International Journal of Core Engineering & Management
Volume-7, Issue-06, 2023 ISSN No: 2348-9510

STRATEGIES FOR MINIMIZING CYCLE TIMES IN ELECTRIC VEHICLE MANUFACTURING

Priyanka Das
Controls Engineer
Cincinnati, USA
priyanka14das@gmail.com

Abstract

Electric vehicle production struggles with cost efficiency, widespread adoption, and scalability due to several challenges. Such issues that electric vehicle manufacturing faces include high costs of battery production as it relies on rare metals such as cobalt and nickel, the manufacturing complexity of transitioning from internal combustion engines to electric vehicle-specific designs, supply chain disruption, and a gap in the skilled labor force. Streamlining the electric vehicle manufacturing process by minimizing cycle times is essential to improve production efficiency, and meet the rising market demand. Thus, innovative strategies are crucial to address these challenges. Such approaches include the adoption of modern methods of battery manufacturing, automation and the use of robotics, among other AI-driven technologies, in production to boost productivity and optimize manufacturing processes and process standardization. Adopting these techniques will enable EV manufacturers to address present challenges, enhance sustainability, and boost production, putting them in a strong position to meet the growing demand for electric vehicles and contribute to global environmental targets.

Index Terms – Component, formatting, style, styling, insert.

I. INTRODUCTION

The increased use of internal combustion vehicles globally has heavily contributed to the increase in greenhouse emissions over the past few decades, leading to the need for sustainable solutions. The development and adoption of electric vehicles (EVs) is one of the major solutions that aims to help the world achieve zero emissions in the future. However, the production of EVs faces numerous challenges that have slowed down their production rate. This has reduced their availability compared to conventional gasoline vehicles, which derails the sustainability goal of achieving zero emissions. By 2020, only 1.8% of car sales globally were EVs, which is a relatively low number and a threat to achieving global emission reduction. [1]. Due to their complexity, EVs require a number of processes and skills to produce, hence increasing the cycle time and the cost of production and, in the long run, reducing the rate of achievement of environmental sustainability. More improvements have been called for in the automotive industry to reduce the cycle time for EV manufacturing to help increase their availability in the market.

International Journal of Core Engineering & Management
Volume-7, Issue-06, 2023 ISSN No: 2348-9510

II. CHALLENGES FACED IN EV MANUFACTURING

1. Complexity of EV Designs

Changing from gasoline or internal combustion engine (ICE) vehicles to electric vehicles comes with a vast change in the automotive industry value and product chain, which has recently created a backlash in EV production. Electric vehicles have different key components and requirements, such as batteries, power systems, and controls, which have led to new production methods.

2. High Battery Production Costs

Among the major challenges faced by EV manufacturing is battery production. Battery production is hectic and consists of expensive and energy-intensive processes. Cell production and assembly require several rare minerals such as cobalt and nickel and use up a lot of energy to produce. Reports on assessing battery production requirements have shown that producing one kWh of battery storage uses up between 97 to 181 kWh of energy. [2]. Researchers have linked battery production to a high emission rate, finding that the production of lithium-ion batteries accounts for at least 45% of total greenhouse gas emissions globally. [3]. This requires the industry to improve the effective production of batteries to reduce delays and energy usage.

3. Supply Chain Constraints

Battery production has also faced constraints in the minerals supply chain due to their unavailability and price fluctuation. To carry on with the mass production of EVs means an increased demand for the rare minerals used in producing batteries, hence more pressure on the supply chain. According to the International Energy Agency, the EV industry requires more than 31 million tons of these minerals to achieve the required target by 2030 [4]. Investigations into the supply of crucial minerals such as copper, lithium, manganese, and nickel show a high risk of a supply crisis since the current demand exceeds the existing global reserves. [5]. These escalating demands of minerals by the EV industry are creating a glitch in the minerals supply chain, which is feared to cause supply risks shortly.

4. Labor Shortage and Skill gaps

To achieve zero emissions, the production of EVs has to increase rapidly to cover the market gap filled by gasoline vehicles. Experts estimate that we need to produce at least three hundred million EVs by 2030 to achieve zero emissions by 2050. [6]. To achieve these figures, the automotive industry must increase the current production rate by at least 6% annually. [7]. However, the production of EVs is still under development and requires a highly skilled labor force. Unlike the internal combustion vehicle industry, which has been around for over a century, the EV industry is barely three decades old. It needs to acquire adequate craftsmanship to compete with internal combustion vehicle production. To achieve the required production rate, the EV industry needs to employ and train more personnel, which may take time due to the complexity of electric vehicle production.

International Journal of Core Engineering & Management
Volume-7, Issue-06, 2023 ISSN No: 2348-9510

III. METHODS OF IMPROVING EV PRODUCTION

The growing demand for EVs and their role in environmental conservation calls for an increased production rate. We can achieve this increased production rate for EVs by applying production methods and improvements that significantly reduce cycle times. Cycle time refers to the time taken to complete the manufacturing process of a product from the start to the end. This is a crucial factor for production, affecting an industry's production rate and efficiency. Solving the problems addressed earlier could lead to the reduction of cycle times in the EV industry, hence increasing the production rate.

1. Innovation

The major problem that delays the production cycle of EVs is the manufacture of batteries. Due to the wide adoption of lithium-ion batteries for use in EVs, there is an increased demand for natural minerals in their production. However, to improve the industry's sustainability, the stakeholders need to embrace modern, innovative technology and research the improvement of battery chemistry that would revolutionize the EV industry and improve production. Researchers have achieved various technological breakthroughs in testing and using new batteries that have lower mineral requirements and higher power storage and output. For instance, there has been successful research on the use of li-metal batteries that do not require the use of nickel and cobalt in their production, which would likely lower their cost and production time. [8]. The development and adoption of such battery technology will not only reduce the cycle time of EV production but also reduce the cost of production.

2. Automation and Robotics

The industry also faces a labor problem, with the demand for skilled labor in the EV industry being higher than the available personnel. This can, however, be curbed through the automation and use of robotics in production. Computers and robots are faster and easier to train than human workers, even though human labor provides employment and stimulates the economy. Adopting robots in the assembly and manufacture of EVs could significantly improve the efficiency of their production and reduce the cycle time. Key EV industries such as Tesla have made huge strides in embracing computerized and AI-assisted production methods such as Industry 4.0. The company uses smart manufacturing, which incorporates programs such as data analytics and predictive maintenance, making it easier for their mass production of vehicles. Companies should adopt and improve such technological advancements to increase the efficiency in the production of EVs and reduce their cycle times.

Fig 1: Advanced Assembly line with Robotic Automation

3. Process Standardization

The EV industry is relatively new and has not managed to create standardized production techniques across its production. This leads to every manufacturer having different production procedures, which need to be improved for effective production. The development of standard manufacturing procedures across the board in the industry could improve the rate of production and make it easy to operate and maintain EVs in the future. Standard manufacturing procedures are easy to develop, maintain, and improve compared to individual procedures and can help improve the production rate of EVs. Such procedures also give more room for research and incorporation of innovative ideas.

IV. CONCLUSION

EVs play a key part in the global achievement of zero emissions and environment conservation. However, the rate of production of EVs is currently lower than expected, which is a deterrent to achieving this goal. There is a need to reduce the cycle times of EV manufacturing and, in turn, increase the rate and cost of production. The adoption of modern methods of battery manufacturing and the improvement of manufacturing technology are among the effective measures that the EV industry can adopt to reduce cycle times in production. The world will achieve zero emissions within the stipulated time frames through these improvements.

REFERENCES

1. H. C. Kim, T. J. Wallington, R. Arsenault, C. Bae, S. Ahn, and J. Lee, “Cradle-to-Gate Emissions from a Commercial Electric Vehicle Li-Ion Battery: A Comparative Analysis,” Environmental Science & Technology, vol. 50, no. 14, pp. 7715–7722, Jun. 2016, doi: https://doi.org/10.1021/acs.est.6b00830.
2. Valero, A. Valero, G. Calvo, and A. Ortego, “Material bottlenecks in the future development of green technologies,” Renewable and Sustainable Energy Reviews, vol. 93, pp. 178–200, Oct. 2018, doi: https://doi.org/10.1016/j.rser.2018.05.041.
3. Z. P. Cano et al., “Batteries and fuel cells for emerging electric vehicle markets,” Nature Energy, vol. 3, no. 4, pp. 279–289, Apr. 2018, doi: https://doi.org/10.1038/s41560-018-0108-1.
4. Z. P. Cano et al., “Batteries and fuel cells for emerging electric vehicle markets,” Nature Energy, vol. 3, no. 4, pp. 279–289, Apr. 2018, doi: https://doi.org/10.1038/s41560-018-0108-1.
5. M. A. Rajaeifar, P. Ghadimi, M. Raugei, Y. Wu, and O. Heidrich, “Challenges and Recent Developments in Supply and Value Chains of Electric Vehicle batteries: a Sustainability Perspective,” Resources, Conservation and Recycling, vol. 180, no. 106144, p. 106144, May 2022, doi: https://doi.org/10.1016/j.resconrec.2021.106144.
6. Andwari, A. M., Pesiridis, A., Rajoo, S., Martinez-Botas, R., & Esfahanian, V. (2017). A Review of Battery Electric Vehicle Technology and Readiness Levels. Renewable and Sustainable Energy Reviews, 78, 414–430, doi: 10.1016/j.rser.2017.03.138
7. Nunes, A., Bennett, N., & Burgess, M. (2020). Design for Manufacture and Assembly in Automotive Manufacturing. Procedia CIRP, 91, 707–712, doi: 10.1016/j.procir.2020.02.208