



Strategies for Reducing Production Costs through Integrated Printing Machines in Living Lab Environments

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ARTICLE INFO

Article history:

Received March 08, 2026

Revised April 29, 2026

Accepted April 30, 2026

Available online June 25, 2026

Kata Kunci:

Mesin Cetak, living lab, reduksi biaya produksi, industry kreatif, efisiensi produk

Keywords:

integrated printing machines, living lab, production cost reduction, creative industry, production efficiency



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ABSTRAK

Industri kreatif semakin membutuhkan sistem produksi yang efisien untuk meningkatkan daya saing dan keberlanjutan. Salah satu inovasi yang muncul adalah implementasi mesin cetak terintegrasi dalam lingkungan living lab untuk mengoptimalkan proses produksi dan mengurangi biaya produksi. Studi ini bertujuan untuk menganalisis strategi pengurangan biaya produksi melalui pemanfaatan mesin cetak terintegrasi dalam lingkungan living lab.

Studi ini menggunakan pendekatan kualitatif dengan menggunakan observasi, wawancara mendalam, dan teknik dokumentasi yang melibatkan pimpinan perusahaan percetakan, operator mesin, dan praktisi industri kreatif. Data dianalisis secara deskriptif untuk mengidentifikasi efektivitas sistem pencetakan terintegrasi dalam mendukung efisiensi produksi.

Temuan menunjukkan bahwa penggunaan mesin cetak terintegrasi dari Tiongkok secara signifikan meningkatkan efisiensi operasional dengan mengurangi waktu produksi, meminimalkan limbah material, mengintegrasikan berbagai fungsi pencetakan ke dalam satu sistem, dan menurunkan biaya tenaga kerja. Selain itu, lingkungan living lab mendukung inovasi, eksperimen, dan pembelajaran kolaboratif dalam mengembangkan sistem produksi yang lebih adaptif dan efisien. Namun, beberapa tantangan diidentifikasi, termasuk adaptasi mesin, pemeliharaan teknis, dan pengembangan kompetensi operator.

Studi ini menyimpulkan bahwa mesin cetak terintegrasi dalam lingkungan living lab dapat menjadi strategi yang efektif untuk mengurangi biaya produksi sekaligus meningkatkan produktivitas dan daya saing dalam industri kreatif. Penguatan pelatihan teknis, sistem pemeliharaan, dan kolaborasi berbasis inovasi sangat penting untuk mendukung implementasi yang berkelanjutan.

ABSTRACT

The creative industry increasingly requires efficient production systems to improve competitiveness and sustainability. One of the emerging innovations is the implementation of integrated printing machines within living lab environments to optimize production processes and reduce production costs. This study aims to analyze strategies for reducing production costs through the utilization of integrated printing machines in living lab environments.

The study employed a qualitative approach using observations, in-depth interviews, and documentation techniques involving printing business managers, machine operators, and creative industry practitioners. Data were analyzed descriptively to identify the effectiveness of integrated printing systems in supporting production efficiency.

The findings indicate that the use of integrated printing machines from China significantly improves operational efficiency by reducing production time, minimizing material waste, integrating multiple

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printing functions into a single system, and lowering labor costs. In addition, the living lab environment supports innovation, experimentation, and collaborative learning in developing more adaptive and efficient production systems. However, several challenges were identified, including machine adaptation, technical maintenance, and operator competency development. The study concludes that integrated printing machines in living lab environments can become an effective strategy for reducing production costs while improving productivity and competitiveness in the creative industry. Strengthening technical training, maintenance systems, and innovation-based collaboration is essential to support sustainable implementation.

1. INTRODUCTION

The creative industry has experienced significant growth in recent years, driven by technological development, market expansion, and increasing consumer demand for customized products. In the printing sector, business competition requires companies and creative industry actors to continuously improve production efficiency while maintaining product quality and innovation. One of the major challenges faced by printing businesses is the high production cost, including labor expenses, material waste, machine operation costs, and production time inefficiency. Therefore, production cost reduction strategies have become essential for improving competitiveness and business sustainability in the creative industry (Heizer, Render, & Munson, 2020).

The advancement of integrated printing technology has created new opportunities for improving production efficiency. Integrated printing machines, particularly those developed in China, offer multifunctional systems capable of combining several production processes into a single operational unit. These technologies enable businesses to reduce operational complexity, minimize material waste, and shorten production cycles. In addition, integrated systems support automation and digital-based production management, which are increasingly important in modern manufacturing and creative production environments (Slack & Brandon-Jones, 2019).

In the context of innovation-based production systems, the concept of the living lab has emerged as an effective approach for integrating technology, experimentation, and collaborative learning. Living labs provide real-world environments where innovation can be tested, developed, and optimized through collaboration among industry practitioners, researchers, technology developers, and users (Bergvall-Kåreborn & Ståhlbröst, 2009). In the printing industry, living lab environments allow businesses to evaluate machine performance, production workflows, and cost-efficiency strategies more dynamically and adaptively. This approach supports continuous innovation and practical problem-solving in production management.

The implementation of integrated printing machines in living lab environments has the potential to significantly reduce production costs while improving productivity and operational flexibility. Previous studies have shown that technology integration in manufacturing processes contributes to efficiency improvement, production accuracy, and resource optimization (Porter & Heppelmann, 2015). However, many small and medium-scale creative industries still face limitations in adopting integrated production technologies due to technical capability, investment concerns, and lack of operational knowledge. Consequently, there is a need to identify strategic approaches that can support the effective utilization of integrated printing systems in creative production environments.

This study aims to analyze strategies for reducing production costs through the use of integrated printing machines in living lab environments. The study focuses on identifying operational benefits, implementation challenges, and institutional strategies that support production efficiency in the creative industry. The findings are expected to contribute to the development of technology-based production management models that are more efficient, innovative, and sustainable for the printing and creative industry sectors.

2. METHOD

This study employed a qualitative case study approach to explore production cost reduction strategies through the utilization of integrated printing machines within a living lab environment, an innovation ecosystem that enables technologies to be tested and implemented under real-world operational conditions. Data were collected through in-depth interviews, participant observations, and the analysis of production-related documents involving business owners, production managers, and machine operators. Production cost reduction was examined through a comparative analysis of operational conditions before and after the implementation of the integrated printing machine, focusing on indicators such as raw material efficiency, labor requirements, production time,

operational expenses, and maintenance costs. To enhance the validity and credibility of the findings, the study employed source and method triangulation as well as member checking. Data were analyzed using thematic analysis, which involved data reduction, data display, and conclusion drawing and verification (Creswell, 2018).

Data collection was conducted through in-depth interviews, direct observations, and documentation techniques. Three informants were selected using purposive sampling, involving printing business owners, production managers, machine operators, and creative industry practitioners who directly utilized integrated printing machines in their production processes. These informants were considered capable of providing detailed information regarding operational systems, production challenges, and cost-efficiency strategies.

The study also observed production workflows within living lab environments to identify the effectiveness of integrated printing systems in reducing material waste, production time, labor usage, and operational costs. Supporting documents such as production reports, workflow records, and operational guidelines were analyzed to strengthen the research findings.

Data analysis was conducted using descriptive qualitative analysis through data reduction, data presentation, and conclusion drawing processes (Miles, Huberman, & Saldaña, 2014). To ensure data validity, triangulation techniques were applied by comparing interview results, observational findings, and supporting documentation obtained during the research process.

3. RESULT AND DISCUSSION

Result

The results of this study demonstrate that the implementation of integrated printing machines in living lab environments significantly improved production efficiency and reduced production costs in the creative printing industry. The integration of multiple printing functions into a single operational system simplified production workflows and reduced dependence on several separate machines. Informants explained that production activities became more efficient because multiple processes, including printing, finishing, and material handling, could be completed simultaneously within one integrated machine system. This operational integration reduced production bottlenecks and accelerated workflow performance in daily production activities (Amri, 2025).

The implementation of integrated printing systems also contributed to improving time efficiency in production management. Before adopting integrated machines, businesses commonly experienced delays due to machine transitions, manual setup adjustments, and fragmented operational processes. Through integrated systems, production cycles became shorter because operators no longer needed to transfer materials between different machines and workstations. As a result, businesses were able to increase production capacity while maintaining production consistency and product quality. Several informants emphasized that production targets could be achieved more effectively after adopting integrated printing technologies.

The findings further revealed that integrated printing machines reduced labor usage and operational complexity. Previously, production processes required several operators to manage different stages of printing activities separately. The use of multiple standalone machines increased coordination difficulties and created inefficiencies in workflow management. Through integrated systems, businesses were able to minimize manual handling activities and improve workflow coordination within the production environment. Consequently, labor costs decreased because fewer operators were needed to complete the same production volume. In addition, simplified operational systems enabled workers to focus more on quality control and production monitoring rather than repetitive manual tasks.

Another important finding was related to the reduction of material waste during production activities. Informants explained that automated calibration systems and digital production controls improved printing precision and reduced production errors significantly. In conventional production systems, material waste often occurred due to inaccurate machine settings, inconsistent color calibration, and human operational errors. However, integrated printing machines provided more accurate and stable operational settings, allowing businesses to optimize material usage and reduce unnecessary waste. This condition contributed directly to lower raw material costs and more sustainable production practices.

The study also identified improvements in product quality consistency after the implementation of integrated printing technology (Zulfah, 2026). Automated operational systems enabled businesses to maintain standardized production outputs across different production batches. Informants stated that customers experienced greater satisfaction due to more consistent printing quality, color accuracy, and finishing results. This consistency became an important factor in

strengthening customer trust and maintaining long-term business relationships within competitive creative industry markets.

Furthermore, several informants explained that integrated printing machines from China offered multifunctional capabilities with relatively affordable operational and maintenance costs compared to conventional systems. The machines were capable of handling various production requirements within a single platform, making them suitable for small and medium-sized creative businesses seeking production flexibility and cost efficiency (Taali, 2026). The affordability of the machines also encouraged wider technology adoption among creative industry practitioners who previously faced limitations in accessing advanced printing technologies.

The study further revealed that living lab environments played an important role in supporting innovation and collaborative learning among production actors. Through living lab systems, businesses were able to test machine performance, evaluate workflows, and develop adaptive production strategies in real operational environments. The living lab approach created opportunities for direct experimentation and continuous process improvement based on actual production challenges. This environment encouraged collaboration between machine operators, business owners, technicians, and technology providers in identifying operational problems and developing practical solutions.

In addition, living lab environments facilitated knowledge sharing and technical skill development among production personnel. Operators were able to learn machine optimization techniques, troubleshooting methods, and workflow improvement strategies through direct operational experiences. Informants highlighted that collaborative learning activities within living lab environments increased employee adaptability toward new technologies and improved overall production management capabilities. This condition contributed positively to the long-term sustainability of integrated printing system implementation (Arrahima, 2024).

Despite the positive impacts, the study also identified several implementation challenges. Technical adaptation difficulties remained a significant issue, particularly during the early stages of machine adoption. Some operators experienced challenges in understanding digital operational systems, machine calibration procedures, and software integration processes. Limited technical knowledge occasionally resulted in operational disruptions and reduced production effectiveness during the adjustment period (Amri, 2024).

Machine maintenance was another challenge identified in this study. Several businesses faced difficulties in accessing technical support, spare parts, and maintenance services for integrated printing machines. Informants explained that regular maintenance was essential to maintain machine performance and operational stability. However, limited technical expertise among operators sometimes caused delays in identifying and resolving technical problems, particularly in small-scale creative businesses with limited maintenance resources.

Additionally, the study found that limited operator competencies continued to affect the optimization of integrated machine utilization. Some businesses still lacked structured technical training programs to support employee adaptation toward advanced printing technologies. As a result, certain machine features and multifunctional capabilities were not fully utilized in production processes. Informants emphasized the importance of continuous technical training and operational mentoring to maximize production efficiency and ensure sustainable technology implementation in the creative printing industry.

Discussion

The findings indicate that integrated printing machines can become an effective strategy for reducing production costs and improving operational performance in the creative industry. The ability of integrated systems to combine multiple production processes into one operational unit supports production efficiency and workflow simplification. This finding aligns with the study by Slack and Brandon-Jones (2019), which emphasizes that process integration and operational efficiency are essential components of modern production management.

The reduction of material waste and labor usage also demonstrates the importance of technology adoption in achieving cost efficiency. Automated production systems improve production accuracy and reduce operational errors, which ultimately contribute to lower production costs. According to Heizer, Render, and Munson (2020), technology-based manufacturing systems play an important role in optimizing resources and improving production sustainability.

The role of living lab environments in this study highlights the importance of collaborative innovation in technology implementation. Living labs provide opportunities for businesses to experiment with production systems directly in real operational contexts. Through collaboration among machine operators, business owners, and technology developers, production challenges can

be identified and solved more effectively. This finding supports the concept proposed by Bergvall-Kåreborn and Ståhlbröst (2009), which states that living labs facilitate innovation through user-centered experimentation and collaborative learning.

Despite the positive impacts, the study also demonstrates that technology implementation requires organizational readiness and human resource development. Technical adaptation, maintenance management, and operator competency remain important challenges, particularly for small and medium-sized creative industries. Porter and Heppelmann (2015) explain that successful implementation of integrated technology depends not only on machine capability but also on managerial support, technical skills, and continuous organizational learning.

Overall, the study confirms that integrated printing machines in living lab environments can support sustainable production management and improve competitiveness in the creative industry. Continuous technical training, institutional collaboration, and innovation-based operational strategies are necessary to maximize the benefits of integrated printing technology in long-term production systems.

4. CONCLUSION

This study concludes that the implementation of integrated printing machines in living lab environments can become an effective strategy for reducing production costs and improving operational efficiency in the creative printing industry. The integration of multiple production functions into a single machine system contributed to faster production processes, lower labor requirements, reduced material waste, and more efficient operational workflows. These improvements enhanced productivity and supported the competitiveness of creative industry businesses in increasingly dynamic market conditions.

The study also highlights the important role of living lab environments in supporting innovation, experimentation, and collaborative learning. Through real operational testing and interaction among business actors, operators, and technology developers, living labs enabled businesses to identify more adaptive and efficient production strategies. This collaborative environment encouraged continuous improvement in production management and technology utilization.

However, several challenges remain, including technical adaptation, machine maintenance, and limited operator competencies. Therefore, successful implementation of integrated printing technology requires continuous technical training, institutional support, and sustainable maintenance systems. Strengthening collaboration between creative industry actors and technology providers is also essential to maximize the long-term benefits of integrated printing systems.

Overall, integrated printing machines in living lab environments have significant potential to support sustainable production management, reduce production costs, and strengthen the competitiveness of the creative industry through technology-based innovation and operational efficiency.

5. ACKNOWLEDGE

The authors would like to express their sincere gratitude to the Malaysian company that invited and facilitated this research activity in China, providing valuable opportunities to observe and study the implementation of living lab printing environments and integrated printing technologies. Special appreciation is also extended to INSAN Malaysia for sharing valuable experiences and practical examples related to the development of living lab systems and innovation-based industrial collaboration.

The authors would also like to thank Politeknik Negeri Media Kreatif (Polimedia Kreatif) for providing academic insight and practical learning experiences in the printing industry, which greatly contributed to the development of this research. Furthermore, sincere appreciation is addressed to Politeknik Negeri Madiun (PNM) for granting permission and institutional support for conducting this research activity.

The support, collaboration, and knowledge shared by all parties have significantly contributed to the completion of this study.

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