West Science Interdisciplinary Studies
Vol. 02, No. 02, February and 2024: pp. 415-422

The Effect of Artificial Intelligence Adoption, Demand Prediction, and Production Planning on Operational Efficiency in the Textile Industry in Jakarta

Loso Judijanto[1], Khamaludin[2], Mahmudin[3], Devi Susiati[4], Hanifah Nurul Muthmainah[5]
[1] IPOSS Jakarta, Indonesia and losojudijantobumn@gmail.com
[2] Universitas Islam Syekh-Yusuf and khamaludin@unis.ac.id
[3] Universitas Islam Syekh-Yusuf and mahmudin@unis.ac.id
[4] Universitas 45 Surabaya and devisusiati@univ45sby.ac.id
[5] Universitas Siber Muhammadiyah and hanifah20220200046@sibermu.ac.id

ABSTRACT

This research investigates the impact of Artificial Intelligence (AI) adoption, demand prediction, and production planning on operational efficiency within the textile industry in Jakarta. A quantitative approach, employing surveys and statistical analysis, was undertaken with a diverse sample of 150 participants representing various company sizes and industry tenures. The study reveals a moderate level of AI adoption, with machine learning algorithms and predictive analytics being prevalent. While perceived benefits include improved production efficiency and enhanced quality control, challenges such as initial investment costs and the need for skilled personnel underscore the nuanced landscape of AI integration. The effectiveness of demand prediction is moderate, with traditional methods prevailing but advanced analytics demonstrating higher efficacy. Production planning strategies exhibit a positive correlation with Industry 4.0 principles, showcasing their role in enhancing operational efficiency. Participants perceive operational efficiency positively, with significant correlations identified between AI adoption, demand prediction, production planning, and perceived efficiency. Key factors contributing to operational efficiency include streamlined processes, effective resource utilization, and adaptive production planning. The findings provide actionable insights for industry stakeholders, emphasizing the importance of a holistic approach to technology adoption and strategic planning.

Keywords: *Artificial Intelligence Adoption, Demand Prediction, Production Planning, Operational Efficiency, Textile Industry in Jakarta*

1. INTRODUCTION

The Indonesian textile industry is facing challenges in terms of sustainability and competitiveness. To address these issues, there is a need for innovative strategies and technologies such as Artificial Intelligence (AI) to improve operational efficiency and production planning. The industry has recognized the importance of sustainable supply chain management (SSCM) [1], as well as the need to assess and regulate hazardous compounds in textiles and textile products [2]. Additionally, the quality of management accounting and the ability to deal with environmental uncertainties have been identified as factors affecting the performance of the industry [3]. Furthermore, the industry needs to address the problem of discarded fashion products and explore circular economy approaches [4]. The effectiveness of fabric safeguards and import duties set by the Indonesian government has also been studied to protect and improve the competitiveness of the textile industry [5].

The emergence of AI technology in the textile sector offers opportunities for optimizing processes, reducing costs, and improving product quality. Machine learning algorithms, predictive analytics, and intelligent automation can be harnessed to achieve these goals. Accurate demand prediction and efficient production planning are crucial for creating an efficient and responsive

manufacturing ecosystem [6], [7]. Despite the potential benefits of AI adoption, demand prediction, and production planning, there are gaps in our understanding of how these elements collectively impact operational efficiency in the textile industry in Jakarta. The unique challenges and opportunities specific to this region warrant a focused investigation into the intricacies of technology integration and its effect on manufacturing processes.

This research aims to bridge existing gaps by examining the intricate relationship between AI adoption, demand forecasting practices, production planning strategies, and their collective impact on operational efficiency. The study's overarching objectives are diverse, beginning with an exploration of the current status of AI adoption in the textile industry in Jakarta. This involves scrutinizing the extent of AI integration and identifying the specific technologies employed across the manufacturing spectrum. The research also delves into the realm of demand prediction, assessing the efficacy of existing methodologies in the textile sector and elucidating how accurate predictions contribute to mitigating shortage or overstock scenarios. Furthermore, the study evaluates the role of production planning by analyzing strategies employed by textile manufacturers in Jakarta and elucidating how robust planning can enhance overall operational efficiency. Finally, the research addresses challenges associated with AI adoption, demand prediction, and production planning, while also highlighting potential opportunities to leverage these technologies for overcoming industry-specific hurdles.

2. LITERATURE REVIEW

2.1 Artificial Intelligence in Textile Manufacturing

The integration of AI in the textile manufacturing sector has shown great potential in revolutionizing various aspects of the production process. Machine learning algorithms have been effective in optimizing production schedules, enhancing quality control, and improving resource utilization [8]. AI-based predictive maintenance has been implemented to reduce downtime and increase machine efficiency in textile mills [9]. AI also plays a crucial role in automating complex tasks such as pattern recognition and defect detection, leading to higher quality output [7]. These advancements not only improve production efficiency but also have implications for overall product quality and customer satisfaction [10]. However, the literature also recognises challenges, including initial investment costs, the need for skilled personnel, and potential resistance to technological change in traditional manufacturing environments.

2.2 Demand Prediction in the Textile Industry

Accurate demand prediction is crucial for textile manufacturers to optimize production levels, minimize inventory costs, and respond promptly to market fluctuations. Incorporating advanced analytics and data-driven models in demand forecasting is of utmost importance, especially in the volatile textile industry [11]. Predictive modeling, which takes into account historical data, market trends, and consumer behavior, has emerged as a key strategy for effectively anticipating demand patterns. Real-time data integration is also significant in demand prediction as it enables manufacturers to adapt swiftly to changing market conditions [12]. Challenges such as data quality, lead time variations, and the complexity of global supply chains were

acknowledged, highlighting the need for robust predictive models tailored to the unique characteristics of the textile industry.

2.3 Production Planning and Operational Efficiency

Efficient production planning is crucial for achieving optimal operational efficiency in textile manufacturing. It involves strategic resource allocation, workflow synchronization, and responsiveness to demand fluctuations. Advanced planning and scheduling systems have been shown to bring significant improvements in production lead times and resource utilization [13]. Production planning also plays a vital role in minimizing waste, reducing production costs, and enhancing overall supply chain efficiency [14]. The integration of Industry 4.0 principles, including the Internet of Things (IoT) and smart manufacturing, has further expanded the capabilities of production planning systems, enabling real-time adjustments based on demand variations and machine performance.

3. METHODS

This study employs a quantitative research design to investigate the impact of Artificial Intelligence (AI) adoption, demand prediction, and production planning on operational efficiency in the textile industry in Jakarta. The research design involves the use of surveys to collect data from key stakeholders, including manufacturers, suppliers, and distributors within the Jakarta textile industry. The choice of a survey-based approach enables the systematic gathering of quantitative data to address the research objectives.

3.1 Sampling

The research will utilize a stratified random sampling technique to ensure representation from different segments of the textile industry in Jakarta. The population will be stratified based on key criteria such as company size, production capacity, and years in operation. From each stratum, a proportionate number of participants will be randomly selected to form a sample size of 150 respondents. This approach ensures that the sample represents the diversity present within the textile industry in Jakarta.

3.2 Data Collection

The primary method of data collection will be through the distribution of electronic and print surveys to the selected participants. The survey questionnaire will be designed to capture information on AI adoption, demand prediction practices, production planning strategies, and their perceived impact on operational efficiency. The survey will consist of both closed-ended and Likert-scale questions to facilitate quantitative analysis.

In addition to the surveys, semi-structured interviews may be conducted with industry experts to gain qualitative insights and a deeper understanding of certain responses. The interviews will complement the quantitative data collected through the surveys.

3.3 Survey Questionnaire

The survey questionnaire will encompass a comprehensive exploration of key areas crucial to the study. Firstly, it will gather demographic information such as company size, years in operation, and other pertinent details. Subsequently, the questionnaire will delve into the realm of AI adoption, posing questions to assess the extent of adoption, the types of AI technologies employed, and the perceived benefits or challenges associated with their implementation. The survey will also address the domain of demand prediction, inquiring about current methodologies, the utilization of data analytics, and the resulting impact on inventory management. Additionally, participants will be prompted with questions concerning production planning, including strategies

employed, technology integration, and perceived effectiveness in optimizing operational efficiency. To gauge participants' perspectives on operational efficiency and its key determinants, Likert-scale questions will be incorporated into the survey. Through this structured approach, the questionnaire aims to provide a comprehensive understanding of the intricate dynamics within the surveyed organizations.

3.4 Data Analysis

The data gathered from the surveys will undergo rigorous statistical analysis using IBM SPSS Statistics version 26. The analytical process encompasses various techniques, starting with descriptive statistics such as mean, median, and standard deviation calculations to elucidate the central tendency and variability of the collected data. Furthermore, regression analysis will be employed to investigate the relationships between AI adoption, demand prediction, production planning, and operational efficiency. Correlation analysis will be conducted to scrutinize the strength and direction of associations between different variables, while cross-tabulation will explore relationships between categorical variables. Factor analysis will be utilized to identify underlying factors contributing significantly to operational efficiency. These statistical tests and techniques aim to provide a comprehensive examination of the quantitative data, yielding valuable insights into the intricate interplay between AI adoption, demand prediction, production planning, and operational efficiency within the textile industry in Jakarta.

4. RESULTS AND DISCUSSION

4.1 Demographic Profile

The demographic profile of survey respondents offers valuable insights into the diverse composition of participants within the textile industry in Jakarta. Categorization based on company size reveals a well-distributed representation across small, medium, and large enterprises, with 30%, 45%, and 25% participation, respectively. This diverse distribution ensures a comprehensive perspective, encompassing insights from businesses with varying scales of operations. In terms of industry experience, participants were categorized by the duration of their involvement in the textile sector. Notably, 70% of respondents have more than five years of industry experience, with varying durations, from less than 1 year to over 10 years. This majority with substantial industry tenure indicates a seasoned perspective on the dynamics of the textile industry. These demographic insights serve as a crucial foundation for comprehending the diverse perspectives and experiences that contribute to the overall research findings, ensuring a nuanced understanding of the textile industry in Jakarta.

1) AI Adoption:

The analysis of AI adoption in Jakarta's textile industry reveals a balanced mean adoption level of 3.8 on a scale of 1 to 5, indicating a moderate integration of artificial intelligence technologies. Predominantly, participants showcased a strategic focus on machine learning algorithms (65%) and predictive analytics (48%), underlining a commitment to data-driven decision-making. Perceived benefits of AI adoption include improved production efficiency (72%), enhanced quality control (58%), and optimized resource utilization (45%). These findings align with existing literature emphasizing AI's potential to enhance manufacturing processes.

However, participants acknowledged challenges, with 35% citing initial investment costs and 28% recognizing the need for skilled personnel. These challenges underscore the financial and human resource considerations involved in integrating AI technologies into textile operations. In summary, the study offers a comprehensive overview of AI adoption in Jakarta's textile industry, depicting a moderate integration level with a specific emphasis on machine learning algorithms and predictive analytics. The reported benefits and challenges provide valuable insights into the current landscape, contributing to a nuanced understanding of technology implementation in the sector.

2) Demand Prediction:

The examination of demand prediction practices in Jakarta's textile industry yields a comprehensive insight into methodologies, their effectiveness, and the challenges faced by companies in this domain. The mean effectiveness score of 5.4, with a moderate standard deviation of 1.2, indicates a reasonably successful implementation of demand prediction methodologies among the surveyed companies. When delving into the types of methods employed, a notable 65% of participants rely on traditional approaches such as historical data and market trends, while 35% adopt advanced analytics like machine learning and data-driven models. Interestingly, companies utilizing advanced analytics report a higher mean effectiveness score for demand prediction (Mean = 6.2), suggesting the potential advantages of incorporating data-driven approaches into their strategies.

Despite the moderate effectiveness observed, challenges persist in demand prediction. Lead time variations, identified by 42% of participants, and the complexity of global supply chains, reported by 31%, emerge as the primary obstacles. These challenges underscore the intricacies involved in accurately forecasting demand, particularly in the face of variable lead times and the intricate dynamics of global supply chains. To optimize operational efficiency, it is imperative for the textile industry in Jakarta to address these challenges while considering the potential benefits associated with the adoption of advanced analytics in demand prediction methodologies.

3) Production Planning:

The examination of production planning strategies within the textile industry in Jakarta has yielded valuable insights into their effectiveness and impact on operational efficiency. Participants rated the effectiveness of their current production planning strategies, with a mean effectiveness score of 4.2 and a standard deviation of 0.7. This moderate mean effectiveness score indicates a generally favorable perception of production planning strategies among surveyed companies.

The survey also delved into the integration of Industry 4.0 principles, such as real-time data exchange, IoT, and smart manufacturing, into production planning. Approximately 58% of participants reported integrating Industry 4.0 principles, and these companies demonstrated a higher mean effectiveness score for production planning (Mean = 4.6). This suggests a positive correlation between the adoption of advanced principles and improved planning strategies.

In terms of operational efficiency, participants rated their perceived efficiency on a Likert scale from 1 to 7, resulting in a mean perceived operational efficiency of 5.9 and a standard deviation of 1.0. A positive correlation ($r = 0.72$, $p < 0.01$) was identified between the effectiveness of production planning and perceived operational efficiency, indicating that more effective production planning is associated with higher perceived operational efficiency.

Despite the generally positive outlook, challenges in production planning were explored, and the most commonly reported obstacle was adapting to fluctuating demand, cited by 47% of participants. This underscores the dynamic nature of the textile industry in Jakarta and emphasizes the need for flexible production planning strategies. In conclusion, the findings highlight the moderate effectiveness of production planning, the positive impact of Industry 4.0 integration, and the importance of addressing challenges for refining strategies and ensuring adaptive responsiveness to market dynamics within the textile industry in Jakarta.

4) Operational Efficiency:

The evaluation of operational efficiency within Jakarta's textile industry offers a comprehensive insight into perceived efficiency levels and their associations with various operational aspects. To gauge operational efficiency, participants utilized a Likert scale ranging from 1 to 7, with 1 indicating very low efficiency and 7 denoting very high efficiency. The mean perceived operational efficiency, calculated at 5.9 with a standard deviation of 1.0, signifies a generally positive perception among surveyed companies.

In-depth correlation analysis revealed positive connections between perceived operational efficiency and key factors. Notably, companies with higher AI adoption, effective demand prediction, and efficient production planning tended to view their operational efficiency more favorably. Correlation coefficients for AI adoption, demand prediction effectiveness, and production planning effectiveness were 0.48, 0.52, and 0.72, respectively (all with $p < 0.01$), underlining the significant impact of these factors.

Participants were further prompted to identify key contributors to their perceived operational efficiency. The top factors reported were streamlined production processes (68%), effective resource utilization (54%), and adaptive production planning (48%). These factors align with the correlation findings, emphasizing the pivotal role of streamlined processes and optimized resource utilization in achieving operational efficiency.

Additionally, participants offered valuable suggestions for improvement. The most common recommendations included investing in advanced technologies (62%), continuous workforce training (48%), and enhancing collaboration across the supply chain (34%). These suggestions underscore the recognition of technology, skilled personnel, and collaborative relationships as crucial elements for enhancing operational efficiency.

In conclusion, the findings highlight the positive perception of operational efficiency within Jakarta's textile industry. The correlations with AI adoption, demand prediction, and production planning emphasize the interconnected nature of these factors. Key operational factors such as streamlined processes, resource utilization, and adaptive planning emerge as vital contributors to perceived efficiency. The provided suggestions for improvement offer practical insights for companies seeking to enhance their operational efficiency and stay competitive in the dynamic textile industry landscape.

Discussion

The Role of AI in Enhancing Operational Efficiency

The findings support existing literature on the positive impact of AI adoption in the textile industry. The moderate level of AI integration observed suggests a willingness among industry players to embrace transformative technologies. The reported benefits align with previous research, indicating that AI technologies contribute to improved production processes, enhanced quality control, and resource optimization.

Challenges and Opportunities in AI Adoption

Despite the recognized benefits, challenges related to initial investment costs and the need for skilled personnel echo concerns outlined in the literature. The industry must address these challenges to fully harness the potential benefits of AI technologies. Recognizing these challenges as opportunities for improvement, industry stakeholders can focus on targeted investments and workforce development to overcome barriers to adoption.

Importance of Advanced Demand Prediction

The study underscores the critical role of demand prediction in achieving operational efficiency. Companies utilizing advanced analytics for demand forecasting reported more favorable outcomes, highlighting the need for data-driven approaches in anticipating market fluctuations. Addressing challenges related to lead time variations and supply chain complexity will be essential for refining demand prediction practices in the Jakarta textile industry.

Synergies Between Production Planning and Operational Efficiency

The diverse production planning strategies observed in the industry suggest a need for a tailored approach that aligns with the unique characteristics of each company. Industry 4.0 principles, particularly real-time adjustments based on demand variations, emerged as a key driver

of operational efficiency. Integrating such principles into production planning strategies presents an avenue for further optimization.

Implications for Industry Practices

The statistically significant relationship between AI adoption, demand prediction, production planning, and operational efficiency provides a basis for actionable insights. Industry stakeholders can leverage these findings to inform strategic decision-making, emphasizing the importance of holistic approaches that consider the interdependencies among these factors.

Limitations and Suggestions for Future Research

While the study provides valuable insights, it is not without limitations. The cross-sectional nature of the research may limit the ability to establish causal relationships. Additionally, the self-reported nature of survey responses introduces the potential for bias. Future research could explore longitudinal studies and incorporate objective performance metrics to strengthen the robustness of findings.

CONCLUSION

In conclusion, this research contributes a nuanced understanding of the interplay between AI adoption, demand prediction, production planning, and operational efficiency within the textile industry in Jakarta. The positive perceptions of operational efficiency, coupled with identified correlations, highlight the interconnected nature of these factors. Industry stakeholders are encouraged to leverage AI technologies strategically, addressing challenges such as initial investment costs and workforce skill gaps. Advanced analytics in demand prediction and the integration of Industry 4.0 principles in production planning emerge as avenues for improvement. The study underscores the significance of adaptive planning strategies and investments in technology and workforce development for sustained growth in the dynamic textile industry. As technology continues to evolve, the insights presented herein serve as a valuable guide for informed decision-making and strategic positioning within this ever-evolving sector.

REFERENCES

[1] F. Suciati, D. B. Aviantara, A. Purnomo, and M. Krauss, "Chemical of concern for raising awareness to Indonesian textile sustainability," in *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 2023, p. 12006.

[2] V. Sarasi, I. Primiana, B. Harsanto, and Y. Satyakti, "Sustainable supply chain of Indonesia's textile & apparel industry: opportunities and challenges," *Res. J. Text. Appar.*, 2023.

[3] R. RACHMAWATI and E. OCTAVIA, "Inability To Adapt To Environmental Changes Causes the Declining Performance of Indonesia's Textile Industry," *Int. J. Environ. Sustain. Soc. Sci.*, vol. 4, no. 1, pp. 1–9, 2023.

[4] E. L. Zahra and S. L. Suryawati, "Analyzing The Implementation of Sustainable Fashion In The Fashion School Curriculum in Jakarta.(A Case Study: Fashion Design in IKJ and Polimedia Jakarta)," in *ACEIVE 2022: Proceedings of the 4th Annual Conference of Engineering and Implementation on Vocational Education, ACEIVE 2022, 20 October 2022, Medan, North Sumatra, Indonesia*, European Alliance for Innovation, 2023, p. 36.

[5] S. Nurkomariyah and A. E. Tyasti, "The Effectiveness of Fabric Safeguards in Protecting and Improving the Indonesian Textile Industry Competitiveness," *J. Manaj. Agribisnis*, vol. 19, no. 3, p. 351, 2022.

[6] F. Cleary, W. Srisa-An, D. C. Henshall, and S. Balasubramaniam, "Emerging AI Technologies Inspiring the Next Generation of E-textiles," *IEEE Access*, 2023.

[7] A. Gangoda, S. Krasley, and K. Cobb, "AI digitalisation and automation of the apparel industry and human workforce skills," *Int. J. Fash. Des. Technol. Educ.*, pp. 1–11, 2023.

[8] H. Ailisto, H. Helaakoski, and A. Neuvonen, "Benefits of Machine Learning in the Manufacturing Industry," 2023.

[9] S. J. Plathottam, A. Rzonca, R. Lakhnori, and C. O. Iloeje, "A review of artificial intelligence applications in manufacturing operations," *J. Adv. Manuf. Process.*, p. e10159, 2023.

[10] I. Batra, S. A. H. Prasad, and K. S. Arvind, "Review On the Techniques Used for Detection of Fabric Defects Using AI," in *2023 International Conference on Advances in Electronics, Communication, Computing and Intelligent Information Systems (ICAECIS)*, IEEE, 2023, pp. 534–539.

[11] M. Kunz *et al.*, "Deep Learning based Forecasting: a case study from the online fashion industry," *arXiv Prepr. arXiv2305.14406*, 2023.

[12] M. Koren and M. Shnaiderman, "Forecasting in the fashion industry: a model for minimising supply-chain costs," *Int. J. Fash. Des. Technol. Educ.*, pp. 1–11, 2023.

[13] M. Wahyudi, H. T. Sihotang, S. Efendi, M. Zarlis, H. Mawengkang, and D. Vinsensia, "A stochastic approach for evaluating production planning efficiency under uncertainty," *Int. J. Electr. Comput. Eng.*, vol. 13, no. 5, pp. 5542–5549, 2023.

[14] H. Ding, H. Gao, Y. Dong, and S. Huang, "Research and implementation of order-oriented textile production scheduling system," *J. Chinese Inst. Eng.*, vol. 46, no. 4, pp. 331–344, 2023.