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# INVESTIGATING COMPLEXITIES TO BE RESOLVED FOR SEAMLESS INTEGRATION OF INTELLIGENT ROBOTIC PROCESS AUTOMATION IN PARTIALLY AUTOMATED SHOP FLOOR ENVIRONMENT OF INDIAN AUTOMOTIVE MANUFACTURING

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**Abstract:** Robots and Intelligence are turning into more prevalent in automobile production. The speedup of this disruptive technologies has streamlined procedures in a numerous manufacturing firm. Robots and use of advanced AI technologies that are highly time and cost effective are progressively improving efficiency and productivity. Automation levels are projected to climb high in near future, cutting process turnaround times and improving overall quality of end service. Increasing and improving AI enabled robots will mechanize overall monitoring and control of industry processes. This paper focuses on describing the current practices used by the Indian Car Manufacturing and finding where AI robots, also known as artificial agents, can be used work in real-world settings. Manufacturers are shifting away from traditional automation methods and towards ones that use autonomous learning because of advancements in robotics and AI. In addition to that, Robots can now adapt to changes in input from humans and the environment, in addition to completing conventional jobs. Further this paper investigates complexities involved in integrating Intelligent Robotic Process automation and solution which suggests that there are many more processes that are automated even though they require a human Help that needs more automation and one of the possible solutions is using AI in current Robotic Process Environment. Finally paper projects on futuristic approach the car manufacturing will use to build efficacy and efficiency in automotive production.

**Keywords:** Indian Car, Car Manufacturing, Robotic Process Automation, Artificial Intelligence

## I. INTRODUCTION

In order to thrive in the new normal, automotive suppliers will need to adapt their operating model to become more agile, flexible, and customer focused. According to our study, companies that have strong financial management capabilities, prioritize increasing the value added per employee, and establish strong partnerships with both suppliers and customers are likely to be successful. Additionally, implementing best practices such as attracting and retaining top talent, cultivating a strong leadership team, and separating ownership from company management can also contribute to a company's success in a volatile market. Although the future of the automotive industry may be challenging, it is also full of exciting opportunities for transformation. It is essential for existing players to take advantage of these changes, innovate, collaborate, and capitalize on the momentum of the industry's evolution. It is time to embrace the changes and accelerate towards a new future [1].

In Mid-2021, the government of India announced a Production-Linked Incentive (PLI) scheme for the automobile and auto components sector worth Rs. 26K Crores (approximately) which is expected to attract investments of over Rs. 40K Crores by 2026. The Department of Heavy Industries has been allocated very huge amount for this sector. In late 2021, the Indian Government Under the PLI programme for automobiles, added over 100 new technologies were included, including alternate fuel systems flex-fuel engines, intelligent control units, sophisticated driver aid systems, and e-quadricycles etc. [2][3][15].
The aforementioned initiatives are reflective of the government's efforts to bolster the manufacturing sector and promote the use of innovative technology in the automotive industry. It is highly likely that the COVID-19 pandemic will accelerate the adoption of automation in various economic sectors. On one hand, employing automation during the pandemic has yielded significant advantages. For example, robots have been installed in warehouses and hospitals for sanitization, mobile robots for delivery. The knowledge gained from these experiences has resulted in increased investments in robotics, as it is now recognized that automation can provide greater productivity than traditional manual labour. [2].

Various techniques in car manufacturing needs the highest amount of precision that robots can implement efficiently. Therefore, modern robots do the work and only skilled workers maintain the machines. In some factories, the workers in this workshop were transferred to the assembly line for production demands, while in smaller companies their labour force was replaced.

Few challenges faced by Indian car manufacturing:

1. Speedup in manufacturing.
2. Creating market position.
3. Improve quality.
4. Need self-configurable robots
5. Cyber Security and IOT security
6. Setup cost

II. Current State of Manufacturing Cars in India

The manufacture of a car is divided into several stages, with the primary ones being stamping, sheet metal, painting, and assembly.
Stamping is the initial step, where steel sheets are converted into body parts as seen in Figure 1.

Figure 1: Stamping Process
Credit: plm automation siemens

Sheet metal, the next stage, involves joining the aluminium and sheet metal parts to create the car's structure, as shown in Figure 2. Welding robots were initially used for spot or arc welding to reduce safety risks. Modern six-axis robots can perform a wide range of welding techniques, requiring minimal supervision from welding specialists [5].

Figure 2: Robotic Welding
Credit: zzkehui.com

After the bodywork has been prepared, the third step in the process is painting, which both protects the vehicle from corrosion and gives it a final appearance. To seal the vehicle, putty is applied, as illustrated in Figure 3. A robotic arm is used to apply an even coating, resulting in a high-quality finish on every occasion. These robots not only provide precise coverage, but they also work much faster than a skilled human painter. [5].

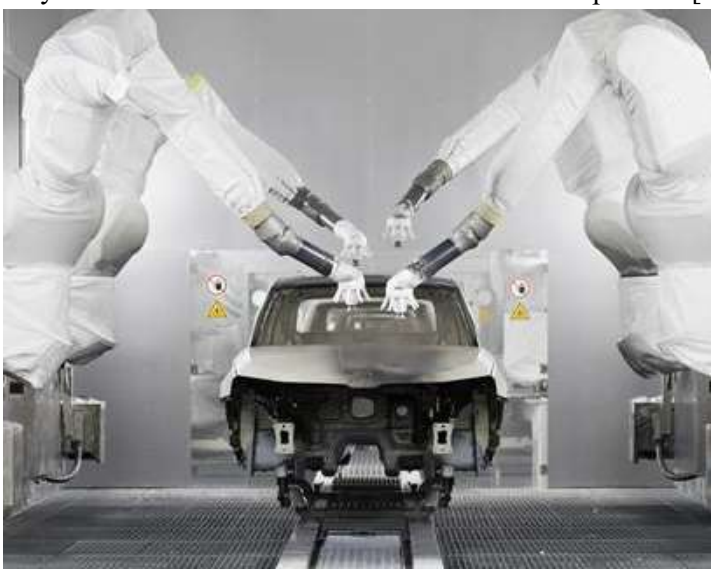

Figure 3: Robotic Painting
Credit: Automotive Manufacturing Solutions
https://www.automotivemanufacturingsolutions.com/paintshop/painting-sideways/39638.article

Finally, assembly is the last stage, where the mechanical components, driving position, mirrors, and interior trim of the car are put together and installed, as shown in Figure 4. Collaborative Robots work safely alongside human operators and can react to human contact using sensors. They can automate challenging tasks, which leads to increased versatility and efficiency in production. CoBots do not require constant monitoring, freeing up resources for other areas[5].

Figure 4: Assembly Line
Credit: https://auto.economictimes.indiatimes.com/news/aftermarket/toyota-launches-ghanas-second-auto-assembly-plant/83976137

Factory operators currently rely on their experience and intuition to manage multiple screens, monitor various signals, and make manual adjustments to equipment settings. This approach places the burden of troubleshooting, running tests, and other tasks on the operators, which can lead to added strain and decreased efficiency. Moreover, operators may take shortcuts, mis prioritize tasks, and not prioritize economic value.

However, there are two issues with this approach. Firstly, relying on human-intensive systems can increase the risk of errors, equipment malfunctions, and reduce overall factory efficiency. Secondly, the dependence on experienced operators makes it challenging to replace them. Additionally, when a skilled operator leaves, it can result in a loss of contextual knowledge on factory operations[4].

## III. Survey and Review analysis

The studies and research on process automation are neglecting the linkages between domains, customization, and integration. Instead, they tend to focus primarily on specific areas such as intelligent process automation, robotic process automation, and the use of artificial intelligence in manufacturing. As a result, there is a need for more extensive research on Intelligent Robotic Process Automation. This exploratory study aims to address this gap and bridge the divide by conducting a survey of various original equipment manufacturers (OEMs), Tier 1, and Tier 2 manufacturers.

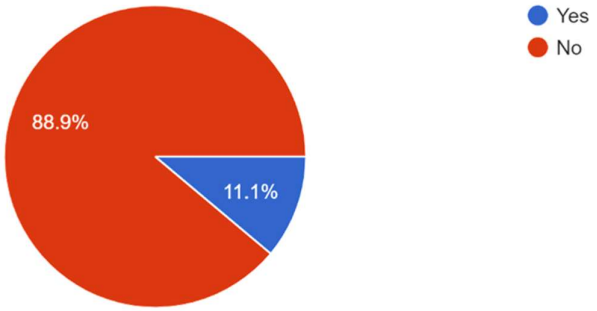


Figure 5: Survey to check degree of automation shop floor is it controlled by AI adaptive procedures.

As seen in the figure 5, survey for the question If you are having robotic process automation in shop floor is it controlled by AI adaptive procedures? Approximately 90% of OEMs, Tier 1 and Tier 2 manufacturers claim that shop floors many operations still need AI Adaptive procedures and very few have started using adaptive AI procedures in shop floor to build good amount of efficiencies.

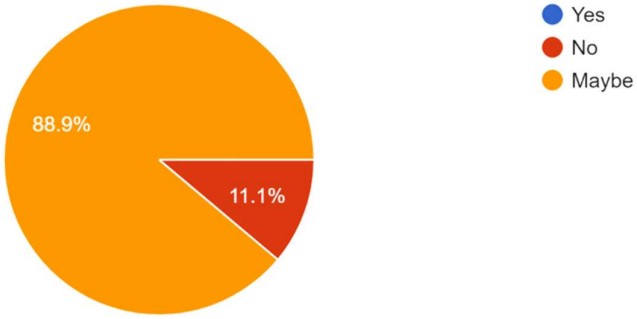


Figure 6: Survey to check AI based robots considering the cost and maintenance

As seen in the figure 6, survey for the question Will it be efficient to implement AI based robots considering the cost and maintenance? Approximately 90% of OEMs, Tier 1 and Tier 2 manufacturers claim that designing, implementing new AI based robots might be an costly affair and hence AI practitioners should implement such a program which can be easily integrated incurrent infrastructure.

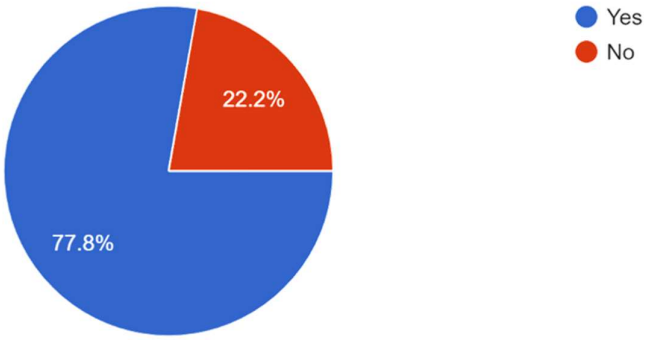


Figure 7: Survey to check system in place to integrate emerging technologies and practices.

As seen in the figure 7, survey for the question Whether you have system in place to integrate emerging technologies and practices? Approximately 77.8% of OEMs, Tier 1 and Tier 2 manufacturers claim their current infrastructure has provision to adapt to new emerging technologies. So, adapting to AI with RPA is bit easier to integrate.

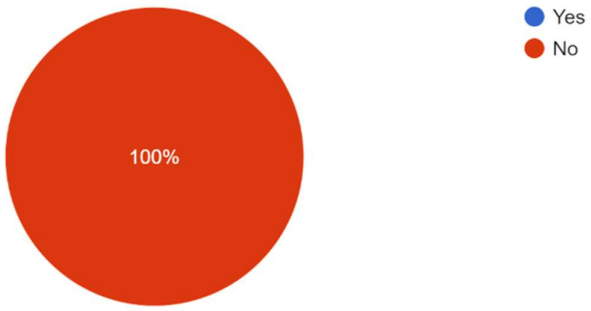


Figure 8: Survey to check automated system self-configurable.

As seen in the figure 8, survey for the question Is your automated system self-configurable? All OEMs, Tier1 and Tier 2 claim that there is no self-configurable robots present and hence there is huge scope to get self-configurable preventive robots to reduce the downtime.

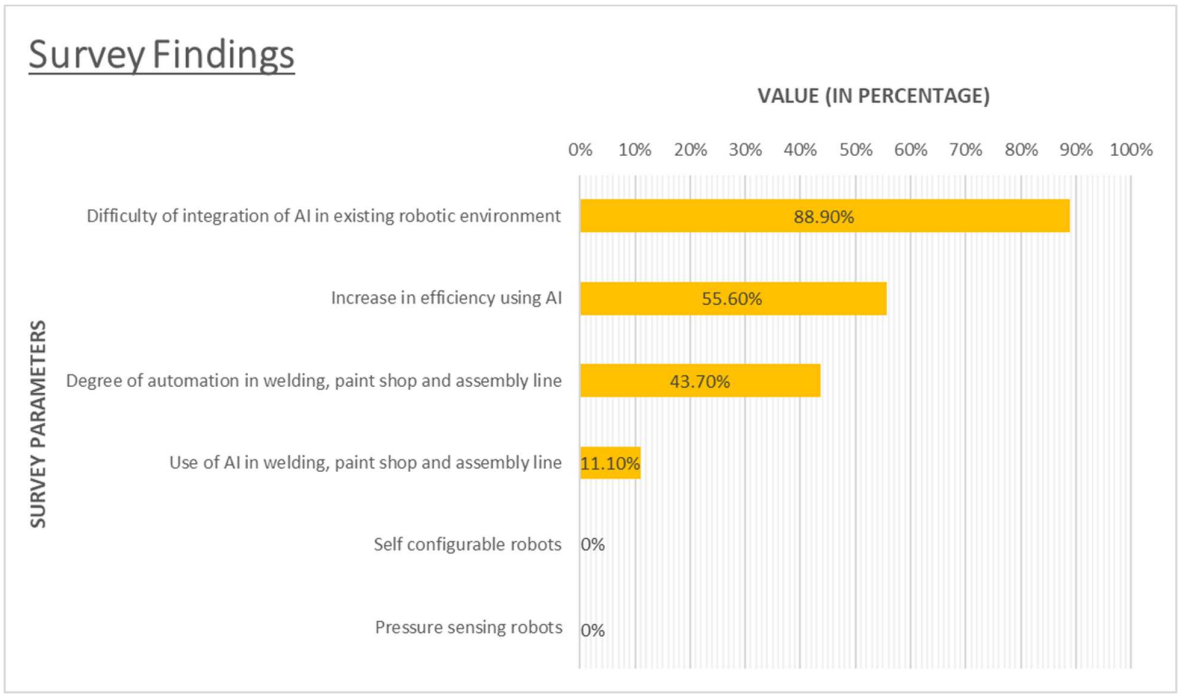


Figure 9: Survey Findings

As seen in the figure 9 survey findings it can be concluded stating that a well-defined and well researched AI based system is necessary to be designed to build good amount of efficiencies in existing robotic process environment.

IV. Complexities and solution to integrate AI in current RPA

The automotive manufacturing industry has undergone significant changes over the years, with the introduction of robotics and automation. These advancements have enabled the industry to

streamline operations and increase production efficiency, ultimately leading to improved bottom lines for companies across the industry.

Most assembly lines in Indian car manufacturing are entirely manual, with not even a semi-automatic process. This presents a significant opportunity for automating the overall process.

Although the paint shop in India is entirely automated with robots, manual inspection is still necessary for overall quality control after the car comes out of the oven. In this case, implementing IRPA (Intelligent Robotic Process Automation) is a possible solution.

Solution: Vision Based Image Processing Robots

Part lift assist robots, also known as ergonomic robots, are relatively simple robots that are primarily used for pick and place tasks. They are designed to transport parts, while the workers manually assemble them. With around 4,000 parts being manually assembled, the use of more intelligent robots that can assist with the assembly process would ultimately increase the speed and efficiency of the overall manufacturing process. Components such as bumpers, door fittings, and dashboard are typically purchased directly from Tier 1 manufacturers and then manually mounted during the assembly process. However, there is a need for intelligent robots to assist with the mounting process. While fitting any part, the worker may tweak and try to fit the part. Here the need of Sense-Adopt-process robots are necessary, sensing the pressure points and fitting.

Solution: Use of AI based Pressure Sensing Robots.

If any of the existing robots fail, they need to be repaired manually, hence self-learning robots are needed for fail free operation.

Solution: Self Configurable preventive maintenance vibration-based robot

Incorporating industrial robotics into conventional plant operations can be a difficult undertaking, requiring consideration of various technical, financial, and logistical factors. Although there are numerous challenges to navigate, it is best to address the most significant ones initially. Few of them are as mentioned below:

New skillset and training:

***Although industrial robots can work independently once programmed, they still require occasional maintenance and intervention from on-site employees. To ensure seamless operation, employees must possess a new level of expertise and skill set. Providing employee training and introducing new team members to aid in the transition is a good starting point [.6]***

***Available Funds:***

Robots can be expensive, often requiring a substantial upfront investment, despite recent technological advancements that have lowered their costs. To minimize additional expenses, it is crucial to choose the right robot based on careful planning and a thorough understanding of the requirements. Oversizing the robot as a precautionary measure would only diminish the potential return on investment[6].

### AI Integration into existing infrastructure

Many organizations face a significant challenge when attempting to upgrade their traditional legacy systems and replace outdated infrastructure. Although artificial intelligence (AI) solutions offer fast computational capabilities, having a sturdy infrastructure and high-end processors can further enhance their speed. According to a report by McKinsey, companies that are ready to embark on a digital journey are the ones that are embracing AI technology. From conception to deployment, enterprises need the support of AI solution providers with deep AI expertise and experience to successfully implement artificial intelligence into their existing systems. [7].

### New and Complex Algorithms

It is evident that as AI-based algorithms are put into operation or developed, continuous training of ML or AI models can be time-consuming and a significant challenge for organizations. However, the benefits of incorporating AI solutions in the enterprise far outweigh the difficulties.[7].

## V. What next in Indian Car Manufacturing?

Automakers worldwide are incorporating AI technology into every aspect of vehicle production. By combining AI and machine learning, self-driving cars can navigate traffic safely. This convergence all Intelligent emerging trend as well as technology and cognitive systems in the automotive industry will lead to the launch of safe and efficient self-driving cars. Additionally, the use of AI in smart automotive manufacturing is expected to increase in tandem with technological advancements. Although AI robots have not yet completely replaced human workers, they are poised to take over manufacturing operations in the next decade. As demonstrated in the previous section, the list of AI applications in the automotive industry will continue to grow in importance in the future. The figure below illustrates the growth of AI development and deployment in the automotive industry from 2015 to 2030 [8].

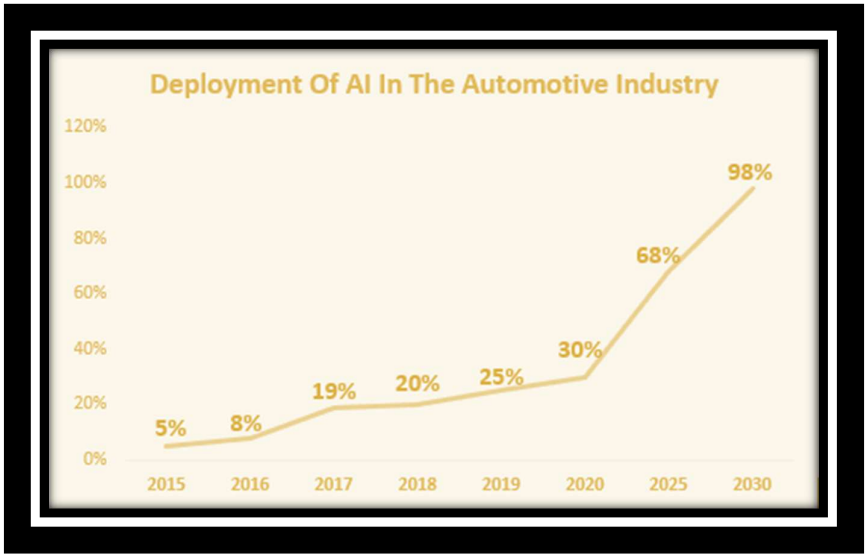


Figure 10: Deployment of AI in Automotive Industry

Credit: https://usmsystems.com/ai-in-automotive-industry/

As the automotive industry shifts to greener energy and electric technologies, robotic automation will play a critical role in driving this change. While the conventional production of internal combustion engine vehicles is not yet obsolete, manufacturing plants are starting to modernize their assembly lines to meet the evolving demands of their customers. During this transitional period, robotic workers can continue to perform their usual tasks, adapt and learn about the latest technology as needed, and fulfill increased demand and production schedules. By working in collaboration with humans, robots can eliminate downtime, enhance production speeds, and considerably reduce production costs. This makes new technology more quickly available to the consumer market. [11].

## VI. CONCLUSION

Globally, there is increasing research being conducted on automated tasks and processes, data-driven decision-making automation, and intelligent automation of ecosystems. While the automotive industry has made significant strides in process automation, there is still much to be accomplished in terms of automating data. Additionally, automobile companies have only just begun to automate their ecosystems, which is a vital area for future growthThe utilization of AI robots on assembly lines is becoming more common, and industrial robots are now more efficient than human workers in car manufacturing processes. Moreover, these robots are capable of undertaking tasks that were traditionally performed by humans. The automotive industry is experiencing a significant transformation due to the integration of artificial intelligence. Major technology leaders such as Google, Tesla, Uber, and established car companies in the region have made substantial investments in this area. The opportunity is not limited to big companies, as even startups can benefit from this technology. The integration of AI not only modernizes the automotive industry but also enhances passenger safety. This document serves as an introduction to the integration of AI, IoT, and the automotive industry.

Vehicle communication has been discussed in detail and is being strongly emphasized by original equipment manufacturers (OEMs) to create a safe and standardized product. Although there are challenges related to security and privacy, the application of AI in the automotive sector is gaining attention and is expected to grow in the coming years. To successfully integrate AI into their operations, businesses must become acquainted with its workings. While implementing AI in business can present challenges, these can be addressed by developing a thoughtful and incremental AI strategy. By taking a strategic approach, the process of implementing AI can be made simpler and more manageable.

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