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Original Article (Qualitative)

Designing a model for improving commercialization in the PVC industry with an emphasis on the role of emerging technologies

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Abstract

The aim of this study is to design a model for improving commercialization in the PVC industry with an emphasis on the role of emerging technologies. The research method is applicable in terms of its purpose, and exploratory in terms of qualitative approach and data analysis. The statistical population of the study consisted of 15 experts in the PVC industry, including technical and production managers of factories, formulation and R&D specialists, and faculty members in the fields of polymer and technology management, selected by purposive and snowball sampling methods. Semi-structured interviews were applied to collect information. Thematic analysis approach and MAXQDA software were applied to analyze the data. The results showed that the initial codes extracted were categorized into five organizing themes including “Environmental Pressures on Commercialization”, “Technological Capabilities and Capacities”, “Organizational and Management Factors”, “Market and Commercialization Processes”, and “Consequences and Achievements of Commercialization”. Finally, the overarching theme of the research was identified as “Improving Commercialization through Emerging Technologies in the PVC Industry”. The research findings showed that utilizing new technologies, enhancing technological capacities, strengthening knowledge management, developing market-oriented interactions, and improving organizational infrastructure play a decisive role in increasing the effectiveness of the commercialization process in the PVC industry. The results of this research can be used as a practical framework for industrial managers, policymakers, and polymer activists to develop the commercialization of innovative products and technologies.

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Extended Abstract

Introduction

In recent decades, emerging technologies have played a prominent role in improving organizational performance, increasing competitiveness, and sustainable development as key drivers in the transformation of the structure of various industries. In the meantime, the polymer industry, and especially polyvinyl chloride (PVC), has become one of the most important sub-sectors of the petrochemical industry due to its unique characteristics, including reasonable price, high durability, flexibility in application, and recyclability. The development of new technologies in this area can lead to the production of products with better performance, reduced energy costs, improved environmental properties, and expanded the range of industrial applications (Delogu et al., 2020). Internationally, several models for technology commercialization have been developed that focus on interaction and synergy between key stakeholders such as universities, the private sector, government institutions, and investors. For example, the "triple helix" model emphasizes the synergy of knowledge, policy, and economics to facilitate the process of transforming science into products (Etzkowitz & Leydesdorff, 2022). In these frameworks, knowledge management, market analysis, technology assessment, and business model design are key elements for successful commercialization. However, adapting these models to the economic, cultural, and structural environment of countries such as Iran requires localization and redesign based on local realities (OECD, 2021). New approaches such as open innovation and technology co-creation platforms can be used as components that strengthen the commercialization model. By facilitating participation among stakeholders, these approaches help accelerate the idea-to-market process and can lead to the creation of a sustainable value chain in the PVC industry (Chasbro, 2020). Although the international literature has extensively addressed business models in the polymer materials and chemical industries, a review of recent articles shows that existing research is often either generic and cross-industry, without focusing on the specific characteristics of PVC such as high environmental and regulatory sensitivity, or solely on sectors such as market, technology or regulation, rather than on a comprehensive commercialization model. In particular, the integration of sustainability, circular economy and digitalization dimensions in the design of commercialization models for PVC technologies is less visible in a structured manner. Therefore, the main question that this research seeks to answer is: what does a commercialization improvement model look like in the PVC industry with an emphasis on the role of emerging technologies?

Theoretical Framework

Commercialization in the PVC Industry

In PVC extrusion and granulation lines, monitoring indicators include a set of process, equipment, quality and maintenance variables that comprehensively describe the behavior of the production system. Variables such as temperature, pressure, screw speed, equipment vibration, product weight and color, cutting blade speed, and production rate are among the indicators whose deviation from the optimal range can lead to quality degradation or line shutdown. The thermal sensitivity of PVC makes precise control of temperature and pressure in different areas of the extruder particularly important, as any fluctuations can lead to thermal degradation of the material and an increase in defective products (Pinto et al, 2020).

Adomako & Tran (2026) examined Innovation versus Chance; The impact of regulatory challenges on technology commercialization performance and product innovation. Using two-wave, multi-informant survey data from 336 SMEs in Vietnam, the results confirm the mediating role of commercialization potential. Furthermore, while intangible resource

advantage strengthens the link between commercialization and innovation, environmental hostility unexpectedly weakens it, indicating that external pressures can overshadow firms' commercialization efforts. These findings contribute to regulatory science and innovation research by highlighting commercialization potential as a critical mechanism through which institutions influence innovation. The present study provides insights for managers seeking to overcome institutional barriers and for policymakers seeking to create more innovative regulatory environments.

Pujotomo et al. (2025) examined a scenario of accelerating technology commercialization in a research university, applying a systems dynamics approach. The results show that TTO participation can reduce delays by directly matching university inventions with early adopters. Furthermore, given that TTOs coordinate initial grants, competitions, and external support; the results also increase funding prospects. Meanwhile, additional funding for inventors can further influence the speed of development, emphasizing the importance of team performance and resource availability. Overall, team dynamics, including expertise and time allocation, are crucial for rapid progress towards TRL levels. Active participation of end-users in design and testing also accelerates improvements. Based on these insights, we provide a practical scenario guide for technology transfer office managers to address budget shortfalls, optimize resources, and shorten commercialization timelines.

Research Methodology

The research method is applicable in terms of its purpose, and exploratory in terms of qualitative approach and data analysis. The statistical population of the study consisted of 15 experts in the PVC industry, including technical and production managers of factories, formulation and R&D specialists, and faculty members in the fields of polymer and technology management, selected by purposive and snowball sampling methods. Semi-structured interviews were applied to collect data.

Research Findings

Thematic analysis approach and MAXQDA software were utilized to analyze the data. The results showed that the initial codes extracted were categorized into five organizing themes including "Environmental Pressures on Commercialization", "Technological Capabilities and Capacities", "Organizational and Management Factors", "Market and Commercialization Processes", and "Consequences and Achievements of Commercialization". Finally, the overarching theme of the research was identified as "Improving Commercialization through Emerging Technologies in the PVC Industry". The research findings showed that utilizing new technologies, enhancing technological capacities, strengthening knowledge management, developing market-oriented interactions, and improving organizational infrastructure play a decisive role in increasing the effectiveness of the commercialization process in the PVC industry. The results of this research can be used as a practical framework for industrial managers, policymakers, and polymer activists to develop the commercialization of innovative products and technologies.

Conclusion

The present study was conducted with the aim of designing a model for improving commercialization in the PVC industry with an emphasis on the role of emerging technologies. The results of this study are consistent with those of Adomako & Tran (2026), Pujotomo et al. (2025), Sato et al. (2025), Banoo Farhang & Ansari (2025), and Momiyond et al. (2024). Pujotomo et al. (2025) showed that TTO participation can reduce delays by

directly matching university inventions with early adopters. Furthermore, given that TTOs coordinate initial grants, competitions, and external sponsorships, the results also increase funding prospects. Meanwhile, additional funding for inventors can further impact development speed, emphasizing the importance of team performance and resource availability. Overall, team dynamics—including expertise and time allocation—are critical for rapid progress toward TRL levels. Active participation of end users in design and testing also accelerates improvements.

Based on the research results, the following suggestion was made:

PVC industry managers should create a structured "environmental monitoring" system to continuously collect, analyze, and link changes in the market, competitors, standard requirements, and environmental policies to technological decisions. This system should be able to provide early warnings and prepare the organization to face external threats. Such an approach prevents the organization from being caught in the middle of sudden changes and makes technological decisions more rational and forward-looking.