Entrepreneurship and Machine Learning: A Review

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ABSTRACT

Machine learning (ML) is reshaping the entrepreneurial landscape, empowering startups to gain a competitive edge, develop innovative products and services, and accelerate business growth. This study conducts a review of the emerging field of ML entrepreneurship, leveraging through the pre-recording systematic reviews and meta-analysis (PRISMA) methodology to analyse publications from Web of Science (WoS) and SCOPUS. The author keywords demonstrate that the term 'machine learning' is the most frequently used keyword, followed by 'entrepreneurship', 'performance', 'innovation', 'artificial intelligence', 'management', 'impact', 'technology', 'deep learning', and 'big data'. Three key themes emerged, namely start-ups, technology, and education. The prominence of the technology theme in scholarly discourse highlights the pivotal role of ML in entrepreneurial innovation. ML is enabling startups to capitalize on emerging market opportunities, automate tasks, make informed decisions based on real-time data insights, and ease and enable other tasks more efficiently and effectively. By providing a comprehensive overview of the ML entrepreneurship landscape, this study offers valuable insights for all readers. Researchers and scholars can leverage these findings to identify emerging research areas, contribute to the advancement of knowledge in this field, develop new theories and models of ML entrepreneurship.

Keywords:
Machine learning; Entrepreneurship; Systematic literature review; Technology; Start-ups; Education

1. Introduction

The advancement of technology has created the term "digital entrepreneurship" and "digital innovation" which refer to the fusion of conventional entrepreneurial and innovative processes and outputs with digital technology (Berger *et al.,*). Both areas benefit from the revolutionary advances brought about by digital technologies. This is especially true for start-ups functioning in a dynamic and unpredictable digital environment, where the effect of pervasive and multifunctional digital

technology accelerates development, resulting in huge shifts in a variety of industries including entrepreneurship (Ghezzi & Cavallo). According to researchers, digital technologies dismantle conventional limits and change the agency of entrepreneurial and innovative processes and results (Nambisan *et al.,*). The growth of digital platforms and related entrepreneurial contexts has given entrepreneurship a novel and conceptually significant perspective (Paul *et al.,*). The advantages to entrepreneurs related to their involvement in these entrepreneurial settings, on the other hand, are well established, and the accompanying technology disruptions leading to digital entrepreneurship have yet to be researched (Nambisan & Baron).

Innovative digital technologies had emerged throughout the entrepreneurial progression due to the disruptive technological changes in the global business landscape over the prior decade, which were sought after, implemented, and then seized by entrepreneurs worldwide (Autio; Paul *et al.,*). By utilising cutting-edge digital tools, digital competencies and skills may be built to enhance the performance of a variety of entrepreneurs (Paul *et al.,*). Topical research studies in entrepreneurship and digital innovation have revealed that digital technology enables businesses at various stages of their evolution; as a result, digital entrepreneurship has advanced into an increasingly important research area and is a current issue with both research and practical implications (Ghezzi & Cavallo). Consequently, the digitalisation phenomena has numerous ramifications due to rapid and disruptive change, entrepreneurs and entrepreneurship researchers must be aware of connected results and linkages in order to uncover potential business prospects (Kraus *et al.,*) because the processes has enabled people and organisations to break beyond the limits of physical and digital enterprises to achieve new business milestones (Huang *et al.,*).

A part form that, researchers now have new methodological options for building models that can anticipate a variety of human behaviours in the fields of artificial intelligence (AI) and machine learning (ML) as these tools been able to learn more about how precisely entrepreneurial events may predict the entrepreneurial occurrences in the actual world [19]. As such, ML is most often employed in business and is utilised to carry out the most difficult prediction tasks [16], thus the primary advantage of ML is its high forecast accuracy, which is essential in many commercial fields (Hyytinen *et al.,*). However, while the disruptive potentials of AI and ML in analysing (big) data with a large number of observations or high dimensionality have received increasing attention in a variety of research and application fields, they have not yet been thoroughly examined in present-day entrepreneurship research [16,19,20]. Thus, this study is intended to present systematic review of entrepreneurship and machine learning

2. Materials and Method

This section addresses the need for a systemic analysis of the entrepreneurship study in relation to machine learning. The paper is categorized into two sections: the first part discusses on entrepreneurship, and the second part discusses on machine learning. The paper explores the papers that discuss the two disciplines with different focuses. Next, the paper systematically reviews and synthesises the literature to select relevant papers that meet the objectives of this study and analyse them accordingly. The pre-recording systematic reviews and meta-analysis (PRISMA) approach is applied in this analysis, which is a published standard for conducting a systematic literature review. PRISMA basically highlights the randomised studies' evaluations as illustrated in Figure 1. (Mustafa *et al.,*).

Considering the robust nature of Scopus and Web of Science (WoS), these two databases are used to acquire the scientific papers for evaluation of systematic review analysis. These databases provide

differences in scope, data volume and coverage policies with a high degree of unique sources and articles, resulting both of them complementary and not mutually exclusive (Sánchez *et al.,*).
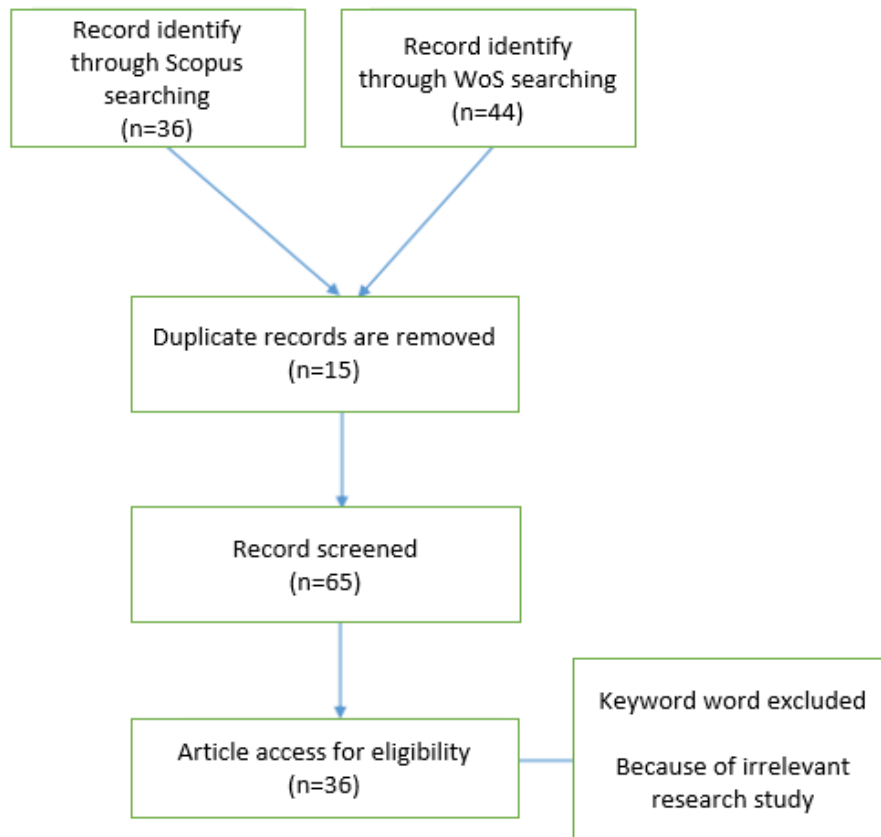

Fig. 1. Flow diagram of the proposed study search

2.1 Identification

In choosing relevant papers to meet the objectives of this paper, a systematic review process was carried out. It consists of three main phases: the first step is keyword recognition. In this process, similar terms with reference to the thesaurus, dictionaries, encyclopaedia, and previous studies were identified. After confirming all the relevant keywords, search strings were created on the Scopus and WoS database (Table 1). Upon completing this first step, 80 papers were identified from both databases.

Table 1
The data sources and search strings for data collection

Sources	Search strings
Scopus	(TITLE-ABS-KEY(entrepreneurship) AND TITLE-ABS-KEY(machine AND learning)) AND (LIMIT-TO (OA,"all")) AND (LIMIT-TO (PUBYEAR,2019) OR LIMIT-TO (PUBYEAR,2020) OR LIMIT-TO (PUBYEAR,2021) OR LIMIT-TO (PUBYEAR,2022) OR LIMIT-TO (PUBYEAR, April 2023)) AND (LIMIT-TO (SUBJAREA,"BUSI") OR LIMIT-TO (SUBJAREA,"SOCI")) AND (LIMIT-TO (LANGUAGE,"English"))
WoS	(ALL=(entrepreneurship) AND ALL=(machine learning)) AND (OA==("OPEN ACCESS") AND PY==("April 2023" OR "2022" OR "2021" OR "2019" OR "2020") AND TMSO==("6.3 Management") AND LA==("ENGLISH"))

2.2 Screening

Duplicated papers found were excluded in this step of screening, which omitted 15 articles. Literature (research articles) was the first criterion because it is the primary source of practical information. It also includes the exclusion from the current study of publications in the form of systematic review, review, meta-analysis, meta-synthesis, book series, books, chapters, and conference proceedings. Furthermore, the review concentrated exclusively on papers written in English. It is essential to note that the schedule was chosen for a five-year duration (2019-April 2023) which was selected from subject area "Management, Business and Accounting" and "Social Science".

2.3 Data Abstraction and Analysis

An integrated analysis was performed in this study, which was one of the examination techniques used to analyse and synthesise keywords that are used in this study, namely entrepreneurship and machine learning. Expert research centred on developing appropriate topics and sub-topics. The first step in the development of the theme was the data collection phase. The authors have carefully reviewed a group of 43 papers. Here, a log was maintained during the data analysis process to document the issues, opinions, and other ideas relevant to the data interpretation. The authors also compared the findings to resolve any discrepancies in the theme creation process.

3. Results and Discussions

3.1 Article Finding

Rapid technological growth has spurred the continuous development of industries, and machine learning (ML) has become increasingly significant in this context. The integration of ML is widely seen in many aspects of entrepreneurial activity, and it is regarded essential for entrepreneurs to focus on ML in order to succeed in the rapidly changing global economy. The importance of ML in entrepreneurship is evident in the growing number of papers published on this topic. However, only 43 articles were extracted and analysed after using the searching technique. Two articles were removed as they are not relevant to the topic being discussed. Table 2 shows the research article finding based on the proposed search criterion:

Table 2
The research article finding based on the proposed searching criterion

No.	Author	Title	Journal
1.	[13]	Predicting New Venture Gestation Outcomes with Machine Learning Methods	Journal of Small Business Management
2.	Zhou *et al.,*	The Influence of Entrepreneurial Cognition on Business Model Innovation: A Hybrid Method Based on Multiple Regressions and Machine Learning	Frontiers in Psychology
3.	Weber *et al.,*	AI Startup Business Models Key Characteristics and Directions for Entrepreneurship Research	Business & Information Systems Engineering
4.	[4]	It's A Peoples Game, Isn't It?! A Comparison Between the Investment Returns of Business Angels and Machine Learning Algorithms	Entrepreneurship Theory and Practice
5.	Guerzoni *et al.,*	Start-Ups Survival Through a Crisis. Combining Machine Learning with Econometrics to Measure Innovation	Economics of Innovation and New Technology
6.	Williamson *et al.,*	Entrepreneurial Disappointment: Let Down and Breaking Down, a Machine-Learning Study	Entrepreneurship Theory and Practice

| 7.	Ferrati & Muffatto	Setting Crunchbase for Data Science: Preprocessing, Data Integration and Feature Engineering	3rd International Conference on Advanced Research Methods and Analytics (CARMA 2020)
8.	Ridho & Abdullah	Improving The Ability of Entrepreneurs to Use Alternative Learning Models in the Automotive Field	International Conference on Innovation in Engineering and Vocational Education 2019 (ICIEVE 2019)
9.	Isabelle *et al.,*	A Machine-Learning Analysis of the Impacts of the COVID-19 Pandemic on Small Business Owners and Implications for Canadian Government Policy Response	Canadian Public Policy-Analyse De Politiques
10.	Gök *et al.,*	Building the European Social Innovation Database with Natural Language Processing and Machine Learning	Scientific Data
11.	Li *et al.,*	Technical Founders, Digital Transformation and Corporate Technological Innovation: Empirical Evidence from Listed Companies in China's STAR Market	International Entrepreneurship and Management Journal
12.	Hyytinen *et al.,*	Ex Ante Predictability of Rapid Growth: A Design Science Approach	Entrepreneurship Theory and Practice
13.	Haefner *et al.,*	Artificial Intelligence and Innovation Management: A Review, Framework, and Research Agenda	Technological Forecasting and Social Change
14.	Ng & Sherman	In Search of Inspiration: External Mobility and the Emergence of Technology Intrapreneurs	Organization Science
15.	Bertoni *et al.,*	Digitization in the Market for Entrepreneurial Finance: Innovative Business Models and New Financing Channels	Entrepreneurship Theory and Practice
16.	Shetty *et al.,*	Assessing and Comparing Top Accelerators in Brazil, India, and the USA: Through the Lens of New Ventures' Performance	Entrepreneurial Business and Economics Review
17.	[2]	Artificial Intelligence and Entrepreneurship Education: A Paradigm in Qatari Higher Education Institutions After Covid-19 Pandemic	International Journal of Data and Network Science
18.	Shi	College Students' Behaviour Initiative, Psychological Availability, and Innovation and Entrepreneurship: The Mediating Effect of Interest Orientation	International Journal of Emerging Technologies in Learning
19.	[6]	Digital Entrepreneurs in Artificial Intelligence and Data Analytics: Who are They?	Journal of Open Innovation: Technology, Market, and Complexity
20.	[8]	The Crowdfunding of Altruism	Journal of Risk and Financial Management
21.	[14]	Entrepreneurship: Analysis by Country Through Machine Learning Techniques	Proceedings of the European Conference on Innovation and Entrepreneurship
22.	Savin & Teplyakov	Using Computational Linguistics to Analyse Main Research Directions in Economy of Regions	Economy of Regions
23.	Mansouri & Momtaz	Financing Sustainable Entrepreneurship: ESG Measurement, Valuation, and Performance	Journal of Business Venturing
24.	Mavlutova *et al.,*	Innovative Teaching Techniques for Entrepreneurship Education in The Era of Digitalisation	WSEAS Transactions on Environment and Development
25.	Arranz *et al.,*	Institutional Pressures as Drivers of Circular Economy in Firms: A Machine Learning Approach	Journal of Cleaner Production
26.	[2]	Artificial Intelligence and Entrepreneurship Education: A Paradigm in Qatari Higher Education Institutions After Covid-19 Pandemic	International Journal of Data and Network Science
27.	Savin *et al.,*	Topic-Based Classification and Identification of Global Trends for Startup Companies	Small Business Economics

28.	Mckenzie & Sansone	Predicting Entrepreneurial Success is Hard: Evidence from a Business Plan Competition in Nigeria	Journal of Development Economics
29.	Ahmad *et al.,*	Knowledge Discovery in Surveys Using Machine Learning: A Case Study of Women in Entrepreneurship in UAE	Proceedings of 2nd IEEE International Conference on Computational Intelligence and Knowledge Economy, ICCIKE 2021
30.	Anna & Kaisu	Entrepreneurial Cognition, Sustainability and Venture Performance: A Machine Learning Approach	Sustainable Entrepreneurship and Entrepreneurial Ecosystems
31.	[17]	Why Data Matters for Development? Exploring Data Justice, Micro-Entrepreneurship, Mobile Money and Financial Inclusion	Information Technology for Development
32.	Antretter *et al.,*	Predicting New Venture Survival: A Twitter-Based Machine Learning Approach to Measuring Online Legitimacy	Journal of Business Venturing Insights
33.	[10]	Artificial Intelligence as an Enabler for Entrepreneurs: A Systematic Literature Review and an Agenda for Future Research	International Journal of Entrepreneurial Behaviour and Research
34.	[5]	A Machine Learning Approach to Rural Entrepreneurship	Papers in Regional Science
35.	[18]	The Impact of Entrepreneurship Orientation on Project Performance: A Machine Learning Approach	International Journal of Production Economics
36.	Graham & Bonner	One Size Fits All? Using Machine Learning to Study Heterogeneity and Dominance in the Determinants of Early-Stage Entrepreneurship	Journal of Business Research
37.	[16]	Artificial Intelligence and Big Data in Entrepreneurship: A New Era has Begun	Small Business Economics
38.	Rivera-Kempis *et al.,*	Entrepreneurial Competence: Using Machine Learning to Classify Entrepreneurs	Sustainability
39.	Friberg & Thomassen	Embedding Innovation and Entrepreneurship in Engineering Education Through Curriculum Development and Educator Training: A Case from Denmark	Proceedings of the 16th European Conference on Innovation and Entrepreneurship
40.	[9]	Impact Tech Startups: A Conceptual Framework, Machine-Learning-Based Methodology and Future Research Directions	Sustainability
41.	Prüfer & Prüfer	Data Science for Entrepreneurship Research: Studying Demand Dynamics for Entrepreneurial Skills in the Netherlands	Small Business Economics
42.	[16]	Big Data Methods, social media, and the Psychology of Entrepreneurial Regions: Capturing Cross-County Personality Traits and Their Impact on Entrepreneurship in the USA	Small Business Economics
43.	Suarez *et al.,*	Entrepreneurship Bias and the Mass Media: Evidence from Big Data	Academy of Management Discoveries

Source: Authors

3.2 Keywords Frequency

Consequently, a keyword analysis was carried out to provide an understanding of the overview of the trends related to Entrepreneurship and Machine learning research. The study analysed the top 50 most frequent keywords, which indicate the most important trends highlighted by authors. To be noted, the most cited keywords usually are the 'hot topics' that are used in research, and therefore they are regarded as the 'trendy' words in the research realm. In this research, the authors used the

50 most frequent keywords used by the respective authors. Figure 2. presents the authors' keywords map that has nodes of different thicknesses and colours, the nodes represent the number of times the keywords are used, and the thickness of the lines and colours indicate the cluster to which the element belongs. As such, Figure 2 is seen demonstrating the term 'machine learning' as the most frequently used keyword, followed by 'entrepreneurship', 'performance', 'innovation', 'artificial intelligence', 'management', 'impact', 'technology', 'deep learning', and 'big data' with more than 20 occurrences each. These keywords enable us to interpret that most research initiatives are gearing towards artificial intelligence and its subsets like machine learning, deep learning, big data and also the integration of these fields with entrepreneurship, performance, education and other disciplines.
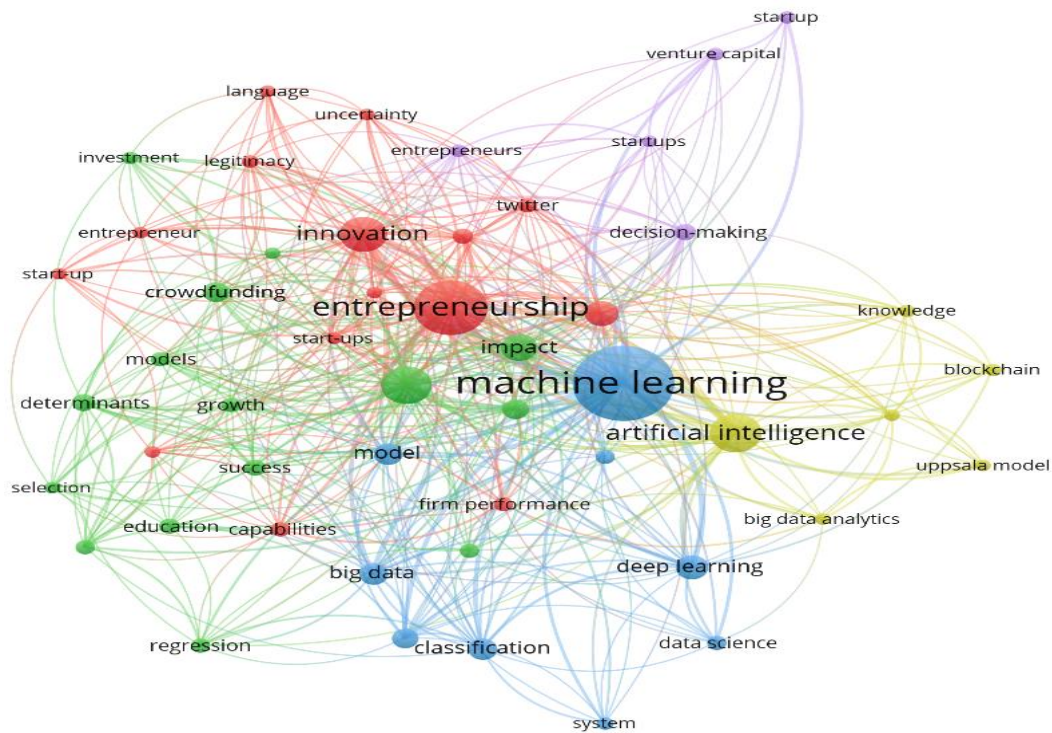
Rank	Keyword	Occurrences	Total Link Strength
1	Machine Learning	112	265
2	Entrepreneurship	65	208
3	Performance	35	120
4	Innovation	31	117
5	Artificial Intelligence	37	113
6	Management	18	79
7	Impact	20	71
8	Technology	12	56
9	Deep Learning	17	54
10	Big Data	14	53

Fig. 2. Keywords map with top 50 occurring words (Network visualization map)

3.3 Themes

Based on the paper's main objectives and discussions, this research then categorized the papers into three (3) main themes: start-ups, technology, and education as shown in Figure 3 below.
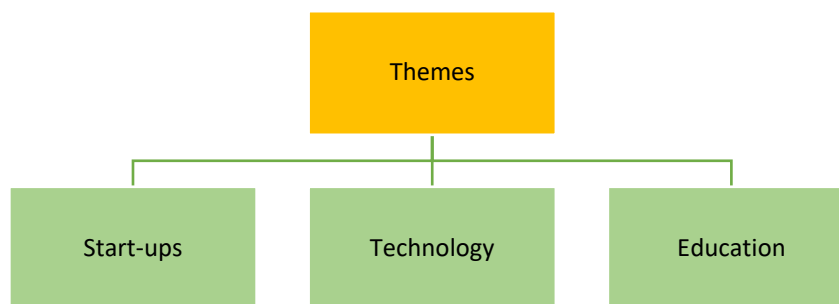
Fig. 3. Chart shows three main themes of the research papers discussed

The illustration as shown in Figure 3. is presented according to the themes as presented in Table 3 below. Each row is showing the category, and each category displaying the paper titles and respective authors.

Table 3
Top three most discussed themes in Entrepreneurship and Machine learning

No.	Theme	Author	Title
1.	Start-ups	Weber *et al.,*	1. AI Startup Business Models Key Characteristics and Directions for Entrepreneurship Research
		Guerzoni *et al.,*	2. Start-Ups Survival Through a Crisis. Combining Machine Learning with Econometrics to Measure Innovation
		Bertoni *et al.,*	3. Digitization in the Market for Entrepreneurial Finance: Innovative Business Models and New Financing Channels
		Mckenzie & Sansone	4. Predicting Entrepreneurial Success is Hard: Evidence from a Business Plan Competition in Nigeria
		Anna & Kaisu	5. Entrepreneurial Cognition, Sustainability and Venture Performance: A Machine Learning Approach
		Antretter *et al.,*	6. Predicting New Venture Survival: A Twitter-Based Machine Learning Approach to Measuring Online Legitimacy
		Graham & Bonner	7. One Size Fits All? Using Machine Learning to Study Heterogeneity and Dominance in the Determinants of Early-Stage Entrepreneurship
		Rivera-Kempis *et al.,*	8. Entrepreneurial Competence: Using Machine Learning to Classify Entrepreneurs
		Gidron *et al.,*	9. Impact Tech Startups: A Conceptual Framework, Machine-Learning-Based Methodology and Future Research Directions
		Koumbarakis & Volery	10. Predicting New Venture Gestation Outcomes with Machine Learning Methods
		Ahmad *et al.,*	11. Knowledge Discovery in Surveys Using Machine Learning: A Case Study of Women in Entrepreneurship in UAE
		Gök *et al.,*	12. Building the European Social Innovation Database with Natural Language Processing and Machine Learning
		Zhou *et al.,*	13. The Influence of Entrepreneurial Cognition on Business Model Innovation: A Hybrid Method Based on Multiple Regressions and Machine Learning
		Savin *et al.,*	14. Topic-Based Classification and Identification of Global Trends for Startup Companies
2.	Technology	Arranz *et al.,*	1. Institutional Pressures as Drivers of Circular Economy in Firms: A Machine Learning Approach
		Blohm *et al.,*	2. It's A Peoples Game, Isn't It?! A Comparison Between the Investment Returns of Business Angels and Machine Learning Algorithms
		Williamson *et al.,*	3. Entrepreneurial Disappointment: Let Down and Breaking Down, a Machine-Learning Study

		Isabelle *et al.,*	4. A Machine-Learning Analysis of the Impacts of the COVID-19 Pandemic on Small Business Owners and Implications for Canadian Government Policy Response
		Li *et al.,*	5. Technical Founders, Digital Transformation and Corporate Technological Innovation: Empirical Evidence from Listed Companies in China's STAR Market
		Hyytinen *et al.,*	6. Ex Ante Predictability of Rapid Growth: A Design Science Approach
		Haefner *et al.,*	7. Artificial Intelligence and Innovation Management: A Review, Framework, and Research Agenda
		Ng & Sherman	8. In Search of Inspiration: External Mobility and the Emergence of Technology Intrapreneurs
		Shetty *et al.,*	9. Assessing and Comparing Top Accelerators in Brazil, India, and the USA: Through the Lens of New Ventures' Performance
		Chae & Goh	10. Digital Entrepreneurs in Artificial Intelligence and Data Analytics: Who are They?
		Faust *et al.,*	11. The Crowdfunding of Altruism
		Martinez-Velasco & Terán-Bustamante	12. Entrepreneurship: Analysis by Country Through Machine Learning Techniques
		Savin & Teplyakov	13. Using Computational Linguistics to Analyse Main Research Directions in Economy of Regions
		Mansouri & Momtaz	14. Financing Sustainable Entrepreneurship: ESG Measurement, Valuation, and Performance
		Qureshi	15. Why Data Matters for Development? Exploring Data Justice, Micro-Entrepreneurship, Mobile Money and Financial Inclusion
		Giuggioli	16. Artificial Intelligence as an Enabler for Entrepreneurs: A Systematic Literature Review and an Agenda for Future Research
		Celbis	17. A Machine Learning Approach to Rural Entrepreneurship
		Obschonka & Audretsch	18. Artificial Intelligence and Big Data in Entrepreneurship: A New Era has Begun
		Friberg & Thomassen	19. Embedding Innovation and Entrepreneurship in Engineering Education Through Curriculum Development and Educator Training: A Case from Denmark
		Obschonka *et al.,*	20. Big Data Methods, social media, and the Psychology of Entrepreneurial Regions: Capturing Cross-County Personality Traits and Their Impact on Entrepreneurship in the USA
		Suarez *et al.,*	21. Entrepreneurship Bias and the Mass Media: Evidence from Big Data
3.	Education	Alqahtani	1. Artificial Intelligence and Entrepreneurship Education: A Paradigm in Qatari Higher Education Institutions After Covid-19 Pandemic
		Shi	2. College Students' Behaviour Initiative, Psychological Availability, and Innovation and Entrepreneurship: The Mediating Effect of Interest Orientation
		Mavlutova *et al.,*	3. Innovative Teaching Techniques for Entrepreneurship Education in The Era of Digitalisation
		Prüfer & Prüfer	4. Data Science for Entrepreneurship Research: Studying Demand Dynamics for Entrepreneurial Skills in the Netherlands
		Ridho & Abdullah	5. Improving the Ability of Entrepreneurs to Use Alternative Learning Models in the Automotive Field
		Sabahi & Parast	6. The Impact of Entrepreneurship Orientation on Project Performance: A Machine Learning Approach

Source: Authors

3.3.1 Technology

Broadly speaking, there are two areas of research on technological aspect of entrepreneurship (Li *et al.,*). The first category is concerned with the how, why, and when of technological

entrepreneurship's impact on a region's socioeconomic growth. Obviously, this also encompasses corporate innovation from a micro perspective and macro-level societal performance. Most academics concur that technological entrepreneurship is one of the major drivers of economic expansion and considerably boosts income and employment creation (Gu & Wang; Mackiewicz & Błoch). There is a claim that inventive entrepreneurship and the creation of new technologies contribute to technical progress, which encourages productivity growth and, as a result, the upward movement of national production frontiers (Lafuente *et al.,*). Consequently, the emergence of ML algorithms has permitted not only quick but also highly accurate information processing that is beyond the reach of human capacities, hence presenting rewarding chances for decision making generating money through entrepreneurship [4]. Technologies are anticipated to become more significant as the market for early-stage venture capital evolves towards more competitive and complicated trajectories [3].

The second category investigates how small technology firms are formed and flourish, as well as the relationship between technology paths (Li *et al.,*). Furthermore, previous research has established that, from an internal organizational perspective, the entrepreneur is a significant factor influencing technology entrepreneurship, which involves entrepreneurial traits such as education background (Blankesteijn *et al.,*; Fayolle *et al.,*), human capital (Sierotowicz) and entrepreneurial capability (Roma *et al.,*). For the external organizations, national entrepreneurial culture, resource environment and regional knowledge production all influence the creation and development of new technology firms (Li *et al.,*). The environment that supports technological entrepreneurship has altered as a result of the advancement of communication technologies and digitalization therefore, researchers have started to look at the relationship between digital transformation and technological innovation in addition to how favourable legislative and normative environmental factors impact the configuration of technology entrepreneurship projects (Hanoteau & Rosa).

However, when technical entrepreneurs engage in entrepreneurial activities, their knowledge capabilities and technical skills can be transformed into intangible assets that are constantly used and updated during the entrepreneurial process, opening up more innovative fields and providing high-quality problem solutions for corporate innovation (Marvel *et al.,*). As mentioned by Hyytinen *et al.,* ML has a significant impact on technology as it allows for the prediction of high-growth enterprises (HGEs) and helps budget-constrained venture capitalists source investments for a fixed size portfolio. In fact, technology and entrepreneurs has created digital entrepreneurs in the AI and data analytics (AIDA) industry as they are active and connected online than non-digital entrepreneurs [6].

3.3.2 Start-ups

AI start-ups employs novel or different business models that are different from common IT-related business models (Lee *et al.,*). Based on the study conducted by Weber *et al.,* startups can be more flexible in responding to changes in the market and customer needs. For example, according to Guerzoni *et al.,* the uses of machine learning algorithms create a new holistic measure of innovation and analyses the impact of innovativeness on a large population specifically on Italian firms which entered the market at the beginning of the 2008 global crisis. The key characteristics of AI startup business model are, new value propositions through AI capabilities, different roles of data for value creation, and the impact of AI technology on the overall business logic (Weber *et al.,*).

A study by Anna and Kaisu identified that the use of ML approach, namely artificial neural network, can help entrepreneurs to make better decisions and improve their venture performance. The findings of the study provide new understanding about the use of two different decision-making

logics, conditions under which those decision-making logics are used and the performance implications of the logics combined with certain conditions. Plus, the use of Twitter has gained increasing popularity in entrepreneurship research (Fellnhofer) because entrepreneurs interact more positively in public (Waters *et al.,*). Twitter accounts using machine learning approaches and found that they could correctly discriminate failed ventures from surviving ventures up to 76% of cases, however, in the context of entrepreneurship research it shows a promising area of study that has the potential to provide valuable insights into new venture survival and other aspects of entrepreneurship (Antretter *et al.,*).

Yet, the digitization also impact on the market for entrepreneurial finance, which is the financing of start-ups and other entrepreneurial ventures and aim to improve the understanding of the changes in the entrepreneurial finance ecosystem due to digitization (Bertoni *et al.,*). Entrepreneurs require financial assistance to boost the efficiency of technological innovation, which has resulted the amount of regional financial development is directly proportional to the level of regional technical innovation (Yang *et al.,*). It allows them to access funding from a variety of sources, including angel investors, venture capitalists, and crowdfunding platforms that can help them overcome the funding gap that often exists in the early stages of a venture's life cycle (Owen *et al.,*). Additionally, entrepreneurial finance can provide more flexible terms than traditional financing options such as in terms of repayment terms, interest rates, and collateral requirements, this allowing entrepreneurs to retain more control over their ventures (Eniola). Finally, the involvement of investors with expertise in the industry can provide valuable guidance and support to entrepreneurs (Bertoni *et al.,*).

3.3.3 Education

The research found that all dimensions of AI had a positive impact on entrepreneurship education, with the highest impact being machine vision and the lowest impact being natural language processing [2]. According to Bell and Bell, entrepreneurship education is an educational strategy that aims to increase students' financial independence and inspire them to start enterprises that provide new job possibilities. Additionally, [7] believed that the foundation of entrepreneurship education is teaching students to use their inventive skills to ventures that increase profits while enhancing their feeling of self-respect and discipline. Apparently, entrepreneurship education's strategic objective is to produce graduates who can sustainably contribute to the growth of their local economies [2].

When studying entrepreneurship, students prefer innovative, practical teaching methods, involving automatic tools for validation of business idea feasibility (Mavlutova *et al.,*). They want to use automated tools to test and improve the viability of their business ideas. This is because automated tools can provide quick and accurate feedback, which is essential for students to learn and improve their business ideas (Rong *et al.,*). According to Ridho and Abdullah, entrepreneurship is the best solution to reduce unemployment rate among graduates, therefore entrepreneurship learning in schools is good to introduce an entrepreneurial spirit early on. In order to better prepare themselves for the competitive climate of today, students in higher education have consistently demonstrated an interest in entrepreneurship education [18].

The findings of this review reveal a strong focus on the technology aspect of ML in entrepreneurship, with a majority of papers published on this topic. This is likely due to the rapid pace of innovation in ML and the growing availability of ML tools and resources. However, there is also a growing body of research on the use of ML in start-ups and education. In terms of papers on start-ups, ML is being discussed to support a wide range of activities, including product development,

marketing and sales, operations, and decision making. Finally, the papers on education discussed ML as a tool to develop new teaching and learning methods, and to create personalized learning experiences for students.

4. Conclusion

The study found that ML has the potential to transform entrepreneurship. By adopting ML, entrepreneurs can increase revenue, improve efficiency, and create innovative new products and services. Therefore, it is necessary to review the research in the integrated domain of entrepreneurship and ML. This paper has specifically explored the publications from established database, namely WOS and SCOPUS and analysed them using PRISMA approach. The papers were grouped according to three themes developed: technology, start-ups, and education. In term of numbers, most of the papers inclined towards Technology theme, followed by start-ups, and minimal research papers are in the theme of Education. This is simply due to rapid advancement of technology and innovation in ML. Subsequently, a growing number of papers are found under the theme start-ups, and lastly the theme of education.

These outcomes are applicable to both theoretical and practical viewpoints, with broad possibilities for producing new theory and new types of management practices. With respect to theoretical implications, the findings showed that the strategic utilization of ML advancements has not been comprehensively addressed by researchers. There is a need for study on the conception and application of ML, and its application in the digital age. From practical view, the emergence of ML as a key technology for entrepreneurship has a number of implications for policymakers. First, there is a need to invest in research and development to accelerate the development of ML-based tools and resources for entrepreneurs. Second, governments should develop policies and programs to support the adoption of ML by entrepreneurs. This could include providing financial assistance, developing training programs, and reducing regulatory barriers. Third, policymakers should focus on developing the skills and knowledge of entrepreneurs and educators in the area of ML. This could be done through funding educational programs and providing access to ML training resources. Fourth, policymakers should promote collaboration between entrepreneurs, researchers, and educators to foster innovation in the area of ML and entrepreneurship. This could be done through creating innovation hubs and funding joint research projects. Thus, this finding indicates that there is room for more research to be conducted in this discipline.

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