Anode Spike Model - A Case Study of Challenges and Future Directions

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Abstract

In 2020, Emirates Global Aluminium (EGA) leveraged Industry 4.0 technologies to develop a predictive model using big data and machine learning for detecting anode spikes, a critical aspect of aluminium production. Despite its innovative approach, the implementation faced significant challenges, including variability in adherence to model predictions by potroom employees, and a noticeable degradation in model accuracy and model drift over time due to changing operating conditions and operational parameters, such as amperage fluctuations. Model drift, a common issue in machine learning, occurs when the predictive performance degrades as the underlying data patterns change, necessitating continuous model evaluation and updating.

Addressing these challenges, this paper underscores the importance of adaptive change management strategies in the era of digital transformation, particularly within the context of Industry 4.0 technology integration. Through a comprehensive case study of EGA's technological adoption of anode spike models in Al Taweelah DX and Jebel Ali D20 technologies, we explore the impact of model drift and the essential role of iterative model recalibration and employee engagement in maintaining the efficacy of such digital solutions.

Key to our findings is the application of a dynamic adaptation strategy to manage model drift, ensuring that predictive models remain accurate and sustainable amidst evolving operational conditions. This approach facilitated smoother transitions and significantly mitigated resistance among potroom employees, enhancing overall acceptance and effectiveness of the deployed Industry 4.0 solutions.

Keywords: Industry 4.0, Anode spike prediction model, Change management, Model drift, Sustainability.

1. Introduction

Emirates Global Aluminium (EGA) stands as the globe's foremost producer of 'premium aluminium' and holds the distinction of being the largest industrial entity in the United Arab Emirates, excluding the oil and gas sector. This study delves into the challenges and reservations encountered during the integration of Anode Spike Soft Sensors by personnel in the potroom, coupled with the issue of model inaccuracy over time. These obstacles are examined within the framework of addressing crucial operational issues associated with the timely identification of anode spikes as they occur.

The Anode Spike Model was seamlessly integrated with state-of-the-art technology in EGA as presented in ICSOBA 2022 [1]. However, the evaluation of its performance and efficacy lacked comprehensive monitoring. This deficiency persisted as the model effectiveness remained contingent on the proactive engagement of shop floor employees. The graph below illustrates the impact of checking compliance on detection accuracy for D20 technology. Notably, a single model was utilised for two potlines, both equipped with the same technology. While the model performance showed similarity during the initial deployment phase, it gradually diverged across both potlines in distinct manners. In Potline 7 (L7), initial checking compliance experienced a decline, mirroring the subsequent decrease in model detection accuracy. However, the model performance began to fluctuate again (Figure 1), despite checking compliance maintaining a consistent level of around 60 %, falling short of the target of 80 %.

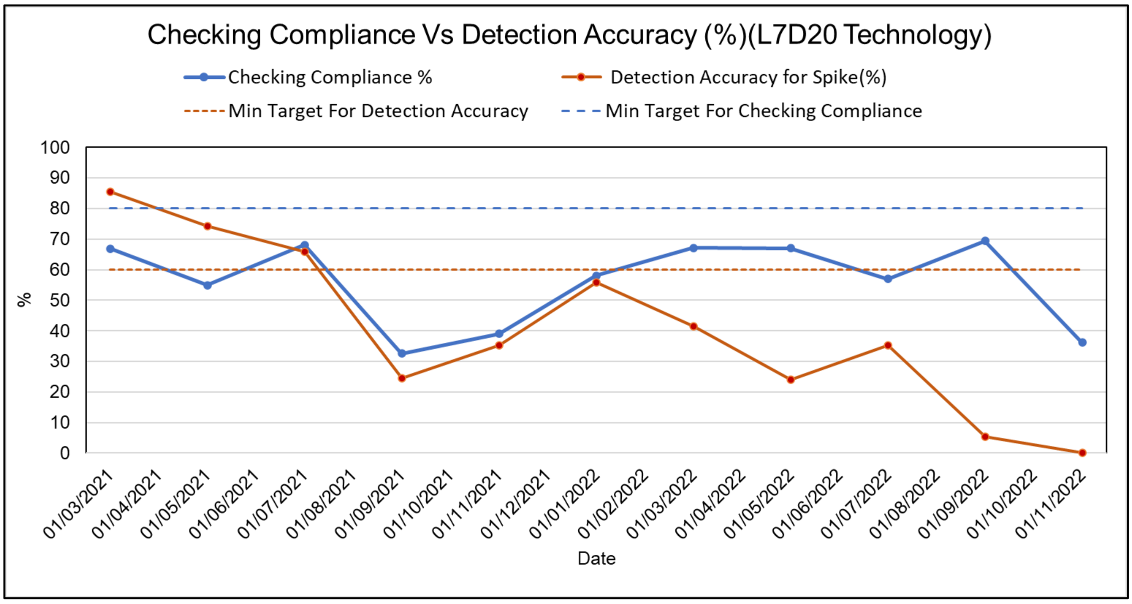

Figure 1. Line7 (D20) potline checking and detection accuracy.

During October-November 2021, Potline 9 (L9) witnessed a decline in checking compliance, which corresponded to a subsequent decrease in model detection accuracy. Nevertheless, the model performance started to show signs of improvement as the checking compliance level reached around 75 % (Figure 2).

The graph depicted in Figure 3 shows the accuracy trend for DX potlines, exemplifying a typical case of model degradation over time, despite never meeting the established target for checking accuracy.

As we delve deeper into understanding why employees are not complying with the checking procedures, it becomes evident that their reluctance stems from doubts about the accuracy and reliability of modern technology. They harbour concerns about potential errors or inaccuracies in predictive models or automated systems, which breeds scepticism and resistance to adopting change. Moreover, there is apprehension about the additional workload and potential for rework that comes with early flags or alerts generated by these models. Such interruptions could disrupt established workflows, necessitating extra time and effort to resolve issues, so it was decided to do an analysis which will clarify the reason for checking noncompliance and enhance customer satisfaction.

8. References

1. Najeeba Aljabri et al, Advanced Process Control with Smart Smelter Sensors at EGA, *Proceedings of 40th International ICSOBA Conference*, 10–14 October 2022, Athens, Greece, *TRAVAUX* 51, 1049–1051.
2. Hans de Visser, Why Do 70% of Digital Transformations Fail? *Mendix* 2024, February 12, https://www.mendix.com/blog/why-do-digital-transformations-fail/#:~:text=Digital%20transformation%20projects%20fail%20when. (Accessed on April 2024).
3. Ruzual Singh, The psychology of change management, study the psychological factors influencing employee reactions to organisational change initiatives. Identify effective change management strategies that consider individual attitudes and behaviour: a review-based study, *Indian Journal of Psychology*, 2023, 58-67.
4. Ik Muo, The other side of change resistance. *International Review of Management and Business Research*, 3(1), March 2014, 96-112.