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Digital entrepreneurship in U.S. pharmaceuticals: Integrating marketing innovation and supply chain efficiency

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Abstract

Digital entrepreneurship transforms the U.S. pharmaceutical industry by integrating innovative marketing strategies with efficient supply chain operations. This paper explores how advancements in digital technologies, such as artificial intelligence, blockchain, predictive analytics, and omnichannel platforms, enhance marketing outreach and optimize supply chain processes. The analysis highlights the growing importance of aligning marketing and supply chain functions to meet consumer demands, ensure regulatory compliance, and foster operational excellence. The synergistic integration of these domains drives cost efficiency and improves customer satisfaction and responsiveness in a highly competitive market. However, challenges such as data security, regulatory constraints, and the complexity of implementation must be addressed to unlock the full potential of digital entrepreneurship. The paper concludes with actionable recommendations, including investing in comprehensive digital ecosystems, fostering cross-functional collaboration, and leveraging partnerships to achieve sustainable growth and innovation in the pharmaceutical sector.

Keywords: Digital Entrepreneurship; Pharmaceutical Marketing; Supply Chain Optimization; Artificial Intelligence; Blockchain Technology; Predictive Analytics

1. Introduction

1.1. Defining Digital Entrepreneurship in the Context of U.S. Pharmaceuticals

Digital entrepreneurship refers to adopting and utilizing digital technologies to create and sustain business ventures, encompassing innovative operations, marketing, and customer engagement approaches (Bican & Brem, 2020). In the U.S. pharmaceutical industry, digital entrepreneurship is reshaping traditional practices, enabling companies to enhance efficiency, expand market reach, and respond more dynamically to consumer needs (Kraus, Palmer, Kailer, Kallinger, & Spitzer, 2019). This transformation involves strategically deploying tools like big data analytics, artificial intelligence (AI), blockchain, and cloud computing to streamline operations, improve customer experiences, and achieve competitive advantages. By integrating these technologies, pharmaceutical companies address long-standing challenges, such as navigating complex regulatory landscapes, improving drug accessibility, and ensuring supply chain transparency (Modgil, Dwivedi, Rana, Gupta, & Kamble, 2022).

The U.S. pharmaceutical market, one of the largest and most influential globally, is a fertile ground for digital innovation. Companies operating in this sector are compelled to adopt entrepreneurial strategies to remain competitive amidst evolving consumer expectations, global health crises, and stringent compliance requirements (Acs, Song, Szerb, Audretsch, & Komlósi, 2021). As digital entrepreneurship gains traction, it facilitates operational efficiencies and fosters

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innovation in drug discovery, personalized medicine, and patient engagement, creating a profound impact on public health and economic growth (Daraojimba et al., 2023).

1.2. The Significance of Marketing Innovation and Supply Chain Efficiency

Marketing innovation and supply chain efficiency are pivotal components of digital entrepreneurship in the pharmaceutical sector. Marketing innovation encompasses the adoption of advanced technologies and strategies to reach target audiences effectively, ensuring that pharmaceutical products and services meet patient and healthcare provider needs. This includes leveraging digital platforms for personalized marketing campaigns, utilizing AI-driven insights to understand consumer behavior, and implementing omnichannel strategies to enhance customer interactions (Saha, Rathore, Parida, & Rana, 2022).

The growing reliance on digital marketing is driven by shifts in consumer behavior and the increasing use of online platforms to access healthcare information and services. Innovative marketing enables pharmaceutical companies to increase brand awareness and build trust by delivering accurate, transparent, and timely product information. Moreover, directly engaging with end-users and healthcare professionals enhances patient education, adherence to medication regimens, and overall health outcomes (Ma, Shi, & Kang, 2022).

On the other hand, supply chain efficiency is crucial for ensuring the timely and cost-effective delivery of pharmaceutical products to end-users. This entails integrating digital tools to streamline logistics, optimize inventory management, and monitor product integrity. Technologies such as blockchain ensure transparency and traceability, reducing risks related to counterfeit drugs. Predictive analytics and IoT solutions enable real-time monitoring of supply chain operations, helping companies anticipate disruptions and make informed decisions (Shashi, 2022).

The interplay between marketing innovation and supply chain efficiency cannot be overstated. For instance, effective marketing strategies often depend on the reliability of supply chains to ensure product availability. Conversely, an optimized supply chain enables seamless execution of marketing campaigns by ensuring that promoted products are accessible to consumers. Together, these elements underpin the success of digital entrepreneurship initiatives in the pharmaceutical sector, enhancing both operational performance and customer satisfaction (Gardner et al., 2019).

1.3. Objectives and Scope of the Paper

This paper explores how digital entrepreneurship drives innovation and efficiency within the U.S. pharmaceutical industry. By examining the intersections of marketing innovation and supply chain efficiency, the study seeks to highlight the transformative potential of digital tools and strategies in addressing industry challenges and fostering sustainable growth.

The primary objective is to analyze how digital entrepreneurship facilitates the development of integrated solutions that bridge marketing and supply chain functions, creating a cohesive framework for enhancing organizational performance. The paper also aims to provide actionable insights for pharmaceutical companies seeking to effectively adopt and scale digital strategies.

The scope of the study is centered on the U.S. pharmaceutical market, considering its unique regulatory environment, market dynamics, and technological advancements. The analysis will delve into key trends, challenges, and opportunities associated with digital entrepreneurship in this context, offering a comprehensive understanding of its implications for industry stakeholders. By addressing these objectives, the paper seeks to contribute to the growing discourse on digital transformation in the pharmaceutical sector, providing a roadmap for companies aiming to leverage digital entrepreneurship to achieve marketing excellence and supply chain resilience. In doing so, it underscores the importance of innovation and collaboration in shaping the future of this critical industry.

2. Digital Marketing Innovation in Pharmaceuticals

2.1. Trends in Digital Marketing Strategies Tailored to Pharmaceuticals

Digital marketing in the pharmaceutical industry has evolved significantly in recent years, driven by advancements in technology and changing consumer behaviors. Traditional marketing approaches such as in-person sales visits and print advertising are increasingly complemented or replaced by innovative digital strategies that allow for greater personalization, scalability, and cost-efficiency. Key trends shaping digital marketing in this sector include content marketing, omnichannel engagement, and the use of data-driven insights to enhance decision-making (Agarwal, Dugas, Gao, & Kannan, 2020).

Content marketing has become a cornerstone of pharmaceutical digital marketing strategies. Companies now focus on creating informative, credible, and patient-centric content to educate consumers about health conditions, treatment options, and their products. This strategy builds trust with audiences and positions pharmaceutical brands as thought leaders in their respective fields. For example, many firms leverage blogs, video tutorials, and webinars to provide valuable information that empowers patients to make informed decisions about their health (Rijcken & Mirzaei, 2019).

Omnichannel engagement is another trend that has gained prominence, enabling pharmaceutical companies to deliver consistent and seamless experiences across multiple platforms. From email campaigns and mobile apps to social media channels, firms aim to create interconnected touchpoints where consumers can access information, interact with healthcare professionals, and even purchase products. This approach ensures that customers receive relevant and timely messaging, fostering stronger relationships and improving patient adherence to prescribed treatments (Adkonkar, Angrish, & Bansal, 2022). Additionally, leveraging data analytics has allowed pharmaceutical marketers to move beyond generalized campaigns toward hyper-personalized strategies. Companies can design targeted campaigns that resonate with specific audiences by analyzing patient demographics, behaviors, and preferences. This precision marketing increases engagement and maximizes marketing efforts' return on investment (ROI) (Palmatier, Sivadas, Stern, & El-Ansary, 2019).

2.2. The Role of Technology in Pharmaceutical Marketing

Technology is at the heart of digital marketing innovation, offering tools and platforms that enable pharmaceutical companies to connect with audiences more effectively. Artificial intelligence (AI) is one of the most transformative technologies in this space, driving automation, personalization, and insights generation. For example, AI-powered chatbots provide 24/7 customer support, answering queries about medications and side effects while freeing up resources for more complex interactions. Similarly, AI algorithms analyze vast amounts of data to identify trends and optimize real-time marketing strategies (Trenfield et al., 2022).

Social media platforms play a pivotal role in engaging both consumers and healthcare professionals. With billions of active users, platforms like Facebook, LinkedIn, and Twitter serve as powerful channels for promoting products, sharing educational content, and gathering feedback. Social media campaigns can be tailored to target specific demographics, ensuring that messaging reaches the intended audience. Furthermore, influencers and key opinion leaders (KOLs) are increasingly leveraged to endorse pharmaceutical products, lending credibility and amplifying brand reach (Farsi, 2021).

Targeted advertising has also revolutionized how pharmaceutical companies communicate with consumers. Programmatic advertising, which uses algorithms to automate the placement of digital ads, ensures that advertisements are displayed to individuals who are most likely to be interested in them. For instance, a company marketing a diabetes medication can target ads specifically to users who have searched for information related to diabetes management or who follow diabetes-related pages on social media. This level of specificity reduces wasted ad spend and enhances campaign effectiveness (Bishop, 2019).

Virtual and augmented reality (VR/AR) are emerging technologies that are being incorporated into marketing strategies to create immersive experiences. For example, pharmaceutical firms use VR to simulate drug mechanisms for healthcare professionals, offering a deeper understanding of how a product works. Similarly, AR applications enable consumers to visualize how medical devices function or interact with products in real-world settings (Renu, 2021).

2.3. Addressing Regulatory and Ethical Considerations

While digital marketing offers immense innovation potential, it also presents significant regulatory and ethical challenges, particularly in the highly regulated pharmaceutical industry. The U.S. Food and Drug Administration (FDA) is critical in overseeing pharmaceutical marketing practices, ensuring that advertisements are truthful, not misleading, and backed by scientific evidence. Compliance with FDA guidelines is essential to maintaining public trust and avoiding legal repercussions.

One key regulatory consideration is the requirement for balanced messaging. Pharmaceutical advertisements must present a product's benefits and risks, ensuring that consumers understand its potential impact. This requirement can be challenging to fulfill in digital formats, such as social media posts or short video ads, where space and time are limited. Companies must find creative ways to convey essential information without compromising clarity or compliance (Bhasale et al., 2021).

Privacy concerns also pose ethical challenges in the digital marketing landscape. The collection and use of consumer data for targeted advertising must adhere to regulations such as the Health Insurance Portability and Accountability Act (HIPAA) and the General Data Protection Regulation (GDPR). Companies must ensure that patient information is handled responsibly, with explicit consent and robust security measures in place to prevent data breaches (Bleier, Goldfarb, & Tucker, 2020).

Transparency is another critical ethical consideration. Pharmaceutical companies must avoid practices that could be perceived as manipulative, such as exaggerating product efficacy or downplaying risks. Additionally, influencers and KOLs require clear disclosure of any financial relationships to maintain credibility and avoid misleading audiences. Finally, companies must navigate the ethical implications of promoting products directly to consumers, particularly in cases where self-diagnosis and self-medication could have adverse outcomes. Balancing the need to educate and inform with the responsibility to protect public health is a delicate task that requires careful planning and oversight (Cosgrove & Vaswani, 2019).

3. Supply Chain Efficiency Through Digital Transformation

3.1. The Impact of Digital Tools on Supply Chain Optimization

Digital transformation has profoundly reshaped the pharmaceutical supply chain, enabling companies to streamline operations, improve efficiency, and enhance transparency. Traditional supply chain models often struggled with inefficiencies, such as delays in production, inadequate inventory management, and poor visibility across stakeholders (Pellicelli, 2022). However, the integration of digital tools has addressed these challenges by automating processes, improving decision-making, and facilitating real-time monitoring. For instance, enterprise resource planning (ERP) systems are now widely employed to integrate and manage core supply chain functions, including procurement, production, distribution, and inventory management. ERP systems enable better coordination among suppliers, manufacturers, and distributors by centralizing data and processes. Additionally, digital platforms for demand forecasting use historical sales data and market trends to predict future demand, reducing overstocking and stockouts while optimizing resources (Faccia & Petratos, 2021).

Advanced transportation management systems (TMS) have also enhanced supply chain efficiency by optimizing shipping routes, managing carrier performance, and tracking real-time shipments. These systems help reduce costs and ensure timely delivery, which is critical in the pharmaceutical industry where delays can disrupt patient access to essential medications. Moreover, digital tools enable pharmaceutical companies to comply with stringent regulations by providing detailed documentation and traceability across the supply chain (Verma & Singh, 2023).

3.2. Examining Key Technologies: Blockchain, IoT, and Predictive Analytics

Among the transformative technologies driving supply chain optimization, blockchain, the Internet of Things (IoT), and predictive analytics have emerged as pivotal solutions. Blockchain technology addresses one of the most pressing challenges in the pharmaceutical supply chain: ensuring the authenticity and safety of products. Counterfeit drugs are a significant global issue, jeopardizing patient safety and eroding trust in the industry. Blockchain creates a decentralized, immutable ledger that records every transaction within the supply chain, from raw material sourcing to the delivery of finished products. This transparency ensures that all parties, including manufacturers, distributors, and regulators, have access to verifiable data. For example, blockchain-enabled systems can provide a tamper-proof record of a medication's journey, enabling swift identification and removal of counterfeit products from the market (Helo & Shamsuzzoha, 2020).

IoT technology enhances supply chain visibility by enabling real-time tracking of assets, monitoring environmental conditions, and improving logistics management. IoT devices, such as smart sensors and GPS trackers, are used to monitor temperature, humidity, and other conditions critical to maintaining the integrity of pharmaceutical products. This is particularly important for vaccines and biologics requiring strict cold-chain management. IoT-enabled systems also provide alerts when conditions deviate from acceptable ranges, allowing for immediate corrective actions. Additionally, IoT improves inventory management by providing accurate, real-time data on stock levels, ensuring that supplies are replenished proactively to meet demand (Pramanik, Upadhyaya, Pal, & Pal, 2019).

Predictive analytics leverages advanced algorithms and machine learning to analyze historical data and identify patterns that can predict future supply chain trends. By forecasting demand, companies can better plan production schedules, reduce waste, and avoid shortages. Predictive analytics is also used to anticipate potential disruptions, such as supplier delays or geopolitical events, allowing companies to develop contingency plans and mitigate risks. For

example, during the COVID-19 pandemic, predictive analytics helped pharmaceutical companies anticipate spikes in demand for certain drugs and vaccines, ensuring that supply chains remained responsive and resilient (Aljohani, 2023).

3.3. Challenges

Despite the numerous benefits of digital transformation, pharmaceutical companies face significant challenges in implementing and maintaining digital supply chain solutions. Data security and compliance are among the most critical concerns. Data security is a paramount issue, as the integration of digital tools and connected devices increases the risk of cyberattacks and data breaches. Supply chains generate vast amounts of sensitive data, including patient information, proprietary formulations, and financial transactions. This data breach could have severe consequences, including financial losses, reputational damage, and regulatory penalties. Companies must invest in robust cybersecurity measures like encryption, firewalls, and secure authentication protocols to mitigate these risks. Regular vulnerability assessments and employee training programs are also essential to maintaining a secure digital environment (Sharma & Barua, 2023).

Compliance with regulatory standards is another major challenge in the pharmaceutical supply chain. Companies must navigate complex regulatory requirements, including the U.S. Food and Drug Administration (FDA) guidelines, the Drug Supply Chain Security Act (DSCSA), and international standards such as Good Distribution Practice (GDP) (Fortin, 2022). Ensuring compliance requires meticulous record-keeping, traceability, and adherence to quality standards at every stage of the supply chain. Digital tools can support compliance efforts by automating documentation, generating audit trails, and providing real-time data for regulatory reporting. However, implementing these tools must be carefully planned to avoid disruptions and ensure alignment with regulatory requirements (Jabbar, Lloyd, Hammoudeh, Adebisi, & Raza, 2021). Additionally, the adoption of digital technologies can be hindered by factors such as high implementation costs, resistance to change among stakeholders, and a lack of technical expertise. Companies must address these challenges through strategic planning, stakeholder engagement, and investment in training and infrastructure.

4. Synergistic Integration of Marketing and Supply Chain

4.1. Enhancing Marketing and Supply Chain Functions with Integrated Digital Solutions

The integration of digital marketing and supply chain functions represents a transformative approach to improving operational efficiency and customer satisfaction in the pharmaceutical industry. Traditionally, marketing and supply chain management have operated as separate entities with limited collaboration. However, digital technologies are bridging this gap, enabling real-time data sharing, synchronized operations, and cohesive decision-making (Faridi & Malik, 2020).

Integrated digital solutions empower pharmaceutical companies to align their marketing campaigns with supply chain capabilities, ensuring that adequate inventory and efficient distribution networks support promotions, product launches, and customer engagement strategies. For instance, advanced customer relationship management (CRM) systems coupled with supply chain analytics provide a holistic view of consumer demand and inventory levels. This alignment helps companies anticipate market needs, prevent stockouts, and reduce excess inventory.

Real-time data sharing between marketing and supply chain teams enhances responsiveness to market changes. For example, suppose a marketing campaign generates an unexpected surge in demand for a specific medication. In that case, integrated systems can trigger adjustments in production schedules and distribution plans to meet the increased demand (Tien, Anh, & Thuc, 2019). Conversely, supply chain data on manufacturing delays or logistical bottlenecks can inform marketing teams to adjust their campaigns and manage customer expectations proactively. By leveraging predictive analytics, companies can create more effective demand forecasts that consider historical sales data and upcoming marketing activities. This synergy enables pharmaceutical firms to allocate resources more effectively, minimize waste, and optimize both marketing and supply chain performance.

4.2. Platforms and Strategies Bridging Marketing and Supply Chain

Several digital platforms and strategies have emerged as enablers of integration between marketing and supply chain functions. Enterprise Resource Planning (ERP) systems are foundational for unifying operations. ERP systems comprehensively view business activities by integrating marketing, sales, supply chain, and finance data into a single platform. This integration facilitates better coordination between marketing campaigns and supply chain planning, ensuring that resources are allocated effectively to meet demand. For example, SAP and Oracle offer ERP solutions tailored to the pharmaceutical industry, helping companies streamline operations and improve visibility across functions (Zhang, MacCarthy, & Ivanov, 2022).

Digital twins are another innovative strategy gaining traction. A digital twin is a virtual replica of a physical supply chain, enabling companies to simulate and analyze different scenarios in real time. For instance, a pharmaceutical company can use a digital twin to predict how a marketing campaign for a new drug will impact inventory levels and distribution networks. This proactive approach allows companies to address potential challenges before they arise, ensuring a seamless customer experience (Javaid, Haleem, & Suman, 2023).

Omnichannel platforms are increasingly used to bridge the gap between marketing and supply chain operations. These platforms integrate e-commerce, digital marketing, and logistics to provide a unified customer experience. For example, a pharmaceutical firm selling over-the-counter (OTC) products online can use an omnichannel platform to track customer orders, manage inventory, and provide real-time updates on delivery status. This integration enhances customer satisfaction by ensuring that marketing promises are supported by reliable supply chain execution (Saghiri & Mirzabeiki, 2021).

AI-driven personalization tools also play a critical role in aligning marketing efforts with supply chain capabilities. AI tools can recommend products, tailor promotions, and optimize delivery options by analyzing customer preferences, purchasing patterns, and supply chain data. For example, Amazon Pharmacy leverages AI to personalize marketing messages and streamline the fulfillment process, creating a seamless customer experience (Nimmagadda, 2021).

4.3. Evaluating Potential Risks and Benefits

While the synergistic integration of marketing and supply chain functions offers significant benefits, it also presents certain risks that must be carefully managed. One of the primary benefits of integration is improved customer satisfaction. By aligning marketing promises with supply chain execution, companies can deliver products more reliably and respond quickly to market demands. This alignment also reduces the risk of overpromising and underdelivering, which can harm a company's reputation.

Cost efficiency is another significant advantage. Integrated systems enable better demand forecasting, inventory management, and resource allocation, reducing waste and minimizing operational costs. For example, companies can avoid the expenses associated with overproduction or emergency shipments by synchronizing marketing campaigns with supply chain capacity. Enhanced data visibility and collaboration foster a culture of agility and innovation within organizations. By breaking down silos between marketing and supply chain teams, companies can respond more effectively to external disruptions, such as regulatory changes or supply chain disruptions caused by pandemics or geopolitical events. However, the integration of digital solutions is not without challenges. One major risk is the complexity of implementation. Integrating disparate systems and processes across marketing and supply chain functions requires significant investment in technology, training, and change management. Companies must ensure that their teams are equipped to navigate this complexity and adopt new working methods.

Data security and privacy are also critical concerns. The sharing of sensitive information between marketing and supply chain systems increases the risk of cyberattacks and data breaches. Companies must implement robust cybersecurity measures and comply with regulations such as HIPAA and GDPR to protect patient and customer data. Additionally, over-reliance on digital tools can create vulnerabilities. For example, system outages or technical glitches can disrupt operations, leading to delays and customer dissatisfaction. Companies must develop contingency plans to mitigate the impact of such disruptions and ensure business continuity.

5. Conclusion

Digital entrepreneurship is revolutionizing the pharmaceutical industry by driving innovation in marketing strategies and supply chain operations. This paper underscored the transformative potential of digital marketing tools, such as AI-driven advertising and personalized communication, allowing pharmaceutical companies to connect more effectively with consumers and healthcare providers. These advancements have expanded customer reach and fortified patient trust and brand loyalty, creating a competitive advantage in an increasingly digitalized marketplace.

Simultaneously, digital tools such as blockchain, IoT, and predictive analytics have optimized supply chain processes, improving transparency and responsiveness to market demands. By leveraging these technologies, pharmaceutical companies can streamline inventory management, ensure drug traceability, and respond dynamically to shifts in consumer needs. These innovations underscore the value of aligning marketing and supply chain functions, demonstrating that an integrated digital approach can drive efficiency, improve operational outcomes, and meet the demands of an evolving industry landscape.

Despite the promise of digital entrepreneurship, significant challenges remain. Data security and regulatory compliance are paramount, as these factors directly impact consumer trust and organizational accountability. Additionally, the complexity of implementing integrated digital systems and the need for a skilled workforce to manage these technologies presents ongoing obstacles. To fully realize the benefits of digital entrepreneurship, pharmaceutical companies must address these challenges proactively, embedding robust governance frameworks and adopting scalable strategies.

Companies should prioritize investment in comprehensive digital ecosystems to maximize digital entrepreneurship's opportunities. Integrating tools like CRM platforms and ERP systems can enable seamless communication across departments and improve decision-making processes. Moreover, fostering cross-functional collaboration between marketing and supply chain teams can break down silos, ensuring that digital strategies are aligned and mutually reinforcing. Partnerships with technology providers and experts can further accelerate innovation, providing access to cutting-edge solutions tailored to the unique needs of the pharmaceutical sector.

Ultimately, digital entrepreneurship represents a pivotal opportunity for the pharmaceutical industry to achieve sustained growth, improve customer experiences, and enhance operational efficiency. Companies can create a resilient and dynamic ecosystem by embracing advanced technologies, strengthening compliance measures, and fostering a culture of collaboration and innovation. This strategic approach ensures that digital transformation is not merely an aspirational goal but a practical and impactful pathway to success in a competitive and rapidly evolving marketplace.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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