



Building Innovation Ecosystems in the Digital Age:

How Can Startups Benefit from AI? Deriving Global Best Practices to Support the Algerian Context

Bourane Soumia*

University Center Nour el Bchir el-Bayadhi,
(Algeria)

S.bourane@cu-elbayadhi.dz

Aouad Abdesselam Belahoual

University Center Nour el Bchir el-Bayadhi,
(Algeria)

a.aouad@cu-elbayadhi.com

Abstract ;

Artificial intelligence is rapidly changing the world, and small startups are leading this transformation. However, their journey is not easy; many face challenges such as high technical costs, lack of expertise, and difficulty accessing appropriate support. This study aims to understand how startups can successfully adopt AI. The research analyzes influencing factors such as costs, management support, and competitive pressure along with a review of prominent global support programs from Singapore and Canada to the UAE and the United States. The findings demonstrate that success does not depend on technology alone, but rather on a potent combination of well-thought-out funding, practical training, strong partnerships, and informed government support. Finally, the study offers a set of practical recommendations tailored specifically to the Algerian context, aiming to help decision-makers and entrepreneurs build an innovation ecosystem that supports startups' progress in the AI race.

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* correspondant auteur

1. Introduction

Artificial intelligence (AI) is accelerating the pace of global innovation, providing startups with unprecedented opportunities for growth and competitiveness. However, the adoption of these technologies is challenging for many of these companies, especially in developing countries, due to technical, regulatory, and financial obstacles. This study aims to explore the global factors influencing AI adoption in startups, combining a theoretical framework (the TOE model and the theory of diffusion of innovation (DOI)) with a comparative analysis of leading international support programs. By examining these models, the paper seeks to extract lessons learned and provide actionable strategic recommendations to enhance the AI innovation environment in the Algerian context. This study aims to:

1. Analyze the technical, organizational, and environmental factors (based on the TOE model) that facilitate or hinder AI adoption in startups.
2. Review and evaluate international support frameworks and programs (national, cluster, private) designed to accelerate the adoption of AI-based innovation among startups.
3. Conduct an analytical comparison between the working mechanisms and outcomes of these support programs to identify best practices and transferable elements.
4. Formulating concrete practical and policy recommendations for decision-makers in Algeria to promote and support the adoption of AI in the local startup sector.

Despite the tremendous potential of AI to drive innovation and create added value for startups, adoption rates of these technologies remain uneven globally and face significant challenges, particularly in developing economies like Algeria. The central problem of this study stems from the gap between the theoretical potential of AI and the reality of its weak adoption by startups, especially in the absence of effective support frameworks adapted to the local context. Therefore, the study poses the following key question: ***What are the critical factors that determine the success of AI adoption by startups, and how can supportive policies and programs, drawn from leading international models, contribute to bridging this gap and building an effective AI innovation system in the Algerian context?***

2. Research Methodology:

This study relied on a qualitative content analysis methodology of secondary sources to explore the factors influencing the adoption of artificial intelligence in startups and analyze international support frameworks. The methodology was implemented in two main phases: first, a systematic review of the academic literature was conducted, gathering data from a wide range of recently published sources, including peer-reviewed articles, reports of international organizations (such as the Organization for Economic Co-operation and Development (OECD)), and specialized books. This review focused on literature relevant to technology adoption theories, such as the Technology-Organization-Environment (TOE) framework and the Diffusion of Innovation (DOI)

theory, as well as previous studies on AI applications and innovation in startups. Second, to achieve the applied and comparative objective, the research relied on a comparative document analysis. Official reports and publications issued by leading global innovation support programs were collected and analyzed, such as Innovate UK in the United Kingdom, SCALE AI in Canada, Hub71 in Abu Dhabi, the NVIDIA Inception program, and the NSF Regional Innovation Engines initiative in the United States. These documents were examined to understand their operating mechanisms, funding models, partnerships, and reported outcomes.

The collected data was analyzed using a multiple-case study (MCS) approach, where each international initiative represented an independent "case" that was studied in depth. A comparative analysis was then applied to these cases based on pre-defined criteria, such as the host country, strategic focus, support mechanisms provided, and reported results. This analysis enabled the identification of similarities and differences between the various models, and the extraction of lessons and elements applicable to other contexts, forming the basis for developing recommendations specific to the Algerian context.

3. Theoretical Framework:

3.1 AI :

Artificial Intelligence (AI) is a fast-growing field that helps machines do tasks that usually need human intelligence. With AI, computers can see, learn, and make decisions using algorithms and data (**Robert & Brown, 2021**). In recent years, it has changed many areas of life. Machine learning, a part of AI, allows computers to study large amounts of data, find patterns, and improve their performance without direct programming (**Miller, 2019**). Thanks to this, we now have progress in speech and image recognition, natural language processing, and self-driving systems.

AI is used in many industries. In healthcare, it helps diagnose diseases, discover new drugs, and create personalized treatments. In finance, it detects fraud and supports smart investments. In transport, it powers self-driving cars and better traffic management. In daily life, AI is behind chatbots, recommendation systems, and smart home devices (**Riedl, 2019**).

Even so, AI comes with some challenges. If not handled properly, it can lead to biased outcomes, and it also brings up concerns about privacy, the potential loss of jobs, and even the development of weapons. Because of this, it's important to focus on fairness, openness, and strong rules to make sure AI grows in a responsible way (**Araujo et al., 2020**).

3.1 AI Tools :

A 2022 study explains that AI tools are advanced software programs made to help and improve human abilities in many areas. These tools use complex algorithms, machine learning methods, and the power to process data, allowing them to examine large volumes of information and provide useful insights. AI tools can be used in a variety of areas like data analysis, natural

language processing, computer vision, robotics, and prediction models (**Pimenov et al., 2023**). One important type of AI tool is the data analytics platform. These tools help organizations get useful information from complicated and large datasets, making it easier to make decisions based on data. They use machine learning to find patterns, connections, and trends, helping businesses get useful information and improve their operations. Data analytics tools can also find hidden patterns and unusual data, spot fraud, and predict future results, which helps different industries work more efficiently and effectively (**Haleem et al., 2022**).

Natural Language Processing (NLP) represents one of the most important branches of artificial intelligence. It provides machines with the capacity to process and generate human language in a meaningful way. Such tools are widely applied in domains like virtual assistants, chatbots, and translation systems, allowing organizations to automate customer interactions, interpret user queries, and facilitate communication across different languages.

Similarly, computer vision constitutes another core component of AI, focusing on enabling systems to extract and analyze information from visual inputs such as images and videos. This technology is utilized in applications including facial and object recognition, medical image diagnostics, autonomous vehicles, and surveillance, as well as in emerging fields like augmented reality (**Torfi et al., 2020**).

Machine learning-based predictive modeling tools are widely applied in forecasting and decision-making systems. By examining past data, these tools detect patterns and build models that can anticipate future events and outcomes. They are used in diverse areas, including sales forecasting, risk evaluation, demand estimation, and tailored recommendations. AI-powered tools are transforming industries by enhancing human abilities, automating processes, and fostering innovation. Their growing adoption promises to boost productivity, improve decision-making, and open new opportunities across sectors. Still, ethical issues such as ensuring transparency, protecting privacy, and reducing bias must be carefully managed to guarantee responsible use of AI technologies (**Deep reinforcement learning for power system, 2019**).

Reference	Advantages	Limitation
(Santos & Qin, 2019)	AI encourages creativity, verify concepts and speed up the process of development, by enhancing both the questions asked and answers provided.	AI could miss some nuances, and conventional methods like controlled test which are still necessary to establish causation.
(Tekic et al, 2019)	Venture capital invested in AI technologies has continued to advance and commercialized, which has become daily part of our lives.	The amount of funding levels isn't always made public, this lack of information reduced the VC backed firms included in the analysis.
(Barakat et al, 2021)	Trade secrets like AI-generated code, or training data offer good solution and prevent and protect disclosure.	However, it is not very effective as others can use similar solutions making protection incomplete. New strategies for IP data must be explored.

<i>(Daraojimba et al., 2023)</i>	AI has the ability to contribute to sustainable development across many sectors, improving efficiency in agriculture, building management, and urban sector.	High- quality training data can be challenging to obtain at low cost, which can result in inaccurate conclusions.
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3.3 Innovation and Digital Innovation:

According to the Oslo Manual (OECD, 2018), innovation is defined as a new or significantly improved product, process, or a combination of the two, which has been introduced to the market (in the case of products) or implemented within an organization (in the case of processes). Innovation activities encompass all developmental, financial, and commercial efforts undertaken by firms to foster such advancements.

Jensen et al. (2007) classify innovation into two distinct types: technological and non-technological. The first type, rooted in science, technology, and innovation (STI), is built on formal research and development (R&D), which often requires significant investments in human capital and technology. (Jensen et al., 2007) This innovation model relies on collaboration with knowledge-producing institutions that practice the fundamentals of the knowledge economy, such as universities and research centers, to generate comprehensive and transferable knowledge that stimulates innovation and, through it, achieves added value (Haus-Reve, et al., 2022). The second mode, learning by doing, using, and interacting (DUI), emphasizes experiential and practice based innovation. Here, progress emerges from organizational learning, internal knowledge-sharing, and interactions with external stakeholders including suppliers, customers, and competitors rather than formal R&D (Haus-Reve, et al., 2022)

Digital innovation isn't just about flashy gadgets or cutting edge apps it's about a deep transformation in how ideas come to life and reach the world. When businesses weave digital tools into their innovation process, they often unlock unexpected, even game-changing, ways to create value. What's truly exciting is how this shift has sp Digital innovation isn't just about flashy devices or sophisticated applications; it's about radically changing how ideas are embodied and communicated. When companies incorporate advanced devices into their innovation plans, they often open up new and astonishing possibilities, even game-changing ones, for value creation. What's truly fascinating is how this transformation has fostered collaboration between companies, and even competitors, in what has become known as collaborative competition based on continuous market development and the creation of added value based on knowledge management. These companies collaborate to reshape entire markets and rethink what is possible (Boudreau, K. J. & Lakhani, K. R, 2013); (Lei et al., 2024)

In our highly interconnected world, the digital economy has become the primary driver of global growth (Brynjolfsson & Collis, A, 2019); (Ali, M. A et al., 2018). As advanced technologies, such as artificial intelligence and big data management, mature, they enhance and facilitate the implementation of key innovation principles, particularly in factories, production lines, and overall production process management (Sutherland & Jarrahi, 2018). The bottom

line? Digital transformation is reshaping everything how we socialize, how leaders make decisions, even how nations prosper. It's not just about working smarter; it's unlocking scientific discoveries, creating meaningful jobs, and ultimately improving lives (**Elder-Vass, D, 2016**); (**Gopal et al., 2003**)

3.4 AI Adoption in Startups:

To thoroughly examine how startups adopt artificial intelligence technologies, it is necessary to rely on theoretical frameworks that offer structured perspectives for analysis. In this study, the Technology–Organization–Environment (TOE) framework is integrated with the Diffusion of Innovation (DOI) theory, providing a comprehensive foundation for understanding the determinants of technological adoption in entrepreneurial settings. The following subsections elaborate on how these frameworks jointly support the exploration of AI adoption within startups.

3.4.1 The technology–organization–environment (TOE) framework:

The Technology-Organization-Environment (TOE) framework is one of the most trusted tools for figuring out why some businesses quickly adopt new technologies while others hold back. What makes it so useful is its simple yet powerful structure: it looks at three key areas that influence adoption the technology itself, the internal dynamics of the organization, and the outside forces in the business environment (**Sun et al., 2024**); (**Tornatzky & Fleischer, 1990**).

At the technological level, it's about how the innovation looks on paper and in practice its cost, benefits, risks, how well it fits with existing systems, and how hard it is to implement. These ideas go back to Rogers' classic Diffusion of Innovations theory (**Tiwari et al., 2023**). The organizational factors are more inward-facing: does the company have skilled people? Is management on board? Are there enough resources? Bigger firms, for instance, might have more flexibility to experiment with new tech (**Dwivedi et al., 2012**). Then there's the environment things the company can't fully control, like industry competition or government regulations. These external pressures often push firms to innovate whether they feel ready or not (**Maroufkhani et al., 2023**). While the TOE model is valued for being flexible and easy to apply in many contexts (**Su et al., 2023**), some critics point out that it might miss some important nuances (**Toufaily et al., 2021**). That's why this study uses TOE not as a rigid formula, but as a guiding lens a way to organize and connect different ideas into a clear and meaningful analysis.

The TOE framework is especially helpful when exploring why Startups choose to adopt or avoid artificial intelligence (AI) (**Zhu et al., 2006**) (**Wen & Chen, 2010**). On one hand, AI brings big advantages: it can improve decision-making, boost efficiency, and open new doors for innovation. But for Startups, the path to adoption isn't always smooth. Many struggle with limited budgets, a shortage of skilled staff, and concerns about data privacy and security (**Duan et al., 2019**) (**Moinuddin et al., 2024**) (**Coleman et al, 2016**) (**Arendt, 2008**). A number of studies using the toe model have checked how these factors take place in different fields. For example, a study showed that the maturity of technology, strong support for management and the pressure of competitors is essential to promote AI production companies. In the field of health

care, the search for Stenberg emphasizes the importance of awareness, organization and legal environment. Because Startups play an important role in many economies, especially in developing countries, it is necessary to understand what will help or hinder their adoption in AI. Common obstacles include lack of awareness, financial closing and no trained staff. The toe frame provides a structured vehicle to discover these challenges and consider the advantages and disadvantages of applying AI in the context of startups businesses. **(Mouakket & Aboelmaged, 2023); (Stenberg & Nilsson, 2020); (Bokhari, A, 2020)**

3.4.2 Diffusion of innovation theory (DOI):

To truly understand how small and medium businesses decide whether to adopt AI, this study combines two powerful frameworks. The TOE approach gives us the big picture looking at technology challenges, company capabilities, and external pressures. Meanwhile, Rogers' innovation theory adds crucial insights about how new technologies spread, focusing on five key factors: whether the AI solution is clearly better than current tools (relative advantage), fits existing workflows (compatibility), isn't too complicated (complexity), allows testing (trialability), and shows visible results (observability). For resource-limited Startups, these factors make all the difference they're much more likely to adopt AI that ticks all these boxes **(Tiwari et al., 2023)**. By blending these frameworks, we can see both the structural barriers Startups face and how their perceptions of AI influence decisions **(Toufaily et al., 2021); (Maroufkhani et al., 2023); (Chau et al., 2021)**. This combined approach is especially valuable in developing countries where adoption patterns tend to be more complex.

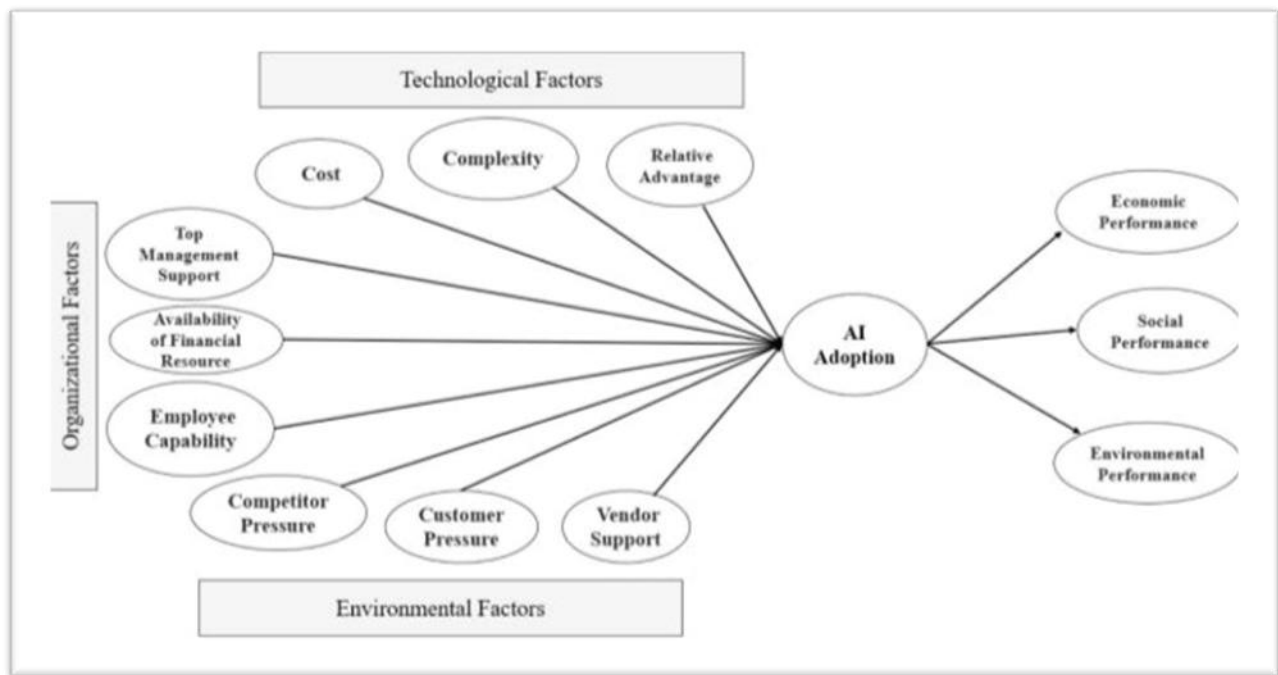
3.5 AI implementation in Startups:

For Startups, bringing AI into their operations isn't always straightforward. On the inside, these firms often grapple with steep implementation costs, a shortage of skilled workers, and the need for strong leadership to drive innovation and change **(Wang et al., 2022)**. On the outside, they're navigating competitive markets where AI can be a real game-changer but only if it's easy to use, affordable, and backed by supportive policies. More and more researchers are pointing out how digital tools like AI have helped Startups stay productive and adapt during tough times, especially during disruptions like the COVID-19 pandemic **(Papadopoulos et al., 2020)**. One key question remains: how do these technologies actually reshape day-to-day business operations? According to the Digital Economy and Society Index, digital transformation improves Startups' agility in tackling business challenges **(Skare et al., 2023)**. Studies like that of Hansen and Bøgh (2021) recommend a gradual, machine-specific approach to AI implementation in manufacturing to reduce costs **(Hansen & Bøgh, 2021)**. They emphasize the importance of predictive analytics, along with other types like descriptive, diagnostic, and prescriptive analytics. Yet, much of the existing research still overlooks the specific realities of the manufacturing sector. For example, Barata et al. (2023) examine how Startups use AI to support e-commerce and agile project management, pointing to tools like cognitive mapping and decision evaluation methods. **(Barata et al., 2024)**

While it's clear that AI can help small and medium-sized businesses make smarter strategic decisions (Kim & Seo, 2023), we still don't fully understand how these companies actually bring AI into their daily routines. As Mikalef and his team (2021) point out, adopting AI isn't just about getting the tech it's also about having the right people, the right skills, and being ready as an organization to make it work (Mikalef & Gupta, 2021). That's no small feat for Startups, which often operate with limited budgets and a shortage of tech talent.

By applying this integrated approach, this study aims to examine the factors influencing AI adoption by Manufacturing Startups.

Fig 1: AI Startup's Adoption



Source: (Soomro et al., 2025)

- **Technical factors :**

1. Implementation Cost and AI adoption by Startups:

Implementation cost is one of the most critical barriers to AI adoption among Startups. Due to their limited financial capacity, Startups often prioritize cost when deciding whether to embrace new technologies (Stenberg & Nilsson, 2020). The expenses associated with AI adoption extend beyond just acquiring software they also include infrastructure, staff training, and ongoing maintenance (Stenberg & Nilsson, 2020);(Burgess, A, 2017). Several studies have shown that high implementation costs can significantly hinder the adoption of advanced technologies. For instance, Djatikusumo (Djatikusumo, 2014) noted that many Startups lack proper organizational management, leading to inefficient IT systems and limited access to funding. This financial constraint restricts their ability to invest in costly digital solutions (Ganguly, 2024). Furthermore, AI implementation requires long-term financial commitment, which can be particularly

challenging in developing countries where capital is scarce and financial markets are underdeveloped (**Khan, A. N et al., 2024**). Chatterjee and Kar (**Chatterjee et al., 2021**) emphasized that cost-effectiveness remains a decisive factor in technology adoption, with many Startups reluctant to adopt AI due to the high upfront costs. In some contexts, Startups explicitly cite financial constraints as the main reason for hesitating to implement AI technologies (**Nazir, M. A. & Khan, M. R, 2024**), (**Rafique & Mujawinkindi, 2023**)

2. Relative advantage and AI adoption:

Relative advantage, as defined by Rogers (**Rogers & Singhal, 2003**), refers to how much better a new technology is perceived compared to the one it replaces. The more benefits it offers such as better performance, lower costs, or greater efficiency the more likely it is to be adopted (**Turner & Rogers, 2007**), (**Tsai et al., 2018**). For Startups, AI brings clear advantages like reducing operational costs, improving decision-making, and offering strong forecasting tools (**Al-Surmi et al., 2022**). These benefits are especially valuable in competitive markets, where efficiency and adaptability are essential (**Ogbuokiri et al., 2015**), (**Merugula, S. et al, 2021**). Research has consistently shown that the perceived benefits of a new technology strongly influence its adoption (**Ramdani & Kawalek, 2007**), (**Grandon & Pearson, 2004**). AI's ability to automate tasks and provide smart insights makes it particularly appealing for performance improvement. This is even more critical for Startups in developing countries, where limited resources make cost-saving innovations like AI especially attractive (**Thong, 2001**), (**Alsheibani et al., 2020**), (**Cidral et al., 2018**), (**Soomro et al, 2024**).

3. Complexity and AI adoption :

Complexity is a major barrier to AI adoption in Startups (**Rogers Everett, M, 1995**). When a technology is seen as difficult to understand or integrate, firms especially those with limited resources tend to avoid it (**Jahanmir & Cavadas, 2018**), (**Waarts et al., 2002**). Studies confirm that perceived difficulty lowers adoption rates (**Zailani, S et al., 2015**), (**Peltier et al., 2012**). In contrast, simplicity and compatibility with existing systems support faster and smoother adoption (**Premkumar & Roberts, 1999**), (**Berman et al., 2012**), (**Bandi et al., 2015**). AI's technical nature, the need for skilled staff, and system integration challenges all add to its complexity, making it harder for Startups to adopt it effectively (**Russo, 2024**), (**Oyekunle et al., 2024**), (**Trianni, A. et al., 2013**).

•Organizational factors:

1. Top Management and AI adoption:

Top management support is essential for effective AI adoption, especially in Startups. When leaders are actively involved, they help secure resources, align AI with strategic goals, and create a culture open to innovation (**Effendi et al., 2020**), (**Enholm et al., 2022**). This leadership becomes even more critical in smaller firms that face limited budgets and technical challenges.

Studies consistently show that such involvement enhances readiness and motivates employees, making it a key factor in successfully integrating AI (Fan et al, 2021),(Mikalef et al, 2022).

2. Availability of Financial Resource and AI adoption:

Resource availability plays a key role in AI adoption. As defined by Maduku et al. (Maduku et al., 2016), it refers to having enough financial means to support new technologies. AI requires major investments not just to set up, but also for training, maintenance, and upgrades (Dwivedi et al, 2021). Startups often face financial constraints (Bughin et al., 2017). Many startups rely heavily on personal funds, which limits their ability to invest in AI (Hasan & Habib, 2017). Unlike larger firms, Startups usually struggle to secure the capital needed for technological adoption (Tob-Ogu et al., 2018), (Harness et al., 2018). Studies show that access to financial resources strongly influences whether Startups adopt AI (Ramadan & Eleyan, 2021). Without adequate funding, firms may delay or avoid such investments altogether (Baabdullah et al, 2021). Research also confirms that companies with stronger financial capacity are more likely to invest in infrastructure, staff training, and technical support elements essential for successful AI integration. (Nguyen et al, 2022), (Kinkel et al, 2022)

3. Employee capability and AI adoption:

Employee capability meaning the skills and knowledge that workers bring is a key factor in adopting AI technologies. Skilled employees help companies handle the complexity of AI and ensure smooth integration into daily operations (Ghobakhloo et al, 2011). According to Maduku et al. (Maduku et al., 2016), having qualified staff is essential for any organization trying to implement new technologies. Employees with strong technical skills are better able to manage AI systems and adapt to changes. However, Startups often struggle with this. They typically don't have as many skilled workers as large firms, which puts them at a disadvantage in adopting new technologies (Harness et al, 2018). Studies confirm that companies with well-trained staff are more likely to succeed with AI adoption (Tajpour et al, 2022). Investing in employee training helps businesses adapt faster, improve performance, and make better use of AI tools.

• Environmental factors:

1. Competitor pressure and AI adoption:

Competitor pressure, defined as the influence of rivals within the same industry (Sun et al., 2020), plays a vital role in motivating organizations to adopt AI technologies. When firms see their competitors gaining advantages through innovation, they feel compelled to adopt similar tools to remain competitive (Obal, M, 2017), (Jia et al, 2017). This pressure pushes companies to improve efficiency, decision-making, and overall performance using AI (Lippert & Govindarajulu, 2006a). Research shows that firms that ignore such trends risk falling behind, while those that embrace AI can strengthen their market position (Bolton, 1993), (Limayem & Cheung, 2007). The link between competitive pressure and technology adoption is well established across sectors (Jia et al., 2017),(Lippert & Govindarajulu, 2006b). Organizations

often act when they see competitors benefiting from new technologies, turning innovation into a strategic necessity. For Startups, this pressure is even more intense. Competing against larger firms forces them to adopt new technologies like AI to survive, stay relevant, and capture market opportunities (S. d. et al., 2020), (Sin et al, 2016)

2. Customer pressure and AI adoption:

Customer pressure refers to the influence of consumer demands and expectations on a business's decision to adopt new technologies like artificial intelligence (AI). In a competitive market, meeting customer needs has become essential for maintaining satisfaction and loyalty (Dhull & Narwal, 2016);(Marikyan et al., 2023). Research shows that customer encouragement, trust, and dedication can push businesses to innovate and embrace new tools (Abed et al., 2016). As consumers become more informed and expect advanced services, organizations are increasingly motivated to use technologies such as AI to improve products, personalize services, and deliver better experiences (Sharma et al., 2020), (Savastano et al., 2019).

3. Vendor support and AI adoption :

Vendor support plays a vital role in helping organizations, especially Startups, adopt new technologies like artificial intelligence (AI). This support includes training, guidance during setup, technical help, and regular updates (Chatzoglou, P. et al., 2016). Studies show that strong vendor support can reduce the risks of implementation and increase an organization's readiness to adopt AI (Weigelt, C, 2009). When vendors assist throughout the entire process from planning to post-deployment businesses are more likely to adopt and integrate AI successfully (Pillai, R. et al., 2023). For Startups, which often struggle with limited resources and technical skills, vendor support is especially important. It helps make the adoption process smoother and more manageable (Hadi Putra & Santoso, 2020); (Kurnia, S & Huang, G. A, 2019). By offering the right training and ongoing help, vendors give Startups the confidence and tools they need to use AI effectively, improve performance, and stay competitive.

4. AI and substaminale performance :

Recent research underscores the significant impact of artificial intelligence on startups' economic, social, and environmental performance. For instance (Soomro et al., 2025). demonstrate that AI adoption improves resource efficiency, lowers operational costs, and enhances financial outcomes, particularly within emerging markets such as Pakistan, where technological integration strengthens processes and supports both profitability and growth. From a social perspective, AI contributes to workplace safety, predictive maintenance, and tailored customer experiences, which in turn promote employee satisfaction and strengthen customer relationships (Lu, X et al., 2022). Likewise, in terms of environmental outcomes, AI has been shown to facilitate waste reduction, resource optimization, and sustainable practices, highlighting its value in advancing environmentally responsible operations (Yan, X. et al., 2019).

Beyond organizational benefits, the role of government and supporting institutions remains critical. Effective implementation of AI in startups requires not only regulatory frameworks that encourage digital transformation but also financial incentives, technical assistance, and robust data infrastructure. Previous studies emphasize that supportive policies and institutional involvement significantly accelerate small businesses' adoption of AI and strengthen their capacity for sustainable growth (Chen, Y. & Lin, Z, 2021),(Bai, C. et al., 2021).

4. Practical Framework:

In this part of the study, we will discuss how artificial intelligence technologies can be used to support innovation and startup development. We have organized them by type: national policies, accelerator and cluster programs, and tech company initiatives.

4.1 National Policies :

Recent reports from the Organization for Economic Co-operation and Development (OECD) highlight the increasing need for integrated strategies to support startups in the era of artificial intelligence. In its 2025 report titled "Emerging Gaps in AI Transition," the OECD introduced a practical framework rooted in place-based innovation strategies. This approach aims to strengthen the ability of Startups to adopt AI technologies by creating supportive local environments (Kergroach & H  ritier, 2025). Additionally, in its 2025 publication "AI Adoption in Business," the OECD provided a comparison of AI adoption practices across G7 nations and Brazil. The report identified key factors that contribute to successful AI implementation, including strong digital governance, specific funding programs, and the role of incubators in promoting knowledge sharing (OECD et al., 2025). This analysis is complemented by the Science, Technology, and Innovation Perspective (2023), which provides a global context for innovation ecosystems, highlighting deep tech funding and its impact on startup dynamics. The OECD thus highlights a comprehensive vision that integrates national policies, spatial mechanisms, and innovative financing as a key approach to accelerating the integration of AI into emerging economic systems.(OECD, 2023)

International experience shows that the most successful AI strategies are those that combine a clear long-term vision with enabling tools for startups. In Singapore, the National AI Strategy 2.0 (2024) outlines fifteen action lines over three to five years, focusing on good governance, digital infrastructure development, and skills enhancement, providing startups with an integrated growth environment (Commerce International, 2024). This approach is reinforced by the Economic Development Authority's (2025) brief on the increasing dynamism of AI companies, as well as sector-specific examples such as a study by the RSIS Institute at NTU University, which highlighted how the interaction between the state, the private sector, and universities contributes to advancing AI applications in advanced fields such as space technology (EDB, 2025);(Karryl Kim Sagun Trajano et al., 2024). In the European Union, the Court of Auditors' report (2024) showed that the effectiveness of AI programs is linked to their ability to transform funded research into scalable innovations for startups.(European Court of Auditors., 2024) In this

context, the European Innovation Council's (EIC) 2024 Action Program plays a crucial role by providing early-stage funding mechanisms and supporting the transition to market, particularly in the field of deep technologies (EIC, 2023). The Innovation Policy Memorandum (2025) also emphasized the importance of facilitating startups' access to high-performance computing (HPC) capabilities, as a prerequisite for accelerating experimentation and commercial innovation in the field of artificial intelligence. (EUROPEAN Commision, 2025)

4.2 Accelerator and Cluster Programs:

In this regard, practical experiences in the United Kingdom, Canada, and the United Arab Emirates stand out as pioneering examples of how AI can be leveraged as an innovation engine through dedicated accelerators and clusters. In the United Kingdom, the Innovate UK BridgeAI program was launched as a national platform aimed at connecting traditional sectors with AI experts through competitive grants and innovation competitions. The 2024 Impact Report demonstrated that this approach helped small and medium-sized enterprises (SMEs) integrate smart solutions that reduced operating costs and accelerated experimentation (**BridgeAI impact report 2024. Innovate UK , 2024**); (**Digital Catapult, 2024**). In Canada, the SCALE AI cluster played a pivotal role in transforming research into market applications, particularly in the field of supply chains, through specialized accelerator programs and industry-academic partnerships documented in multiple case reports (**Innovations Canada, 2024**); (**Scale AI., 2024**). In the Middle East, the Dubai Future Accelerators program, in partnership with the Dubai Center for Artificial Intelligence (DCAI), embodied an innovative government model, allowing startups to test their solutions across government challenge platforms. This was reflected in the 2025 report on 15 use cases that highlighted the depth of public-private partnerships (**Barros, A, 2025**). In the same vein, Abu Dhabi's Hub71 ecosystem offered a pioneering experience in international incubation and funding, registering more than 371 supported startups in 2024 alone. Reports confirm a high selectivity in accepting companies, reflecting a strategic focus on AI and deep technologies (**Hub71, 2024**). Together, these models demonstrate how national programs, clusters, and government initiatives can provide a stimulating environment for startups to embrace AI and transform it into scalable economic value.

4.3 Initiatives by Major Tech Companies Targeting Startups:

The NVIDIA Inception program is one of the world's leading initiatives supporting startups related to artificial intelligence and advanced technologies. It currently includes more than 20,000 startups that benefit from access to technical expertise, advanced resources, and opportunities to enter global markets (**NVIDIA, 2024b**). The program provides an open platform for members to showcase their applied success stories, creating a global community for mutual learning and innovation (**NVIDIA, 2024a**). A notable example is its partnership with OurCrowd, which aims to accelerate startups' integration into markets by providing investment channels and strategic collaborations. This reflects the program's role as a true bridge between technology and venture capital (**NVIDIA & OurCrowd, 2023**). Thus, it can be said that NVIDIA Inception represents a

global model for digital incubation ecosystems that go beyond technical support to building cross-border networks and partnerships.

4.4 United States – Enabling structures to accelerate innovation:

The National Science Foundation (NSF) in the United States launched the Regional Innovation Engines (RIEs) initiative as part of its Translational Innovation Roadmap (TIP), with the aim of building strong regional ecosystems capable of integrating AI into various value chains and economic activities. This initiative focuses on providing long-term strategic funding to support startups, enhancing local digital skills capabilities, and linking scientific research to the economic and social needs of regions (NSF, 2023a). Rather than funding isolated research projects, it seeks to create integrated regional innovation ecosystems that enhance American technological leadership and support sustainable growth through partnerships between universities, the private sector, and government agencies (NSF, 2023b). This initiative can be considered an advanced model for how national policies can be employed to drive AI-based translational innovation, reflecting a shift from traditional support for scientific research to building competitive regional environments with direct economic impact.

4.5 Comparative Overview:

Table 1 : A comparative Overview

<i>Institution / Program</i>	<i>Country / Region</i>	<i>Main Focus</i>	<i>Mechanisms & Support</i>	<i>Outcomes / Impact</i>
NVIDIA – Inception Program	Global (HQ: USA)	Supporting AI-driven startups across sectors	Access to advanced GPU/AI technologies, mentoring by experts, networking opportunities, member showcase platform, partnerships (e.g., with OurCrowd)	+20,000 startups supported; accelerated adoption of AI across industries; stronger market access for emerging ventures
NSF – Regional Innovation Engines (TIP Roadmap)	USA	Regional innovation ecosystems integrating AI	Long-term funding, translational research support, skill development, linking universities with private sector and local governments	Strengthened regional economies; enhanced competitiveness of AI startups; creation of sustainable innovation hubs
Innovate UK – Smart Grants & AI Mission	United Kingdom	Stimulating AI adoption in SMEs and startups	Competitive grants, collaborative R&D projects, knowledge transfer partnerships, regulatory support	Boosted AI commercialization; increased global competitiveness of UK tech startups

<i>Institution / Program</i>	<i>Country / Region</i>	<i>Main Focus</i>	<i>Mechanisms & Support</i>	<i>Outcomes / Impact</i>
<i>SCALE AI – Supercluster</i>	Canada	AI-powered supply chain and industry transformation	Co-investment model, industry-academia collaboration, AI adoption in logistics and manufacturing	Strengthened Canada's position in AI supply chains; improved efficiency and resilience of industrial ecosystems
<i>Dubai – Dubai Future Accelerators</i>	UAE (Dubai)	AI and emerging tech solutions for government & business challenges	Government-backed accelerator, pilot projects with public entities, co-creation with startups	Positioned Dubai as regional AI hub; accelerated AI-based public services and smart city initiatives
<i>Abu Dhabi – Hub71</i>	UAE (Abu Dhabi)	Global startup ecosystem with AI as priority	Financial incentives, global network access, venture capital connections, partnerships with big tech firms	Attraction of global AI startups; stronger MENA entrepreneurial ecosystem

Source: *Elaborated by the authors*

4.6 Comparison Results:

Many different programs exist to help AI startups grow faster, but they each take a unique approach. Some, like NVIDIA's program, operate globally by giving startups access to cutting-edge technology. Others focus on strengthening their local economy by integrating AI into nearby industries. National programs often work by co-investing money into research with private companies. Meanwhile, government-led initiatives in places like Dubai aim to turn their cities into world-class hubs for AI businesses. Ultimately, the most successful strategies combine several key ingredients: technology, funding, training, and strong partnerships to help startups compete and ensure AI benefits everyone.

4.7 Proposed Recommendations for the Algerian Context:

Through the above comparisons and analyses, our study aimed to extract transferable elements and identify "best practices" that could be adapted to a strategic situation in Algeria or to academic/governmental institutions. We also linked all of the above to the Algerian context in our country through several proposed recommendations.

These recommendations are:

1. Use local readiness assessment tools before launching programmes, and design support packages graded according to maturity level.

2. The importance of combining skills, central computing, and private sector partnerships applicable through government-university partnerships in Algeria.
3. Designing phased funding mechanisms and linking research to a clear market helps local startups transition to commercial testing.
4. Organizing similar “sectoral challenges” in Algeria to raise the level of AI adoption within specific sectors (agriculture, energy, health).
5. Adopting a cluster model that links universities, local governments, and private companies in the states or provinces of Algeria.
6. Providing regulatory and business environmental facilities (legal, administrative) to encourage start-up companies to enter local government markets.
7. Partnering with a global technology provider can alleviate the barrier to accessing technology resources in Algeria (computing, tools).
8. Establish regional hubs (such as the Oran or Constantine hubs) to attract investments and build local innovation ecosystems.

5. Conclusion:

This study highlights the diversity of international AI innovation programs, from national platforms such as Innovate UK BridgeAI and Canada’s SCALE AI cluster to regional accelerators like Hub71 in Abu Dhabi and global initiatives such as NVIDIA Inception. Despite differences in scope, governance, and scale, these programs converge on a common purpose: fostering startup growth through funding, technological access, skills development, and strategic partnerships. By examining these cases comparatively, the study underscores the importance of cross-sectoral collaboration and ecosystem-oriented policies in ensuring that AI-driven entrepreneurship can translate research into tangible market applications and contribute to sustainable economic development.

6. Bibliography list:

- A. Torfi, R. A. Shirvani, Y. Keneshloo, & N. Tavaf. (2020). Natural Language Processing Advancements By Deep Learning : A Survey. *E. A. Fox*, 1-23,.
- Abed, S. S, Dwivedi, Y. K, & Williams, M. D. (2016). Social commerce as a business tool in Saudi Arabia’s SMEs. *Int. J. Indian Cult. Bus. Manag.*, 1-19.
- Ali, M. A, Hoque, M. R, & Alam, K. (2018). An empirical investigation of the relationship between e-government development and the digital economy : The case of Asian countries. *Journal of Knowledge Management*, 1176-1200.
- Alsheibani, S. A, Cheung, Y, Messom, C. H, & Alhosni, M. (2020). Winning AI strategy : Six-steps to create value from Artificial Intelligence. *AMCIS*.
- Al-Surmi, A, Bashiri, M, & Koliousis, I. (2022). AI based decision making : Combining strategies to improve operational performance. *Int. J. Prod. Res.*, 4464-4486.
- Araujo, T., Helberger, N., Kruijkemeier, S., & De Vreese, C. H. (2020). In AI we trust? Perceptions about automated decision-making by artificial intelligence. *AI & SOCIETY*, 35(3), 611-623. <https://doi.org/10.1007/s00146-019-00931-w>

- Arendt, L. (2008). Barriers to ICT adoption in SMEs : How to bridge the digital divide? *J. Syst. Inf. Technol.*, 93-108.
- B. Robert, & E. B. Brown. (2021). *Artificial Intelligence for Business*,.
- Baabdullah, A. M., Alalwan, A. A, Slade, E. L, Raman, R, & Khatatneh, K. F. (2021). SMEs and artificial intelligence (AI) : Antecedents and consequences of AI-based B2B practices. *Ind. Mark. Manag.*, 255-270.
- Bai, C., Quayson, M., & Sarkis, J. (2021). COVID-19 pandemic digitization lessons for sustainable development of micro-and small enterprises. *Sustain. Prod. Consum.*, 1989-2001.
- Bandi, R. K, Bose, A. K, & Saxena, A. (2015). *Exploring green IT awareness and adoption among Indian students. In Proceedings of the ACM SIGMIS Conference on Computers and People Research.* 87-96.
- Barakat, Y, Bourekadi, S, Khouliji, S, & Kerkeb, M.L. (2021). *What contributions of Artificial Intelligence in Innovation?*
- Barata, S. F. P. G., Ferreira, F. A. F., Carayannis, E. G., & Ferreira, J. J. M. (2024). Determinants of E-Commerce, Artificial Intelligence, and Agile Methods in Small- and Medium-Sized Enterprises. *IEEE Transactions on Engineering Management*, 71, 6903-6917. <https://doi.org/10.1109/TEM.2023.3269601>
- Barros, A. (2025). *Public sector innovation and AI adoption in Dubai. Dubai Future Foundation Insights.*
- Berman, S. J, Kesterson-Townes, L, Marshall, A, & Srivathsa, R. (2012). How cloud computing enables process and business model innovation. *Strateg Leadersh.*, 27-35.
- Bokhari, A. (2020). *Small and medium-sized enterprises (SMEs) in Pakistan.*
- Bolton, M. K. (1993). Organizational innovation and substandard performance : When is necessity the mother of innovation? *Organ. Sci.*, 57-75.
- Boudreau, K. J., & Lakhani, K. R. (2013). Using the crowd as an innovation partner. *Harvard business review*, 60-69.
- BridgeAI impact report 2024. Innovate UK. (2024). *Innovate UK Business Connect.* <https://iuk.ktn-uk.org/programme/bridgeai/>
- Brynjolfsson, & Collis, A. (2019). How should we measure the digital economy. *Harvard business review*, 140-148.
- Bughin, J, Hazan, E, DC, W, & Chu, M. (2017). *Artificial intelligence the next digital frontier.*
- Burgess, A. (2017). *The Executive Guide to Artificial Intelligence : How to Identify and Implement Applications for AI in your Organization.*
- Chatterjee, S, Kar, A. K, & Mustafa, S. Z. (2021). Securing IoT devices in smart cities of India : From ethical and enterprise information system management perspective. *Enterp. Inf. Syst.*, 585-615.
- Chatzoglou, P., Chatzoudes, D, Frigidis, L., & Symeonidis, S. (2016, septembre 11). *Examining the critical success factors for ERP implementation : An explanatory study conducted in SMEs. In Information Technology for Management : New Ideas and Real Solutions : 14th Conference, AITM and 11th Conference, ISM 2016.*, 179-201.
- Chau, N. T., Deng, H., & Tay, R. (2021). A Perception-Based Model for Mobile Commerce Adoption in Vietnamese Small and Medium-Sized Enterprises: *Journal of Global Information Management*, 29(1), 44-67. <https://doi.org/10.4018/JGIM.2021010103>
- Chen, Y., & Lin, Z. (2021). Business intelligence capabilities and firm performance : A study in China. *Int. J. Inf. Manag.*, 102232.
- Cidral, W. A, Oliveira, T, Di Felice, M, & Aparicio, M. (2018). E-learning success determinants : Brazilian empirical study. *Comput. Educ.*, 273-290.

- Coleman, S et al. (2016). How can SMEs benefit from big data ? Challenges and a path forward. *Qual. Qual. Reliab. Eng. Int*, 2151-2164.
- Commerce International. (2024). *Singapore Artificial Intelligence Strategy 2.0*. https://www.trade.gov/market-intelligence/singapore-artificial-intelligence-strategy-20?utm_source=chatgpt.com
- Daraojimba, C., Abioye, K.M, Bakare, A.D, Mhlongo, N.Z, Onunka, O, & Daraojimba, D.O. (2023). TECHNOLOGY AND INNOVATION TO GROWTH OF ENTREPRENEURSHIP AND FINANCIAL BOOST: A DECADE IN REVIEW (2013-2023). *International. Journal of Management & Entrepreneurship Research*, pp.769-792.
- Deep reinforcement learning for power system : An overview. (2019). *CSEE Journal of Power and Energy Systems*. <https://doi.org/10.17775/CSEEJPES.2019.00920>
- Dhull, S, & Narwal, M. (2016). Drivers and barriers in green supply chain management adaptation : A state-of-art review. *Uncertain. Supply Chain Manag*, 61-76.
- Digital Catapult. (2024). *AI innovation programmes and industry collaborations*. *Digital Catapult*. <https://www.digicatapult.org.uk>
- Djatikusumo, D. S. (2014). *Determinants of SMEs' adoption of information communication technology (ICT) and their impact on organizational performance in Indonesia*.
- Duan, Y, Edwards, J. S, & Dwivedi, Y. K. (2019). Artificial intelligence for decision making in the era of Big Data–evolution, challenges and research agenda. *Int. J. Inf. Manage*, 63-71.
- Dwivedi, Y. K. et al. (2021). Artificial Intelligence (AI) : Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *Int. J. Inf. Manage*, 101994.
- Dwivedi, Y. K., Wade, M. R., & Schneberger, S. L. (Éds.). (2012). *Information Systems Theory : Explaining and Predicting Our Digital Society, Vol. 1* (Vol. 28). Springer New York. <https://doi.org/10.1007/978-1-4419-6108-2>
- EDB, S. (2025). *Artificial Intelligence in Singapore for businesses – a round-up from April to June 2025*. https://www.edb.gov.sg/en/business-insights/insights/artificial-intelligence-in-singapore-for-businesses-a-round-up-from-april-to-june-2025.html?utm_source=chatgpt.com
- Effendi, M. I., Sugandini, D, & Istanto, Y. (2020). Social media adoption in SMEs impacted by COVID-19 : The TOE model. *J. Asian Financ Econ. Bus.*, 915-925.
- EIC. (2023). *European Innovation Council (EIC) Work Programme 2024* (established by the European Commission, under the Horizon Europe programme).
- Elder-Vass, D. (2016). *Profit and gift in the digital economy*. Cambridge University Press.
- Enholm, I. M, Mikalef, P, & Krogstie, J. (2022). Artificial intelligence and business value : A literature review. *Inf. Syst. Front.*, 1709-1734.
- EUROPEAN Commision. (2025, mai 28). *COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS*. https://research-and-innovation.ec.europa.eu/document/download/2f76a0df-b09b-47c2-949c-800c30e4c530_en?utm_source=chatgpt.com
- European Court of Auditors. (2024). *EU Artificial intelligence ambition : Stronger governance and increased, more focused investment essential going forward. Special report,08, 2024*. Publications Office. <https://data.europa.eu/doi/10.2865/923687>
- Fan, M. et al. (2021). Effects of entrepreneurial orientation on social media adoption and SME performance : The moderating role of innovation capabilities. *PLoS One*.
- Ganguly, K. K. (2024). Understanding the challenges of the adoption of blockchain technology in the logistics sector : The TOE framework. *Technol. Anal. Strateg Manag.*, 457-471.

- Ghobakhloo, M., Sabouri, M. S., Hong, T. S., & Zulkifli, N. (2011). Information technology adoption in small and medium-sized enterprises; an appraisal of two decades literature. *Interdiscip J. Res. Bus.*, 53-80.
- Gopal, R. D., Ramesh, R., & Whinston, A. B. (2003). Microproducts in a digital economy : Trading small, gaining large. *International Journal of Electronic Commerce*.
- Grandon, E. E., & Pearson, J. M. (2004). Electronic commerce adoption : An empirical study of small and medium US businesses. . *Inf. Manag.*, 197-216.
- Hadi Putra, P. O., & Santoso, H. B. (2020). Contextual factors and performance impact of e-business use in Indonesian small and medium enterprises (SMEs). *Heliyon*, e03568.
- Haleem, A., Javaid, M., Asim Qadri, M., Pratap Singh, R., & Suman, R. (2022). Artificial intelligence (AI) applications for marketing : A literature-based study. *International Journal of Intelligent Networks*, 3, 119-132. <https://doi.org/10.1016/j.ijin.2022.08.005>
- Hansen, E. B., & Bøgh, S. (2021). Artificial intelligence and internet of things in small and medium-sized enterprises : A survey. *Journal of Manufacturing Systems*, 58, 362-372. <https://doi.org/10.1016/j.jmsy.2020.08.009>
- Harness, D., Ranaweera, C., Karjaluto, H., & Jayawardhena, C. (2018). The role of negative and positive forms of power in supporting CSR alignment and commitment between large firms and SMEs. *Ind. Mark. Manag.*, 17-30.
- Hasan, M. M., & Habib, A. (2017). Corporate life cycle, organizational financial resources and corporate social responsibility,. *J. Contemp. Acc. Econ.*, 20-36.
- Haus-Reve, Silje, Rune Dahl Fitjar, & Andrés Rodríguez-Pose. (2022). *DUI It Yourself: Innovation and Activities to Promote Learning by Doing, Using, and Interacting within the Firm*. Oxfordshire: Taylor and Francis, 1-21.
- Hub71. (2024). *Impact report 2024 : Building global startups from Abu Dhabi*. Hub71. <https://www.hub71.com>
- Innovations Canada. (2024). Supporting AI startups through SCALE AI. *Government of Canada*. <https://www.ic.gc.ca>
- Jahanmir, S. F., & Cavadas, J. (2018). Factors affecting late adoption of digital innovations. *J. Bus. Res.*, 337-343.
- Jensen, Morten Berg, Björn Johnson, Edward Lorenz, Bengt-Åke Lundvall, & Bengt A. Lundvall. (2007). Forms of Knowledge and Modes of Innovation. *The Learning Economy and the Economics of Hope*, 680-93.
- Jia, Q., Guo, Y., & Barnes, S. J. (2017). Enterprise 2.0 post-adoption : Extending the information system continuance model based on the technology-Organization-environment framework. *Comput. Hum. Behav.*, 95-105.
- Karryl Kim Sagun Trajano, Iuna Tsyulneva, & Chee Yong Sean Chua. (2024, octobre). AI in Space Technologies : A Singapore Case Study. *RSIS*.
- Kergroach, S., & Héritier, J. (2025). *Emerging divides in the transition to artificial intelligence* (147^e éd., OECD Regional Development Papers) [OECD Regional Development Papers]. <https://doi.org/10.1787/7376c776-en>
- Khan, A. N., Mehmood, K., & Soomro, M. A. (2024). Knowledge management-based Artificial Intelligence (AI) adoption in construction SMEs : The moderating role of knowledge integration. *IEEE Trans. Eng. Manag.*
- Kim, J.-S., & Seo, D. (2023). Foresight and strategic decision-making framework from artificial intelligence technology development to utilization activities in small-and-medium-sized enterprises. *Foresight*, 25(6), 769-787. <https://doi.org/10.1108/FS-06-2022-0069>

- Kinkel, S., Baumgartner, M., & Cherubini, E. (2022). Prerequisites for the adoption of AI technologies in manufacturing—evidence from a worldwide sample of manufacturing companies. *Technovation*, 102375.
- Kurnia, S., & Huang, G. A. (2019). Hermeneutic analysis of critical success factors for Enterprise systems implementation by SMEs. *Enterp. Inf. Syst.*, 1195-1216.
- Lei, J., Indiran, L., Abdul Kohar, U. H., & Liu, H. (2024). Digital Innovation in Emerging Economies : A Comparative Review of India, Malaysia, China, and Indonesia. *International Journal of Academic Research in Business and Social Sciences*, 14(1), Pages 3207-3227. <https://doi.org/10.6007/IJARBS/v14-i1/20457>
- Limayem, M., & Cheung, C. M. K. (2007). How habit limits the predictive power of intention : The case of information systems continuance. *MIS Q*, 705-737.
- Lippert, S. K., & Govindarajulu, C. (2006a). Technological, organizational, and environmental antecedents to web services adoption. *Commun. IIMA*, 14.
- Lippert, S. K., & Govindarajulu, C. (2006b). Technological, organizational, and environmental antecedents to web services adoption. *Commun. IIMA*, 14.
- Lu, X., Wijayarathna, K., Huang, Y., & Qiu, A. (2022). AI-enabled opportunities and transformation challenges for SMEs in the post pandemic era : A review and research agenda. *Front.Public. Heal.*, 885067.
- Maduku, D. K., Mpinganjira, M., & Duh, H. (2016). Understanding mobile marketing adoption intention by South African SMEs : A multi-perspective framework. *Int. J. Inf. Manage*, 711-723.
- Marikyan, D, Papagiannidis, S, & Alamanos, E. (2023). Cognitive dissonance in technology adoption : A study of smart home users. *Inf. Syst. Front*, 1101-1123.
- Maroufkhani, P., Iranmanesh, M., & Ghobakhloo, M. (2023). Determinants of big data analytics adoption in small and medium-sized enterprises (SMEs). *Industrial Management & Data Systems*, 123(1), 278-301. <https://doi.org/10.1108/IMDS-11-2021-0695>
- Merugula, S. et al. (2021). Study of blockchain technology in empowering the SME. *International Conference on Artificial Intelligence and Smart Systems (ICAIS)*, 758-765.
- Mikalef, P et al. (2022). Enabling AI capabilities in government agencies : A study of determinants for European municipalities. *Gov. Inf. Q.* 39, 1015.
- Mikalef, P., & Gupta, M. (2021). Artificial intelligence capability : Conceptualization, measurement calibration, and empirical study on its impact on organizational creativity and firm performance. *Information & Management*, 58(3), 103434. <https://doi.org/10.1016/j.im.2021.103434>
- Miller, T. (2019). Explanation in artificial intelligence : Insights from the social sciences. *Artificial Intelligence*, 267, 1-38. <https://doi.org/10.1016/j.artint.2018.07.007>
- Moinuddin, M, Usman, M, & Khan, R. (2024). Strategic insights in a data-driven era : Maximizing Business potential with Analytics and AI. *Rev. Esp. Doc. Cient*, 117-133.
- Mouakket, S, & Aboelmaged, M. (2023). Factors influencing green information technology adoption : A multi-level perspective in emerging economies context. *Inf. Dev.*, 699-719.
- Nazir, M. A., & Khan, M. R. (2024). Identification of roles and factors influencing the adoption of ICTs in the SMEs of Pakistan by using an extended Technology Acceptance Model (TAM). *Innov. Dev*, 189-215.
- Nguyen, T. L, Nguyen, V. P, & Dang, T. V. D. (2022). Critical factors affecting the adoption of artificial intelligence : An empirical study in Vietnam. *J. Asian Financ Econ. Bus.*, 225-237.
- NSF, N. S. F. (2023a). *NSF Engines program overview*. U.S. National Science Foundation. <https://new.nsf.gov/funding/initiatives/nsf-engines>
- NSF, N. S. F. (2023b). *Technology, Innovation and Partnerships (TIP) Directorate roadmap*. U.S. National Science Foundation. <https://new.nsf.gov/tip>

- NVIDIA. (2024a). *NVIDIA Inception member showcase*. <https://www.nvidia.com/en-us/startups/inception/members/>
- NVIDIA. (2024b). *NVIDIA Inception program overview*. <https://www.nvidia.com/en-us/startups/inception/>
- NVIDIA & OurCrowd. (2023). *NVIDIA Inception partners with OurCrowd to accelerate AI startups*. *NVIDIA Newsroom*. <https://blogs.nvidia.com>
- Obal, M. (2017). What drives post-adoption usage? Investigating the negative and positive antecedents of disruptive technology continuous adoption intentions. *Ind. Mark. Manag*, 42-52.
- OECD. (2018). Organization for Economic Co-Operation and. Development. Oslo Manual 2018. The Measurement of Scientific, Technological and Innovation Activities. *The Measurement of Scientific, Technological and Innovation Activities*. Luxembourg: OECD.
- OECD. (2023). *OECD Science, Technology and Innovation Outlook 2023 : Enabling Transitions in Times of Disruption*. OECD. <https://doi.org/10.1787/0b55736e-en>
- OECD, Boston Consulting Group, & INSEAD. (2025). *The Adoption of Artificial Intelligence in Firms : New Evidence for Policymaking*. OECD Publishing. <https://doi.org/10.1787/f9ef33c3-en>
- Ogbuokiri, B. O, Udanor, C. N, & Agu, M. N. (2015). Implementing bigdata analytics for small and medium enterprise (SME) regional growth. *IOSR J. Comput. Eng.*, 35-43.
- Oyekunle, D, Matthew, U. O, & Preston, D. (2024). Trust beyond technology algorithms : A theoretical exploration of consumer trust and behavior in technological consumption and AI projects. *J. Comput. Commun*, 72-102.
- Papadopoulos, T., Baltas, K. N., & Balta, M. E. (2020). The use of digital technologies by small and medium enterprises during COVID-19 : Implications for theory and practice. *International Journal of Information Management*, 55, 102192. <https://doi.org/10.1016/j.ijinfomgt.2020.102192>
- Peltier, J. W, Zhao, Y, & Schibrowsky, J. A. (2012). Technology adoption by small businesses : An exploratory study of the interrelationships of owner and environmental factors. *Int. Small Bus. J*, 406-431.
- Pillai, R., Sivathanu, B, & Kaushik, N. (2023). Students' adoption of AI-based teacher-bots (T-bots) for learning in higher education. *Inf. Technol. People*.
- Pimenov, D. Y., Bustillo, A., Wojciechowski, S., Sharma, V. S., Gupta, M. K., & Kuntoğlu, M. (2023). Artificial intelligence systems for tool condition monitoring in machining : Analysis and critical review. *Journal of Intelligent Manufacturing*, 34(5), 2079-2121. <https://doi.org/10.1007/s10845-022-01923-2>
- Premkumar, G, & Roberts, M. (1999). Adoption of new information technologies in rural small businesses. *Omega*, 467-484.
- Rafique, S., & Mujawinkindi, F. (2023). *How can Artificial Intelligence (AI) help SMEs development in emerging economies*.
- Ramadan, M, & Eleyan, D. (2021). Adoption model of social customer relationship management in the Palestinian banking sector. *Mod. Appl. Sci*, 23.
- Ramdani, B, & Kawalek, P. (2007). SME adoption of enterprise systems in the Northwest of England : An environmental, technological, and organizational perspective. In *Organizational Dynamics of Technology-Based Innovation : Diversifying. the Research Agenda: IFIP TC 8 WG 8.6 International Working Conference*, 409-429.
- Riedl, M. O. (2019). Human-centered artificial intelligence and machine learning. *Human Behavior and Emerging Technologies*, 1(1), 33-36. <https://doi.org/10.1002/hbe2.117>
- Rogers, E. M, & Singhal, A. (2003). Empowerment and communication : Lessons learned from organizing for social change. *Ann. Int. Commun. Ann. Int. Commun. Assoc*, 67-85.
- Rogers Everett, M. (1995). *Diffusion of innovations*. 576.

- Russo, D. (2024). Navigating the complexity of generative ai adoption in software engineering. *ACM Trans. Softw. Eng. Methodol.*
- Santos, R.S, & Qin, L. (2019). Risk capital and emerging technologies : Innovation and investment patterns based on artificial intelligence patent data analysis. *Journal of Risk and Financial Management*, p.189.
- Savastano, M, Bellini, F, D'Ascenzo, F., & De Marco, M. (2019). Technology adoption for the integration of online–offline purchasing : Omnichannel strategies in the retail environment. *Int. J. Retail Distrib. Manag.*, 474-492.
- Scale AI. (2024). Annual impact report 2024. *SCALE AI, Canada*. <https://www.scaleai.ca>
- S. d., Li, W, Ahmed, N, Ali Mirani, M, & Khan, A. (2020). Examining the factors affecting SME performance : The mediating role of social media adoption. *Sustainability*, 75.
- Sharma, R, Singh, G, & Sharma, S. (2020). Modelling internet banking adoption in Fiji : A developing country perspective. *Int. J. Inf. Manage*, 102116.
- Sin, K. Y. et al. (2016). Relative advantage and competitive pressure towards implementation of e-commerce : Overview of small and medium enterprises (SMEs). *Procedia Econ. Financ*, 434-443.
- Skare, M., De Las Mercedes De Obesso, M., & Ribeiro-Navarrete, S. (2023). Digital transformation and European small and medium enterprises (SMEs) : A comparative study using digital economy and society index data. *International Journal of Information Management*, 68, 102594. <https://doi.org/10.1016/j.ijinfomgt.2022.102594>
- Soomro, R. B., Al-Rahmi, W. M., Dahri, N. A., Almuqren, L., Al-mogren, A. S., & Aldaijy, A. (2025). A SEM–ANN analysis to examine impact of artificial intelligence technologies on sustainable performance of SMEs. *Scientific Reports*, 15(1), 5438. <https://doi.org/10.1038/s41598-025-86464-3>
- Soomro, R. B et al. (2024). The adoption of digital technologies by small and medium-sized enterprises for sustainability and value creation in Pakistan : The application of a two-staged hybrid SEM-ANN approach. *Sustainability*, 7351.
- Stenberg, L, & Nilsson, S. (2020). *Factors influencing readiness of adopting AI: A qualitative study of how the TOE framework applies to AI adoption in governmental authorities*.
- Su, J., Zhang, Y., & Wu, X. (2023). How market pressures and organizational readiness drive digital marketing adoption strategies' evolution in small and medium enterprises. *Technological Forecasting and Social Change*, 193, 122655. <https://doi.org/10.1016/j.techfore.2023.122655>
- Sun, S, Hall, D. J, & Cegielski, C. G. (2020). Organizational intention to adopt big data in the B2B context : An integrated view. *Ind. Mark. Manag*, 109-121.
- Sun, Y., Tan, C., Lim, K. H., Liang, T., & Yeh, Y. (2024). Strategic contexts, strategic orientations and organisational technology adoption : A configurational approach. *Information Systems Journal*, 34(4), 1355-1401. <https://doi.org/10.1111/isj.12497>
- Sutherland, W, & Jarrahi, M. H. (2018). The sharing economy and digital platforms : A review and research agenda. *International Journal of Information Management*, 328-341.
- Tajpour, M, Hosseini, E, Mohammadi, M, & Bahman-Zangi, B. (2022). The effect of knowledge management on the sustainability of technology-driven businesses in emerging markets : The mediating role of social media. *Sustainability*, 8602.
- Tekic, Z, Cosic, I, & Katalinic, B. (2019). MANUFACTURING AND THE RISE OF ARTIFICIAL INTELLIGENCE: INNOVATION CHALLENGES. *Annals of DAAAM & Proceedings*.
- Thong, J. Y. L. (2001). *Resource constraints and information systems implementation in Singaporean small businesses*. 143 156.

- Tiwari, A. K., Marak, Z. R., Paul, J., & Deshpande, A. P. (2023). Determinants of electronic invoicing technology adoption : Toward managing business information system transformation. *Journal of Innovation & Knowledge*, 8(3), 100366. <https://doi.org/10.1016/j.jik.2023.100366>
- Tob-Ogu, A., Kumar, N., & Cullen, J. (2018). ICT adoption in road freight transport in Nigeria—A case study of the petroleum downstream sector. *Technol. Forecast. Soc. Change*, 240-252.
- Tornatzky, L. G., & Fleischer, M. (1990). *The Processes of Technological Innovation*. (Lexington Books).
- Toufaily, E., Zalan, T., & Dhaou, S. B. (2021). A framework of blockchain technology adoption : An investigation of challenges and expected value. *Information & Management*, 58(3), 103444. <https://doi.org/10.1016/j.im.2021.103444>
- Trianni, A., Cagno, E., & Worrell, E. (2013). Innovation and adoption of energy efficient technologies : An exploratory analysis of Italian primary metal manufacturing SMEs. *Energy Policy*, 430-440.
- Tsai, Y. Y., Chao, C. M., Lin, H. M., & Cheng, B. W. (2018). *Nursing staff intentions to continuously use a blended e-learning system from an integrative perspective. Qual. Quant.* 2495-2513.
- Turner, R. J., & M. Rogers. (2007, 2003). *Diffusion of Innovations*. Free Press.
- Waarts, E., van Everdingen, Y. M., & Van Hillegersberg, J. (2002). The dynamics of factors affecting the adoption of innovations. *J. Prod. Innov. Manag Int. Publ Prod. Dev. Manag Assoc*, 412-423.
- Wang, J., Lu, Y., Fan, S., Hu, P., & Wang, B. (2022). How to survive in the age of artificial intelligence? Exploring the intelligent transformations of SMEs in central China. *International Journal of Emerging Markets*, 17(4), 1143-1162. <https://doi.org/10.1108/IJOEM-06-2021-0985>
- Weigelt, C. (2009). Learning from supply-side agents : The impact of technology solution providers' experiential diversity on clients' innovation adoption. *Acad. Manag J.*, 37-60.
- Wen, K. W., & Chen, Y. (2010). E-business value creation in small and medium enterprises : A US study using the TOE framework. *Int. J. Electron. Bus*, 80-100.
- Yan, X., Tan, Y., & Sun, S. X. (2019). Shared minds : How patients use collaborative information sharing via social media platforms. *Prod. Oper. Manag.*, 9-26.
- Zailani, S., Govindan, K., Iranmanesh, M., Shaharudin, M. R., & Chong, Y. S. (2015). Green innovation adoption in automotive supply chain : The Malaysian case. *J. Clean. Prod.*, 1115-1122.
- Zhu, K., Kraemer, K. L., & Xu, S. (2006). The process of e-business assimilation in organizations : A technology diffusion perspective. *Manage*, 1557-1576.