining lines or even assembly to see how they are performing versus the whole of the EPMC.
- There is no accountability if the adherence is poor.
- There was no recognition of the Lean principles were being utilised.
- Positive engagement communication strategies were not utilised by the management. The lines were not recognised as the best Lean principle adherence.
- Lean principles classroom-based training was removed due to challenges around reducing the spread of the COVID-19 virus.

The authors, therefore, decided to implement improvements that were learned from Module 4, Six Cylinder Engine Assembly Area. This included implementing improved communication, a recognition process, a digital SharePoint® site, and digitalised training solutions [7].

The authors developed and implemented a new IPS SharePoint® site, which contained training materials and assessments [7]. Links to documentation stored on the company's DMS (Document Management System) and, most importantly, a multi-user digital database, which could be used to input the Lean principle adherence data from both Machining and Assembly simultaneously.

The authors then wanted to replicate the Module 4 Six Cylinder Engine Assembly areas recognition process. This was identifying the Team Leader in the Hall with the best Lean principle adherence for that week and month. However, in machining, it was quickly identified that this process would not work due to the organisational structure. The authors, therefore, adapted the process and called it Process Team of the Week / Month. This recognised one of the nine Operations teams weekly and monthly for the best Lean principle adherence.

After utilising the improved process for three weeks, technological improvements to the communication process were identified. One key method was to take all of the current digital information and relocate it to one centralised location. This would, in turn, promote transparency by allowing everyone who needs the information to access it quickly and easily, improving communication and the motivation to adhere to the Lean principles.

2.2 Improved Lean PrincipleAdherence Process

Below is a list that describes the key steps in the new Lean Adherence Process at the EPMC.

1. The Lean principle adherence data for 5S/ SWC /SWC Actions /CCAR's / Kaizen is raised and closed, and Process Confirmation is undertaken each Monday. It is collected by the IPS coaches based in the machining halls and then added to a cloud-based spreadsheet. By adding the data to the cloud-based spreadsheet, the data becomes transparent to the whole machining and assembly operations teams. It is also visible to the IPS Manager and the IPS teams throughout the EPMC.
2. Lean principle adherence scores would then be available on SharePoint®. The scores would also be embedded into an email and sent out to all relevant parties, e.g., IPS, Quality, and Operations, for ease of access. Additionally, on the SharePoint® site are the embedded digital Lean training assessments. These are available for all employees within machining to access and complete.
3. The machining operations team with the greatest Lean principle adherence would be identified as the Process Team of the Week.
4. On a monthly basis, the machining operations team with the greatest Lean principle adherence for the month would receive formal recognition in the form of a certificate presented by the IPS Manager, Mac–

hining Senior Manager, and Technology Manager in recognition for acknowledgment of the greatest Lean principle adherence in that particular month.
5. On a monthly basis, communication via email would then be populated and communicated to all the machining operations teams, showing the Lean principle adherence on a rolling 6-monthly basis, additionally communicating the Process Team of the Month winners.

This new process provided a number of advantages, the main one being that all of the Lean data is gathered together and available in one location along with useful links and the Lean digital training.

Another advantage over the old process is that the Lean data is stored on a SharePoint® site, so it is available 24/7. This means employees in different functions and on different shifts are able to access the Lean data at any time of day or night. It also means that the different shifts can be compared with one another, and best practices can be identified and shared. It is easy for anyone to see how the machining halls are performing with regard to the Lean data and which team had the best Lean adherence. Additionally, it is also important because the machining and assembly IPS teams can see how every area is performing and develop strategies to improve the Lean adherence if necessary.

The Operations team with the best Lean data adherence on a weekly and monthly basis gets recognised by the IPS and Operation Management teams. This, therefore, improves the motivation of the team and the competitiveness among the teams competing for the title on a weekly and monthly basis. The monthly certificate would be given out by the Senior Operations Manager in assembly and machining. The teams receiving the recognition would not necessarily have regular correspondence with the Senior Manager. Having the opportunity to have this public meeting with the team to recognise them reinforced the importance of Lean data adherence and again drove the competitiveness with the teams keen to prove to the Senior Manager that they had the best Lean adherence.

Overall, as in other organisations, this new process was designed to combine Lean data adherence and new technology applications together [8]. In the EPMC, the IPS team examined various new technologies available at JLR and combined them with the IPS systems and tools in an Industry 4.0 approach by utilising the linked Lean adherence spreadsheet and additionally linking documents for the DMS and the digital Lean asses–sments all in one location on the SharePoint® site.

3. RESULTS

The data was collected for SWC, SWC Actions, CCARs, 5S Adherence, and Process Confirmation by the IPS coaches every Monday. The coaches would walk the machine halls in 4 and 6-cylinder machining and check the data handwritten by the operator on the relevant IPS template sheets. For example, the IPS coach would check the CCAR Template to see how many CCARs were raised and closed in the last week and log the data. Kaizens are logged electronically, so they can be accessed by the IPS coaches from a JLR laptop. The data was recorded in a Lean Adherence Excel tracker, which allowed the IPS team to track all lean adherence data from 2019 to 2021, providing the data in the following graphs.

After implementing the new process at the beginning of June 2020, the following results were achieved.

3.1 Standard Work Confirmation and Actions

Below is a graph that shows the SWC adherence in the machining halls between 2019 and 2021.

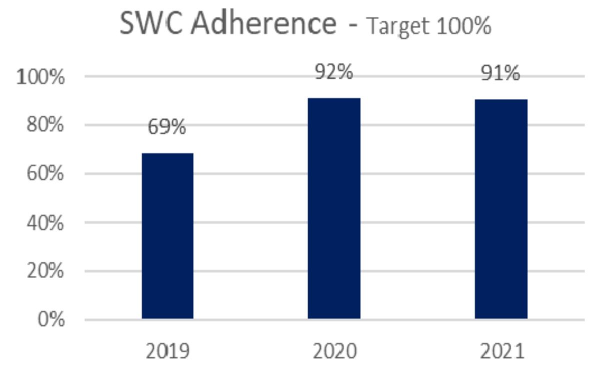

Figure. 3. Standard Work Confirmation Adherence (2019-20)

SWCs are carried out daily on each shift. Figure 3 shows the average adherence rates in 2019, 2020, and 2021. Prior to the introduction of the process improve–ments in 2019, the average adherence for the year was 69%. In June 2020, after returning from the UK lockdown, the process improvements were imple–mented. This gave an SWC adherence of 92% in 2020 and 91% in 2021, which is a significant improvement over the 2019 result.

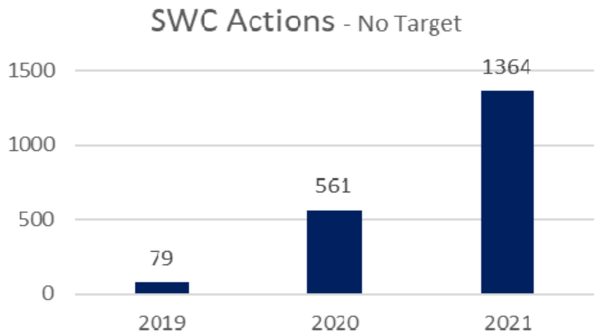

Figure. 4. Standard Work Confirmation Actions Raised (2019-21)

Figure 4 shows the number of SWC actions raised. In 2019, 79 actions were found from the SWC's carried out. After implementing the new processes, improving communication, recognition, and utilising the digitalised Lean training, this improved to 561 actions raised in 2020 and 1364 actions raised in 2021.

3.2 Concern and Corrective Actions Report

Figure 5 shows the number of CCAR raised and closed in the machining halls between 2020 and 2021.

Figure 5. shows the improvement in the number of CCARs being raised and closed. In 2019, the CCARs were not tracked. When the new process was

implemented from June 2020 to December 2020, 647 CCARs were raised, and 439 were closed. However, in 2021, this rose significantly as the new process became embedded. In 2021, 2995 CCAR actions were raised, and 2496 were closed.

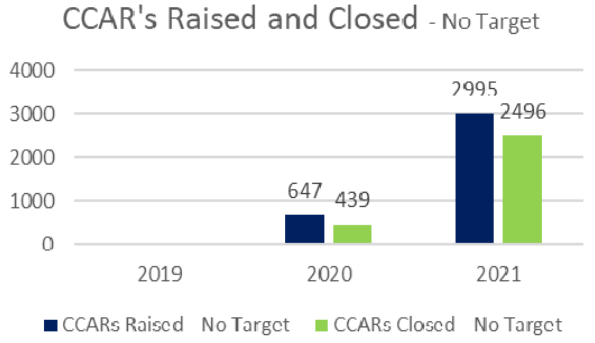

Figure 5. CCAR's Raised and Closed (2019-21)

3.3 5S Adherence

Figure 6 shows the adherence to the 5S process in the machining halls between 2020 to 2021

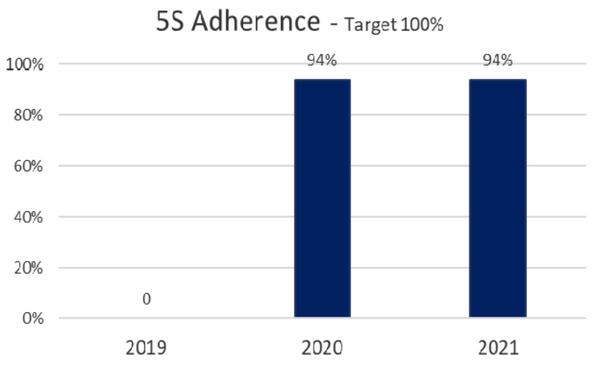

Figure 6. 5S Adherence (2019-21)

Within the two machining halls, there are 48 Tob–lerone's positioned throughout all the machining lines. These Toblerone's contain the IPS template sheets, which are used to track information, and in this par–ticular instance, 5S, utilising the 5S audit sheets, which are filled out daily by each shift. In 2019, the IPS team was tracking the 5S audit scores. However, the scores were also being tracked by operations. The IPS team identified, whilst gathering the scores over a number of weeks that the adherence to 5S was poor. In June 2020, the metric was changed from score to adherence and added to the regular communications and recognition process. Figure 6 demonstrates that implementing the improvements provided an adherence score of 94% in 2020, and this was maintained throughout 2021.

3.4 Process Confirmation Adherence

Figure 7. Shows the Adherence to Process Confirmation between 2019 and 2021.

In 2019, the overall adherence was 60% across both CNC Machining halls. Measured by checking the sign-off sheet adherence signed by the operators, evidencing that they had completed Process Confirmation. In June 2020, the new, improved processes were implemented, and this drove overall adherence to 86%. As the process became embedded in 2021, this rose further to 94% adherence to Process Confirmation.

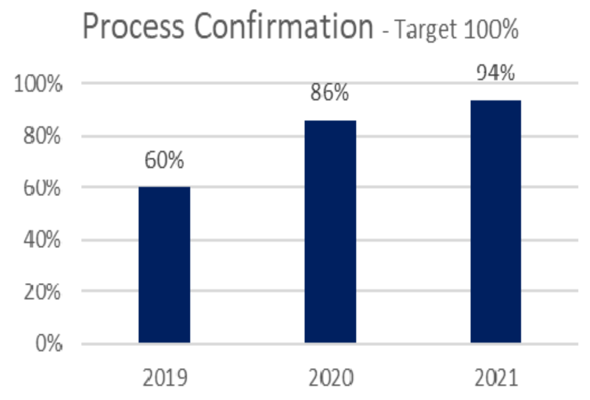

Figure 7. Process Confirmation Adherence (2019-21)

3.5 Kaizens Raised and Closed

Figure 8. shows the Kaizens raised and closed in Mac–hining from 2019 to 2021.

In 2020, due to the lockdown and other challenges associated with resources due to the pandemic, the number of Kaizens raised was down from 2019. However, one aspect the IPS team concentrated on and pushed with operations was the closure of Kaizens. In 2019, there were 500 Kaizens open going into 2020. However, in 2020 and 2021, more Kaizens Improvements were implemented than in 2019. Additionally, in 2021, in the assembly areas, the number of Kaizens raised and closed was down 40% on the 2019 numbers. In machining, due to driving the new processes, the number of Kaizens was down 13.69%, but Kaizens closed were up by 29.09% versus 2019.

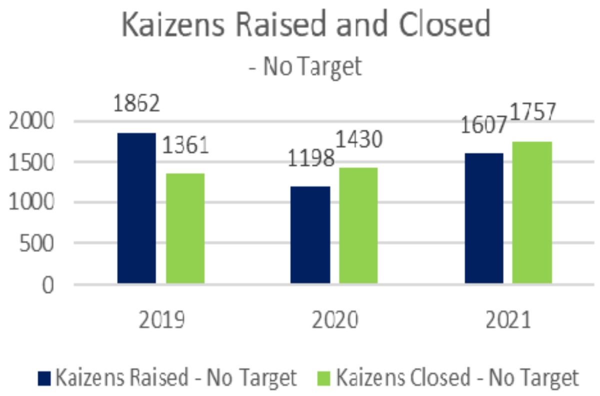

Figure 8. Kaizen's Raised and Closed (2019-21)

4. DISCUSSION

The results shown in Table 2 have demonstrated that improving communication using positive engagement soft words, blending in communications, and directing communications to the management team and indivi–duals of authority has had a positive influence on the Lean principle adherence. This is when it is combined with a recognition process and utilising digitalised solutions such as logging all the data centrally and making it widely available on a SharePoint® site rather than utilising purely paper-based processes. Digitalised Lean training has also been beneficial, especially during the pandemic when classroom-based training was temporarily halted. It has allowed more people to access the Lean training quickly and more easily from any location in the plant or even from home.

Standard Work Confirmation is one of the most important Lean tools at JLR's Electric Propulsion Ma–nufacturing Centre. It allows teams within the EPMC to audit the individual operations within machining and assembly. It ensures that the standardised processes are being followed and, when used correctly, allows ano–malies and improvements to be identified. In 2019, pre-process improvement adherence to SWC was only 69% for the year and only 79 SWC actions were identified. After implementing the improved processes and driving people to complete the digitalised SWC training, this improved to 91% adherence with 1,364 actions iden–tified in 2021. This equates to a 22% increase in adhe–rence and a 1626% improvement in the SWC actions being raised. This means there were more anomalies and improvements being identified and logged, which inevitably promotes a problem-solving and continuous improvement culture.

Table 2. Overall Improvement in the Lean Principles Adherence

IPS System	2019	2020	2021	Percentage Difference / Improvement 2019 (Original Process) Versus 2021 (Embedded Process)
SWC Adherence - Target 100%	69%	92%	91%	22.00%
SWC Actions - No Target	79	561	1364	1626.58%
Process Confirmation - Target 100%	60%	86%	94%	34.00%
CCAR's Raised - No Target	0	647	2995	362.91% (2020 vs 2021)
CCAR's Closed - No Target	0	439	2496	468.56% (2020 vs 2021)
5S Adherence - Target 100%	0	94%	94%	Unknown
Kaizens Raised - No Target	1862	1198	1607	13.69%
Kaizens Closed - No Target	1361	1430	1757	29.10%
Digital Training (Attempts)	**2019**	**2020**	**2021**	**Total Digital Training (Attempts)**
Standard Work Confirmation	0	602	249	851
Process Confirmation	0	515	198	713
CCAR	0	615	300	915
5S	501	440	397	1338
Kaizens	0	339	233	572

CCAR's opened and closed were not tracked in 2019. This meant that the IPS team did not have an awareness of how well the Lean tool was being utilised or if the issues raised were being closed. It was, therefore, important to track CCAR's for this reason and again link it in with the recognition process and develop the digital training. The IPS team started tracking the CCAR's in June 2020, and by the end of 2020, 647 CCAR's had been raised, and 439 had been closed. By the end of 2021, 2995 CCAR's had been raised, a 363% improvement in 2020, and 2496 had been closed, a 469% improvement in 2020. The increase in actions demonstrates that across machining, the teams were utilising the CCAR problem-solving tool to track issues and escalate to management when they were having difficulty closing them out. Going forward, the team will concentrate on the closure of CCAR's by the end of 2021. There were 499 CCARs that had not been closed versus the 2995 that had been opened. This is something that the IPS team concentrated on with Kaizens open vs closed. There was a 13.69% decrease in the number of Kaizens raised in 2021 versus 2019, but overall, in the plant, the number of Kaizens raised and closed was down 40% over the same time period. This was due to a number of factors, mainly that the organisation has had to be flexible with labor during the pandemic. This has an effect on stability, and in order to improve, there needs to be a stable baseline. There was, however, a 29.10% improvement in the number of Kaizens closed in machining in 2021 versus 2019. This is significant because it's good to identify the improvements and raise the Kaizen, but it's equally if not more important to complete the Kaizens and realise the improvements. The 5S score was previously captured, but it was also captured by the Operations team. Whilst collecting the score, the IPS team realised the adherence to 5S was not high, so instead of capturing the score, the metric was changed to 5S adherence. From June 2020 to December 2021, the adherence remained at 94%. Finally, by implementing the improved process, there was a significant improvement in Process Confirmation adherence. In 2019, the adherence to the process was 60%. This improved to 86% in 2020, and when the new process was embedded, it improved to 94% in 2021.

Table 3 shows the original process with regard to Digitalisation, Communication, and Recognition versus the improved process, which shows a digital approach rather than being solely paper-based. It shows different methods of weekly and monthly communication from Machining Managers as well as IPS, who send out the weekly and monthly communications. It also shows a recognition process, which was not in place previously. All of which have contributed to the improvements to the IPS metrics.

The utilisation of the SharePoint® site and bringing together the Lean principles data into a central location has improved the availability to the key tools, systems and data, additionally it has improved the communication channels among the operation team, IPS team, and the quality team. Overall, Communication was improved through utilising the SharePoint® site, as well as utilising soft words, blending, and positive engagement during email and face-to-face communications [34].

Communication was also improved by ensuring that the Process Leaders and Team Leaders were included in all Lean principle data communications. Table 2 displays the numerous attempts at digital training, which can be reviewed at any time, providing a quick and easy refresher to the Lean principles. There was no recognition process previously implemented within machining. The recognition process proved very popular and very effective in engaging the teams to adhere to the Lean principles. It created a healthy competitive environment for the teams to compete for the best Lean principle adherence. Benefitting the company and highlighting the hard work of the individuals in the teams in adhering to the Lean systems and tools.

Table 3. Original Process vs Improved Process

	Original Process	Improved Process
Digitalisation	1. Paper-based data-gathering process	1. SharePoint site created.
		2. Embedded Excel sheet to gather all lean data, easy access to data 24/7 in one digital location
		3. Digitalised lean training and assessments
		4. Useful links to the document management system added to SharePoint
Communication	1. Communicate weekly with Team Leaders when gathering data	1. Weekly adherence email sent to all in Operations, IPS, and Quality detailing lean performance
		2. Monthly adherence email sent to all in Operations, IPS, and Quality detailing lean performance
		3. Machining Managers responding to the lean performance emails (Positive Engagement)
		4. Communication wrote with positive engagement, soft words, and blending
		5. Process Team of the Month - Physical presentation by the Operations team and an opportunity to use positive engagement and blending approach
Recognition	1. No Lean Principles Recognition Process	1. Process Team of the Week - Process team with the best lean adherence in machining - Email
		2. Process Team of the Month - Process team with the best lean adherence in machining - Certificate
		3. Lean Adherence of the Year - Process team with the best lean adherence in machining - Trophy

Combining and utilising Improved communication and Recognition has been proven to improve adherence to the Lean principles. Used individually, there would have been an improvement, but not to the same extent of them being cross-utilised together. The big challenge in the future is in the sustainability of the improvements and investigating new ways of improving the quality of the event. This will ensure everyone in operations has great Lean principle adherence, raising good quality Kaizens, CCAR's raised and effectively closed and generally improve overall adherence.

5. CONCLUSION

This 3-year research study has shown an improvement in Lean practice adherence in Machining within JLRs EPMC. This was achieved by improving communication channels and language by utilising positive engagement, soft words, blending, and utilising digitalised solutions such as SharePoint® and digital Lean training.

Original Process Metrics vs New Embedded Process Metrics:

Problem Solving:

- 362.91% CCARs Raised improvement
- 468.56% CCARs Closed improvement

Kaizens - Continuous Improvements (CI):

- 13.69% Kaizens Raised decline
- 29.10% Kaizens Closed improvement

Problem Solving / Continuous Improvement:

- 22.00% Standard Work Confirmations improvement
- 1626.58% SWC Actions improvement

Standardised Working Improvements:

- 34.00% Process Confirmation improvement
- Tracked 5S Adherence 94% since improvement

Digital Lean Training:

- This allowed for more training to be carried out and reduced peer-to-peer contact in classroom-based training.
- Training 1378 completed attempts on the 5x Lean principles in 2021 versus around 600 people trained in the classroom against 8x Lean principles in 2019.

The Lean principles adherence has significantly improved, but there are some non-tangible benefits also. This process has improved employee engagement with Lean and with the IPS team. One of the most important aspects of manufacturing, in general, is standardisation and ensuring the products are manufactured to the same high-quality standard each time. This is why the Standard Work Confirmation is such an important tool. It allows the Operations team to identify any anomalies or improvements to the baseline condition. This study has shown that implementing these improvements can contribute to a significant improvement in SWC adhe–rence and the number of actions being raised. SWC's not closed out in the same shift are raised to CCAR. This has also been a contributing factor to the increase in the number of CCARs raised. Likewise, some SWC actions may become Kaizens, and even though there was a reduction in the number of Kaizens raised during the pandemic across the plant, there was less of an effect in machining in part due to the SWC actions. This demon–strates how the systems and tools work together to identify and resolve problems and identify improvements.

These process improvements are part of an ongoing evolution. The more data the team has, the more po–tential there is to improve. As mentioned, the disparity between the CCAR's raised and closed in 2021 is an aspect that the IPS team will examine in 2022. Identifying new ways of driving the closure of CCAR's and understanding what the potential challenges to CCAR closures are, developing new processes to add–ress this similar to the challenges associated with Kaizen closures previously.

In the longer term, the IPS team will continue to examine Industry 4.0 solutions. Is there a method to reduce the footfall on the shop floor with regards to gathering the data? Are there digitalised solutions to gathering the Lean data, what is the cost-benefit, and what effect may this have on IPS engagement with the Operations team?

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ПОБОЉШАЊЕ ЛЕАН АНГАЖМАНА КРОЗ КОРИШЋЕЊЕ ПОБОЉШАНЕ КОМУНИКАЦИЈЕ, ПРЕПОЗНАВАЊА И ДИГИТАЛИЗАЦИЈЕ ТОКОМ ПАНДЕМИЈЕ КОВИД-19 У ПОСТРОЈЕЊУ ЗА МАШИНСКУ ОБРАДУ ПОГОНСКИХ СКЛОПОВА ЈЛР

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Током пандемије КОВИД-19, многе компаније широм света наставиле су да примењују и подстичу придржавање Леан принципа. Међутим, постоји низ кључних изазова са којима би се свака компанија суочила приликом имплементације Леан принципа, а један од тих главних изазова је ангажовање радне снаге. Један од начина за мерење ангажовања Леан принципа је процена придржавања. У производним организацијама широм света постоје различите мотивације, које могу зависити од бројних аспеката, као што су култура и организациона структура. Стога је императив разумети мотивацију запослених у односу на придржавање Леан принципа. Ова трогодишња студија принципа Леан процењује придржавање Јагуар Ланд Ровер (ЈЛР) погона за машинску обраду. Такође испитује методе за подстицање новог процеса признавања, развој побољшане методе комуникације и креирање дигиталних решења за питања обуке. Главно достигнуће истраживања је побољшање придржавања Леан принципа, побољшање придржавања стандардизованих радних пракси и побољшање коришћења алата за решавање проблема и континуирано побољшање.