

RESEARCH
ARTICLE**The Role of Artificial Intelligence in the Development and Growth of Startups****Lamia Bakouche**

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Artificial Intelligence, Technology, Startups, Innovative Products, Innovation.

Abstract

This research paper aims to highlight the importance of Artificial Intelligence (AI) in light of the rapid changes and digital transformations in the technology sector globally. By examining how it contributes to the development of startups, and using a descriptive analytical approach, the study concludes that AI plays a central and fundamental role in providing great opportunities for these companies. It has helped them overcome constraints such as limited resources, lack of operational efficiency, and difficulty competing effectively in dynamic markets. By leveraging advanced AI technologies, startups have succeeded in reducing costs, innovating new products, improving product design, and shortening time-to-market, among other improvements that significantly enhanced their overall performance. Nevertheless, AI adoption also poses several challenges, primarily the high implementation costs, technical complexity, and limited data access—forming barriers to the adoption of such technologies.

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1. Introduction

Artificial Intelligence is one of the essential pillars of today's technological revolution. It plays a crucial role in shaping the future of many industries around the world. AI has proven to be effective in offering smart digital solutions to address major crises and problems in various sectors—from agriculture to healthcare and even large economic institutions. Hence, it is regarded as a vital scientific tool for modernizing the economy, which has encouraged the use of AI applications across diverse organizational activities.

Its use has led to a radical shift in how institutions are managed and developed, including startups, which are known for their rapid innovation and adaptability in the face of fast market changes—especially in meeting the ever-evolving needs and expectations of beneficiaries. These characteristics make startups ideally suited to benefit from AI technologies.

In recent years, there has been a rapid emergence of startups that rely on AI as a core element in their products or services, attracting increasing interest from investors and venture capital firms. AI has become one of the most effective tools that play a key role in accelerating the growth and development of these enterprises.

In this context, the research paper addresses the relationship between AI and startups, seeking to understand the importance of adopting AI within these entities and leveraging the new opportunities it offers to enhance their competitiveness and achieve sustainable growth amid ongoing digital transformation and fast technological advancement. This paper also aims to examine how different AI techniques can help empower startups to overcome the challenges they face, such as limited resources, intense competition, and innovation pressure—by using AI applications strategically and efficiently.

The problem statement is thus formulated in the following question: **How does Artificial Intelligence contribute to the development of startups?**

What are the key challenges these startups face in benefiting from AI technologies?

To address this, two main hypotheses are proposed:

Hypothesis 1: The development of startups is contingent upon the strategic and effective adoption of AI technologies.

Hypothesis 2: Multiple challenges hinder startups from fully benefiting from AI.

The importance of this paper lies in shedding light on the concept of AI and how it contributes to the development and growth of startups, while identifying the major challenges that hinder its use. It also seeks to show how AI can help these companies focus on innovation and expansion by applying diverse AI technologies.

Accordingly, the study is divided into three main axes:

1. Fundamental Concepts of Artificial Intelligence and Startups
2. AI's Contribution to the Development of Startups
3. Challenges to the Use of AI in Startups

The study adopts the **descriptive analytical method** as the most suitable approach for the topic, providing a comprehensive understanding of the key concepts related to the research in order to achieve its objectives.

2. Basic Concepts of Artificial Intelligence and Startups

2.1 The Concept of Artificial Intelligence

Artificial Intelligence currently encompasses a wide range of applications across various sectors such as education, healthcare, and sports, thanks to its diversity and its ability to handle complex intellectual tasks. It has become a widely spread concept, especially amid digital transformation and rapid technological advancement.

2.1.1 Definition of Artificial Intelligence

The term "Artificial Intelligence" emerged after World War II and was officially coined in 1956 when American cognitive scientist Marvin Minsky and computer scientist John McCarthy hosted the Dartmouth Summer Research Project on Artificial Intelligence (DSRAI) at Dartmouth College, USA (Marcello M, Isa, Vittoria , & Yogesh K, 2022, p. 2). Since then, AI and its technologies have experienced many fluctuations. Nevertheless, there is no precise and universally agreed-upon definition due to the continuous diversity and evolution of its technologies, which include machine learning, deductive logic, statistical techniques, and mind models inspired by psychology. This has opened a broad debate about the nature of true intelligence and made it difficult to establish a comprehensive definition of artificial intelligence (Arun, David, Vinit, & Patrick, 2024, p. 2).

Artificial Intelligence is defined as "the use of computational machines to simulate fundamental human capabilities, including performing physical or mechanical tasks, engaging in reasoning processes, and expressing emotions." (Marcello M, Isa, Vittoria , & Yogesh K, 2022, p. 2)

Artificial Intelligence has also been defined as "The technology that enables computers to perform decision-based tasks that were previously exclusive to humans. It appears in various forms, most notably machine learning, which improves in analysis and decision-making with increased use, in addition to voice recognition technologies that understand different voices and languages (Ann , 2018, p. 117).

AI is also defined as "The capability of machines to perform tasks that typically require human intelligence, such as learning, reasoning, problem-solving, and adaptation. Artificial intelligence encompasses a variety of technologies including machine learning, natural language processing, computer vision, and predictive analytics" (Stuart J. & Peter , 2010, p. 2).

Artificial intelligence also involves simulating human cognitive functions such as learning, reasoning, problem-solving, and decision-making. AI is a branch of computer science, with machine learning (ML) forming its core foundation by enabling computers to learn from data without explicit programming. Neural networks are modeled after the human brain, facilitating tasks such as pattern recognition and image analysis. Natural Language Processing (NLP) allows computers to understand and generate human language. AI technologies also utilize computer vision to analyze visual inputs and recognize people, objects, and emotions. When considered collectively, these components highlight the transformative potential of artificial intelligence across a wide range of fields (Mitra , Hamed, Michele, & Nachaat, 2024).

From these definitions, it is clear that AI has evolved rapidly to develop systems based on advanced algorithms and programs capable of simulating human intelligence in order to perform tasks that usually require human thinking. AI now includes multiple fields and specialties such as machine learning, computer vision, natural language processing, and robotics. This makes it a powerful tool across many industries. AI assists in decision-making, logical reasoning, environmental interaction, and pattern recognition, which improves efficiency in fields like healthcare, e-commerce, and industry. AI systems can analyze large datasets quickly and more accurately than humans, making it a global, multi-use domain that has attracted interest from scholars across various disciplines.

2.1.2 Characteristics of Artificial Intelligence

The key characteristics of AI include the following (Jebrit & El-hafegh aichouch, 2024, p. 184):

- **Knowledge Representation Ability:** Unlike statistical programs, AI uses structured formats to describe knowledge and build a knowledge base to solve specific problems.
- **Optimistic Experimental Approach:** AI systems use effective methods to solve problems and can adapt to changing conditions. They do not necessarily follow sequential steps but prefer the fastest path to a solution.
- **Handling Incomplete Information:** These systems can process problems and find solutions even when some information is missing, thanks to access to large datasets and the ability to learn from repeated operations.
- **Learning Ability:** AI technologies improve their performance over time by relying on past experiences and repeated practices, helping avoid previous errors.

- **Reasoning Ability:** With vast data and stored information, and experience gained through repeated experiments, AI systems can perform logical reasoning.

2.1.3 Core Components of Artificial Intelligence

AI is made up of several interconnected elements that must function together seamlessly:

- **Machine Learning (ML):** Machine learning enables AI systems to learn from past experiences and improve their performance without direct human intervention (Estiak , Abu , & Rasidul , 2023, p. 2392). It relies on algorithms that understand and analyze data, identify patterns, and then make decisions or provide predictions based on that analysis (Aswathy & M, 2024, p. 299).
- **Deep Learning:** Deep learning is a subset of machine learning that uses artificial neural networks to process data and acquire knowledge (Estiak , Abu , & Rasidul , 2023, p. 2392). It has achieved groundbreaking advancements in various fields such as natural language processing, computer vision, and robotics (Aswathy & M, 2024, p. 299).
- **Neural Networks:** Computer systems modeled after the human brain's neural networks that enable deep learning and the analysis of complex information.
- **Cognitive Computing:** By simulating human thinking processes, cognitive computing enhances the machine's understanding of human language and images, facilitating effective human-machine interactions (Estiak , Abu , & Rasidul , 2023, p. 2392). These systems use a combination of machine learning, natural language processing, and other techniques to handle vast amounts of data, analyze complex situations, and make well-informed decisions (Aswathy & M, 2024, p. 299).
- **Computer Vision:** The field of computer vision in AI aims to enable machines to comprehend and interpret visual data in their environment. Computer vision systems perform tasks such as object detection, facial recognition, and image classification using image and video processing techniques and pattern recognition algorithms (Aswathy & M, 2024, p. 299).
- **Natural Language Processing (NLP):** Enables computers to understand, interpret, and generate human language in written and spoken forms (Estiak , Abu , & Rasidul , 2023, p. 2392).

2.2 The Concept of Startups

Startups hold a unique position in national economies due to the critical role they play in development, economic growth, and in supporting sustainable development. For this reason, many countries place great emphasis on nurturing individuals' creative ideas, promoting startups, and using them as tools to achieve national development goals.

2.2.1 Definition of Startups

Despite the absence of a unified and globally agreed-upon definition of startups, there are a set of common characteristics that distinguish this type of enterprise. Aulet and Murray (2013) defined startups as entities fundamentally driven by innovation. Similarly, the European Startup Monitor report prepared by Kollmann et al. (2015) described startups as companies that are less than ten years old, rely heavily on innovative technologies and/or business models, and aim for significant growth in either the number of employees or revenue (Petra & Agnieszka, 2024, p. 2).

Eric Ries defined a startup as "an organization dedicated to creating and delivering a new product under conditions of extreme uncertainty," while Steve Blank viewed it as "a company built to search for a repeatable and scalable business model". (Ahmed & mohamed, 2017, p. 15) Startups are also defined as "temporary organizations designed to evolve into large enterprises. In their early stages, they seek product-market fit, and in the maturity phase, they aim to find a scalable and repeatable business model that will transform them into a large, stable company." Additionally, they are described as young, creative enterprises in the field of information and communication technologies, whose mission is to develop and market new technologies (Mekhnacha, 2021, p. 771).

From the above, it is evident that although there are numerous definitions of startups, they revolve around a common core. The differences lie mainly in the way each is framed, depending on the researchers' perspectives. Nonetheless, all definitions agree that a startup is:

- An organization based on ideas, creativity, innovation, and the development of new products;

- An entity that seeks to create high value in order to attract investors and funding.

2.2.2 Importance of Startups

Startups represent the lifeblood of modern economies, serving as a source of creativity and innovation well as a key driver of economic and social growth and development (Petra & Agnieszka, 2024, p. 2). These enterprises are distinguished by their significant ability to create new job opportunities, which effectively contributes to reducing unemployment rates and improving living standards, especially among the youth. They also play an important role in developing innovative ideas and solutions, and offering products and services that meet the rapidly changing market needs, thereby enhancing the competitiveness of the national economy.

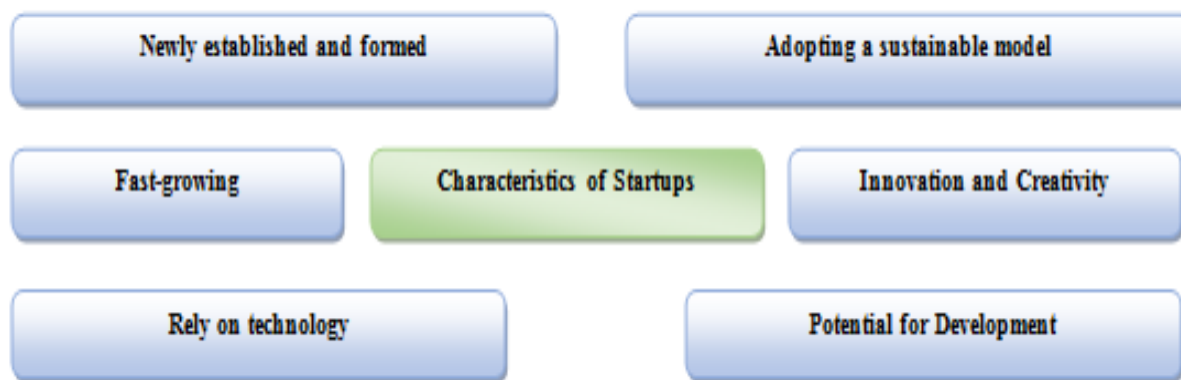
Moreover, startups contribute to the development of young people's skills and foster their entrepreneurial spirit, supporting the creation of a new generation of entrepreneurs capable of facing future challenges. These institutions also help boost economic growth by stimulating investment and promoting innovation, in addition to serving as an effective mechanism for diversifying the national economy and reducing dependence on traditional sectors.

In recent years, there has been increasing attention to startups due to their active role in promoting contemporary economic growth and their positive impact across various sectors. Startups have demonstrated their ability to invigorate local and global markets and build a reputation based on innovation and excellence in providing solutions. Studies have also shown their substantial potential for rapid and effective growth within short periods. Consequently, these institutions have become a central focus of public policies aimed at supporting the entrepreneurial ecosystem and enhancing the capacity for innovation and sustainable expansion (Petra & Agnieszka, 2024, p. 2).

2.2.3 Characteristics and Features of Startups

Startups possess a set of unique traits that distinguish them from traditional companies. These traits give them both general and specific features. The most notable include:

Figure 1: Characteristics of Startups



Source: Prepared by the researchers

Startups are characterized by a set of general features, similar to other startups across the world. The most important of these features can be summarized as follows: (Mekhnacha, 2021, p. 771)

- Startups are **new and innovative projects** that usually involve low costs. They rely heavily on **information and communication technology**, especially **digital tools** and **the knowledge economy**, which are essential for their growth;
- They are **independent and diverse enterprises**, not confined to a specific sector such as technology or commerce. Startups grow progressively through phases often referred to as the **Startup Lifecycle**, which includes:
 - ✓ The **idea formulation phase**,

- ✓ The **launch phase**,
- ✓ The **growth phase**,
- ✓ The **maturity or exit phase**, and
- ✓ The **scaling phase**;

➤ Startups are also characterized by being **temporary in nature**. They either **grow and mature** or **fail and exit** the market. Many rely on **distribution channels** like social media platforms and smart mobile devices as the main method of reaching the internet—making customer access significantly easier.

3. AI's Contribution to the Development and Growth of Startups

Artificial intelligence has emerged in recent years as a major catalyst for innovation and change, leading to a significant transformation in the technological environment. It now mimics human thinking processes through computers, surpassing its traditional limits to become present in many sectors. Its impact is not limited to this; it has also significantly influenced how leadership practices are developed and applied across various types of organizations (Mitra , Hamed, Michele, & Nachaat, 2024), including startups, which have begun to rely on AI technologies as a core element of their business models. These organizations seek to maximize the benefits of AI capabilities to improve performance, increase efficiency, and expand their market reach.

Below are the key ways in which AI contributes to the development and growth of startups:

3.1 AI as a Catalyst for Product Innovation

AI plays a significant role in radically transforming the process of developing and innovating new products. Through leveraging AI technologies, startups can gain deep insights into customer needs, which simplifies product design and improves performance. AI also enables the creation of **more competitive and innovative products** (Omotoso, Eretan, & Salami, 2024, p. 3050)

AI supports product innovation through:

➤ **Rapid analysis of massive data sets**

AI algorithms can process large volumes of data with exceptional speed, uncovering key relationships and reducing uncertainty in experiments. This improves learning efficiency and accelerates innovation.

Example: In the pharmaceutical industry, AI shortened the drug development cycle drastically. Moderna used AI to develop the first COVID-19 vaccine dose in just **65 days**, a process that would typically take years (Tania, Anastassia, Alex, & James, 2024, p. 5).

➤ **Accelerating the development of new or improved products:**

AI extracts trends and offers recommendations, allowing startups to develop or enhance products faster. Techniques such as **product simulation, customer feedback analysis, and performance benchmarking** help generate ideas, validate hypotheses, and improve designs. (Omotoso, Eretan, & Salami, 2024, p. 3040)

➤ **Enhancing customer orientation in product development:**

Using AI tools like Natural Language Processing (NLP) and predictive modeling, startups can gather and analyze direct customer feedback, identify unmet needs, and align product development accordingly.

Example: In the automotive industry, AI is used to design vehicles that match customer preferences—focusing on safety, fuel efficiency, and smart features. (Omotoso, Eretan, & Salami, 2024, p. 3050)

➤ **Cost-effective product development:**

Traditionally, startups used trial-and-error, a costly and time-consuming method. AI provides accurate predictions about which features or designs will succeed. It also helps optimize supply chains and identify the most efficient materials and production methods—cutting costs and boosting profitability (Omotoso, Eretan, & Salami, 2024, p. 3035).

➤ **Improving product appeal through customization:**

AI enables startups to understand customer preferences and personalize offerings.

Example: Behavioral and digital footprint data—like browsing history, location, and past purchases—can be analyzed to develop highly customized products that outperform generic solutions. (Tania, Anastassia, Alex, & James, 2024, p. 5)

3.2 AI as an Aid in Cost Reduction

AI technologies such as machine learning, robotic process automation (RPA), and intelligent data analytics help reduce operational costs by automating repetitive processes, minimizing errors, and freeing up human resources to engage in value-added activities. For example, AI-powered chatbots and customer service tools can handle large volumes of customer inquiries without the need for human intervention, leading to lower labor costs and increased operational efficiency. Additionally, AI capabilities contribute to improving supply chains, logistics, and production scheduling through accurate demand forecasting and inventory management, which reduces waste and enhances effectiveness (Omotoso, Eretan, & Salami, 2024, p. 3040). Furthermore, companies rely on AI systems to reduce manufacturing costs and offer products and services at competitive prices, as well as to cut research and development expenses related to creating and designing new products. These operational savings translate into higher profit margins and sustainable revenue growth (Marcello M, Isa, Vittoria, & Yogesh K, 2022, p. 11).

3.3 AI as a Driver of Process Innovation

AI not only fosters innovation in products but also in internal processes, enhancing productivity and reducing operational costs.

AI contributes in two major ways:

➤ **Replacing human labor in certain tasks**

AI can take over cognitive and decision-based tasks, reducing labor costs—especially in high-skill, high-wage jobs. This marks a shift from past technological adoptions which primarily affected low-skill roles (Tania, Anastassia, Alex, & James, 2024, p. 5).

➤ **Increasing operational and production efficiency**

Through better forecasting under uncertainty, AI reduces the costs of goods and services that depend on accurate predictions. Algorithms analyze historical data to project future trends, minimizing waste and inefficiencies (Mohamed A. , 2024, p. 150).

3.4 Improving Customer Service through Interaction and Personalization

Artificial intelligence enhances customer service and improves user experience through chatbots and virtual assistants. AI can assist customers by providing accurate and relevant information, answering simple inquiries, and referring complex issues to human agents. The use of this technology in customer service also helps reduce operational costs for companies by decreasing their reliance on human staff (Taqwa & Athapol , 2024, p. 156). In addition, intelligent recommendation systems are used to analyze customer behavior and offer personalized suggestions for products and services that match their needs, making the shopping experience more convenient and efficient.

Example: Platforms like Amazon and Netflix use AI to analyze user preferences and provide personalized content, increasing satisfaction and loyalty.

AI also enables mass personalization.

Example: In the fashion industry, AI can design clothing that fits individual measurements and style preferences, improving customer satisfaction and product-market fit (Omotoso, Eretan, & Salami, 2024, p. 3036).

3.5 Supporting Predictive Analytics and Strategic Decision-Making

AI processes massive datasets to generate accurate insights about market trends, consumer behavior, and future demand.

- Startups can improve pricing strategies, forecast demand, and spot market opportunities faster than competitors.
- Predictive tools can anticipate customer churn, adapt production schedules, and refine marketing campaigns.

Such **data-driven decisions** enhance profitability and give startups a major **competitive advantage**. (Omotoso, Eretan, & Salami, 2024, p. 3034)

3.6 AI Enables Scalability and Market Expansion

AI empowers startups to achieve competitive advantages by delivering fast and innovative solutions that meet customer needs more effectively than traditional methods.

Example: In the financial sector, startups use AI to provide personalized financial advice and advanced investment solutions, helping them outperform traditional financial institutions.

AI also facilitates scalability, which is critical for a startup's growth and survival. By automating tasks that once required intensive human labor (e.g., data handling or customer service), AI allows companies to manage greater workloads with fewer resources.

Example: Virtual assistants and AI-powered chatbots help startups expand globally by efficiently handling more clients, increasing market share while minimizing labor costs (Omotoso, Eretan, & Salami, 2024, p. 3040).

3.7 AI Enhances Cybersecurity

Startups can use AI to detect and counter cybersecurity threats, protecting sensitive data and internal systems from malicious attacks. AI systems can identify patterns and anomalies, enabling faster and more accurate responses to cyber risks.

3.8 AI as a Time-Saving Enabler

Time is a critical factor in the process of technology-driven innovation, especially for startups that often operate with limited resources. These organizations can allocate their time either to improving existing products (incremental innovation) or to developing entirely new solutions (radical innovation). The adoption of AI technologies contributes to accelerating workflows in both directions, allowing startups to dedicate more time to research and development and to strengthen their competitive position in the market (Marcello M, Isa, Vittoria, & Yogesh K, 2022, p. 11).

4. Challenges of Using AI in Startups

The emergence of artificial intelligence offers promising opportunities for startups; however, it also presents a set of new challenges. Startups are often constrained by limited resources and lack the technical expertise required to effectively understand and implement AI technologies. One of the most significant challenges is the shortage of specialized professionals, as the demand for AI experts exceeds the available supply, resulting in intense competition for skilled professionals (Mohamed A. T., 2024, p. 155).

Another major challenge in the field of AI is that many startups struggle to collect and process the large volumes of data required to operate AI systems efficiently (Mohamed A. T., 2024, p. 155). These difficulties are further compounded by concerns related to data privacy and security, which are especially critical when dealing with sensitive information associated with startup management. Therefore, it is essential to strike a balance between human intuition and AI-driven insights in order to avoid overreliance on technology (Mitra, Hamed, Michele, & Nachaat, 2024), ensure fairness in AI outcomes, and maintain transparency.

Another challenge faced by startups lies in deciding which type of data to collect and utilize—whether to rely on time-series data that offers long-term historical insights or to use real-time data that provides immediate, up-to-date information. Building a robust, well-organized, and usable database requires a careful balance between extracting accurate and current data on the one hand, and leveraging historical data that can support long-term planning on the other. Subsequently, startups are

confronted with the challenge of deriving accurate insights from the vast amount of information contained in large datasets (Mohamed A. T., 2024, p. 155).

Another challenge faced by startups is the difficulty in processing complex information that is sometimes extracted from deep learning techniques and intricate graphs, due to their limited resources and expertise. Therefore, it is advisable to seek partnerships or specialized consulting services instead of directly hiring highly experienced personnel, especially in the early stages. Startups should also adopt appropriate verification tools and update them regularly, with a strong focus on developing the skills of their current teams through continuous training. It is essential for these organizations to enhance their understanding of artificial intelligence to ensure its fair and ethical implementation, while keeping up with rapidly evolving technologies (Natalia , Ramon, & Raúl, 2024, p. 6). Furthermore, there is an urgent need for specialized research that supports the effective application of AI tools in the startup environment.

Additionally, the costs associated with developing and maintaining AI systems pose a significant burden on startups operating under limited budgets. These costs include not only the development and training of AI models but also the substantial computational resources required—expenses that can accumulate rapidly (Mohamed A. T., 2024, p. 155).

Another critical challenge is related to ethical concerns, particularly the potential biases embedded in AI algorithms. This represents a significant issue for startups, requiring them to remain constantly vigilant (Mohamed A. T., 2024, p. 155) to ensure the development of fair and transparent algorithms. Moreover, compliance with regulatory standards is essential to fully harness the benefits of AI, strengthen credibility, and enable sustainable growth in an ethically responsible environment.

An additional challenge facing the adoption of artificial intelligence, especially in startups and generally in other organizations, is what is known as "artificial stupidity." This term refers to errors that the system learns due to the input of low-quality data, or the system's inability during the training phase to cover all possible scenarios, which leads to failures when applying the system in real-world situations (Nur Syahmina & Ulaganathan, 2024, p. 855).

5. Conclusion

Startups play a vital role in economic development, driving innovation and fostering sustainable growth. Integrating AI into these ventures unlocks new opportunities while presenting significant challenges that must be addressed strategically.

This research highlights AI as a cornerstone of the modern technological revolution. Its tools and techniques have proven effective in overcoming the obstacles startups face. AI represents a transformational asset—reshaping internal processes, improving customer experience, and fostering competitiveness in fast-changing digital environments.

By embracing AI, startups gain a better understanding of customer behavior and needs. This leads to smarter marketing strategies, real-time data analysis, market trend forecasting, and automated decision-making. All of these help reduce costs, eliminate errors, and allow human capital to focus on creative and strategic tasks, ultimately redefining the structure and operations of startups in the modern era.

Moreover, AI enhances problem-solving, enables proactive crisis response, and strengthens cybersecurity, making startups more resilient in the digital economy.

6. Recommendations

To ensure broader adoption of AI, startups must address key barriers—ranging from resource constraints to technical complexity. The following strategies are recommended:

- Invest in AI tools that boost customer analytics and product personalization to increase revenue;
- Integrate AI-powered CRM systems and predictive analytics to improve marketing and sales;
- Analyze customer feedback to ensure product-market fit;
- Prioritize strong data infrastructure from early stages and build organized, scalable databases;
- Embed AI into product development cycles, focusing on tools that simulate designs and forecast trends;

- Train internal teams on AI applications to reduce reliance on external consultants;
- Secure funding to adopt scalable AI solutions that evolve with the business;
- Ensure privacy and compliance through best practices in ethical data use;
- Foster a culture of innovation by exploring emerging AI technologies that can provide a competitive edge.

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