



MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE: THE ENABLERS OF DISRUPTIVE TECHNOLOGIES

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Abstract - This study aims at the latest trends for disruptive technologies. With the emergence of machine learning and artificial intelligence, the very fabric of every system has been shaken, therefore, the study highlights the essential factors through extensive thematic analysis. As it is qualitative research that employs content analysis to explore the impact of machine learning (ML) and artificial intelligence (AI) as enablers for disruptive technologies. This study has been done in three major phases: 1) data collection, 2) theme extraction, and 3) thematic analysis. A total of 570 articles encompassing industry reports, academic databases, and news sources, published between 2013 and 2023, were analyzed using content analysis. A coding scheme was developed, and key themes were extracted and categorized. The developed categories include efficiency, innovation, accessibility, network effects, scalability, and disintermediation. To substantiate the extracted themes, we also conducted interviews of 27 experts from the field of AI and ML to gain a deeper understanding. Thematic analysis was employed to analyze the interview data, and a set of findings and conclusions were developed based on the recurring themes that emerged from the data. The study provides valuable insights regarding the role of AI and ML as enablers of disruptive technologies and their impact on different sectors.

Keywords: Thematic analysis, disruption, interviews, content analysis, systems

INTRODUCTION

Machine Learning (ML) and Artificial Intelligence (AI) are two major and fast developing fields in the domain of computer sciences and engineering. ML is considered a subdivision of AI that focuses on the building of statistical models and algorithms which enable machines to learn from data and enhance the performance without explicit programming. On the other side, artificial intelligence aims to pretend intelligent behaviour in machines that can reason, learn and give solutions to the problems. Both artificial intelligence and machine learning has been transforming into our interactions and influencing our communications significantly with newly developed technologies ranging from chatbots and becoming self-driving cars, personal assistants and predictive analytics. The newly developed modern technologies have similarly a thoughtful impact on several sectors including manufacturing, finance and healthcare, through helping companies to make better decisions, generate novel services and products and on the other side automate processes.

The continuous developments in modern computing powers, algorithmic innovations and big data management techniques have impacted significantly the sector of artificial intelligence and machine learning. The practitioners and learners and on the other side the professionals and researchers as well in a variety of disciplines have adopted different modern technological techniques such as neural networks, deep learning, natural language processing and reinforcement learning to develop enhanced sophisticated artificial intelligence systems. Nevertheless, like any other major technology, artificial intelligence and machine learning posed economic, social and ethical concerns. For instance, an ongoing debate has been emerged recently about the impact of automation on responsibility, employment and equity of artificial intelligence and the degree of potential impact of malicious use of these modern developed technologies.

This study has been conducted to analyse the circumstantial context, current status and future potential of machine learning and artificial intelligence. This study also focused to highlight the opportunities and challenges that artificial intelligence and machine learning have business sectors. This research analyses the ethical implications, practical applications and theoretical foundations of these challenges and opportunities as well as the study has discussed in detail the impact of



these modern technologies on our economy and society at large in coming future. The both selected fields artificial intelligence and machine learning are two related fields of study. The major purpose of artificial intelligence is to create machines that can perform tasks which most commonly require human intelligence whereas the major purpose of machine learning is teaching the machines how to learn and process the provided data on their own without being programmed normally. The both fields; artificial intelligence and machine learning, have common shared features like statistical algorithms and also have shared common models that both domains use to accomplish their tasks. For example, artificial intelligence depends upon machine learning algorithms to study and examine big data sets, classify patterns and bring up with the relevant solutions of the problems. Machine learning algorithms depend upon the principles of artificial intelligence which assist to understand and translate multifaceted data sets. This relationship among artificial intelligence and machine learning goes beyond the knowledgeable attraction.

The recent developments on machine learning algorithms play a significant role in developing the systems of artificial intelligence. As machine learning algorithms if become more sophisticated and advanced, the artificial intelligence systems can learn from enhanced and increasingly becoming artificial intelligence systems and big data sets that actually lead toward increased and enhanced overall performance. The study also discussed that the existing relationship between machine learning and artificial intelligence is actually essential for the development of intelligent integrated systems which are playing their part to reshape the modern technologies and ways of our interactions and communications and giving the solutions to tackle the problems.

LITERATURE REVIEW

Artificial Intelligence has recently been evolving rapidly to develop intelligent machines which perform the tasks of human intelligence. Over the past decade, the field of artificial intelligence has witnessed continuous significant progress and development especially in the area of computer vision, natural language processing and robotics (Hinton, 2019). The literature review on the artificial intelligence and its role is a summary of recent research conducted in the field of artificial intelligence and its different applications in different sectors of human activities.

Artificial Intelligence and Its Role

LeCun et. al. (2015) stated that the most significant development in the field of artificial intelligence is the emergence of deep learning algorithms. This development of machine learning includes the training of algorithms on big data sets in order to identify the patterns and make different predictions relating to different human problems and issues. The field of deep learning is very successful area in speech recognition, image classification and natural language processing (LeCun, 2015). The researchers stated that virtual assistant, for example, like Siri and Alexa have been developing using deep learning algorithms.

Artificial Intelligence has also proved to be playing significant role in healthcare sector as it can analyse big amounts of patient data to identify patterns and assist doctors in making more authentic and accurate examinations and diagnoses. For instance, Topol (2019) has stated that practitioners have used artificial intelligence algorithms to predict the probability of developing certain conditions of deceases in patients as per their genetic information and medical history (Topol, 2019).

Esteva et. al. (2019) stated that artificial intelligence has also developed personalized treatment plans to diagnose cancer patients using different AI techniques based on the patient's response to therapy and their individual characteristics (Esteva et al., 2019). On the other side, financial industry also has been transformed by artificial intelligence as artificial intelligence systems can examine large amounts of data sets to predict trends and patterns that statistical and traditional models may oversee.

In financial industry, for instance, fraudulent transactions can be identified through artificial intelligence algorithms through unusual patterns in spending through credit cards, as reported by Kashetri (2018). Liu et. al. (2017), in his study, has also given an example of trading algorithms



which would be developed using artificial intelligence to forecast market trends and make one more exact decisions of investment.

Despite the great positive benefits of artificial intelligence, there are a number of concerns exist regarding potential negative impacts of artificial intelligence. Artificial intelligence has imposed displacement of human workers as one of the major concerns upon human activities as much advanced and enhanced artificial intelligence systems may alternate tasks earlier accomplished by humans and leading towards job losses in a number of industries. Among these concerns, potential misuse of artificial intelligence for malicious purposes is another concern likewise the creation of autonomous weapons and cyberattacks (Brynjolfsson and McAfee, 2014 and Bostrom, 2014).

Artificial intelligence, therefore, has achieved a significant development during recent years and also has the further potential to transform into other industries as well like finance, healthcare and transportation. Nevertheless, the concerns about its negative impacts like potential misuse and job displacement are required to be addressed properly by conducting further research and developing responsible and ethical systems of artificial intelligence.

Machine learning and its role

Machine learning has become a widely researched variable in the field of computer science during recent years and has witnessed to be the research interest of major scholars in this field. Machine learning has been considered as one of the subfields of artificial intelligence. Algorithms and different models are developed through machine learning and these models help computers to learn from big amount of data sets and play their role to increase and enhance their performance with any further programming.

The review of literature available in this field aims to examine the recent status of research in machine learning, through stressing the need of its techniques, applications and challenges. There are a numerous diverse applications of machine learning in different fields like speech and image recognition, predictive analytics and natural language processing.

Alom et. al. (2019) revealed that machine learning is most probably utilized in healthcare sector in order to diagnose diseases, in transportation to optimize routes and in finance field to detect fraudulent activities. Moreover, Khosravi et. al. (2019) stated that machine learning is considered an integral part in autonomous vehicles, where sensor data is interpreted through machine learning and further take the necessary decisions. There are a number of techniques used in machine learning like supervised learning, unsupervised learning and reinforcement learning.

In reinforcement learning, the algorithms learn to take actions that maximize a reward signal. On the other hand, unsupervised learning is trained on an unlabelled dataset to identify structures or patterns in data sets whereas during supervised learning the algorithms is trained on a labelled datasets to predict the output of new inputs. Goodfellow et. al., (2016) defined that deep learning is considered a type of supervised learning and it employs neural networks with multiple layers to extract high level features from datasets.

As in the area of artificial intelligence, there are also a number of challenges in the field of machine learning despite the remarkable progress and these challenges must be carefully tackled through proper attention. One of these challenges is the problem of bias in learning algorithms. Buolamwini and Gebru (2018) have established that biased datasets may lead towards amplification and perpetuation of societal biases through learning algorithms. Lack of interpretability in machine learning models is another challenge which is becoming more difficult to understand the logic behind the decisions made through applying these models. This issue is highlighted by Rudin (2019) and proved that machine learning models can be black boxes.

Machine learning, therefore, is considered very critical tool in different fields like finance, transportation, autonomous vehicles and healthcare. Different techniques which are utilized in machine learning are supervised learning, unsupervised learning and reinforcement learning. Whereas, the challenges like biasness in algorithms of machine learning and lack of interpretability in machine models are the concerns which are needed to be addressed properly through research and development by interpretable, fair and transparent machine learning algorithms. There is a



much research required to tackle these types of challenges and further progress in the field of machine learning.

Disruptive Technologies and its Role

Disruptive technologies, during recent years, have witnessed a revolutionary shift in various industries through different identifying new markets and disrupting the existing ones. During this review of literature, the concept of disruptive technologies is explored and their characteristics are discussed and their impact on business and industries have been analyzed. Bagheri et. al. (2019) stated that technological innovation is that innovation which is considered in form of activities, inputs and outputs. Innovation basically characterizes as one of the significant sustainable sources of competitive advantage of the firms. The activities of innovation include brand loyalty, first mover advantages and reduced-price sensitivity for customers, assimilating and applying knowledge, learning in identifying, increased productivity and economic growth. Cantwell (2021) has stated that organizations of technologically innovative activities can no longer be simply illustrated on the basis of concepts of simple transaction costs mechanisms. Instead, the trend actually has been increasingly observed for international companies to establish internal and external works for technological innovations which are characterized by different levels of disruptive technologies with reference to the degree of attractiveness which can be summarized into technological congruence.

Disruptive technologies are actually those innovative activities that can provide a simpler, more convenient and more affordable substitute to be added to the present results through forming innovative marketplaces or disrupting already existed ones. Christensen et. al. (2015) stated that disruptive technologies initiate with minor outcomes than existing outcomes then ultimately surpass them by leading them to a shift in the dynamics of the relevant industry. Disruptive technology also tends to carry minor costs and is more convenient and straight forward to utilize.

Various industries are significantly impacted by disruptive technologies through shifting the viable landscape and disrupting existed markets. The personal computer, for instance, disrupted the super computer market through providing more accessible and affordable substitute, (Bower and Christensen, 1995). The rise in online streaming services has similarly disrupted the traditional cable TV industry through subscribing the customers more flexible and reasonable watching choices. Bower and Christensen (1995) argued that disruptive technologies suggest modern opportunities and choices but on the other side also imposing new challenges to industries and businesses. Potential buyers often try to adapt to newly establishing disruptive technologies due to their personal interests in adapting new current business models but may not distinguish the potential of recent entrants in the markets. However, disruptive technologies offer new opportunities for increased efficiency and growth.

Disruptive technologies, therefore, are those innovations which generate new markets or disrupt already existed ones through providing more convenient and more flexible substitute to already presented solutions. The disruptive technologies have common characteristics like lower simplicity, lower performance and above all lower prices. Various industries are significantly impacted by disruptive technologies through shifting the viable landscape and disrupting existed markets through increasing efficiency and growth. Therefore, more research is required to identify the dynamics of disruptive technologies and their impact on industries and businesses.

CONCEPTUAL FRAMEWORK

Artificial Intelligence and Machine Learning are considered critical drivers of innovation, transforming different industries by developing disruptive technologies. To explore this argument more, this study has highlighted how artificial intelligence and machine learning are assisting these discoveries and their significant impact on industries and businesses. In the beginning, artificial intelligence and machine learning have facilitated to improve disruptive technologies through the provision of advanced predictive models and algorithms. Artificial intelligence and machine learning can categorize patterns, trends and insights. These types of analysis allow the researchers to create innovative solutions which may disrupt traditional industries like personalized medicines, autonomous vehicles and smart homes. Artificial intelligence and machine learning have basically



opened up new horizons to analyse, process and make sense of big data sets through the means and ways which were not available previously.

In addition to that, artificial intelligence and machine learning have made disruptive technologies more reachable and accessible. These technologies are becoming easier to deploy and more affordable day by day, resulting in allowing smaller businesses to contest with existing big players and removing the barriers to enter to the new markets. Most recently, the cloud based artificial intelligence and machine learning, for instance, Google Cloud and Web Services have simplified the ways for newly established businesses to reach to the more influential tools of machine learning and artificial intelligence and scale their operations.

Moreover, machine learning and artificial intelligence are considered the influential dynamics of innovation for development of new business models and finance generating streams. As artificial intelligence and machine learning can open up new horizons for great market opportunities through analysis of big sets of data and identifying new patterns to give innovative solutions which fulfil customer's needs. This led to the formation of new markets, businesses and financial streams as well as subscription services and online marketplaces.

To this end, artificial intelligence and machine learning are currently transforming into more traditional businesses and industries through optimizing operation, automating routine responsibilities, reducing costs and improving productivity. For instance, chatbots powered by artificial intelligence can control routine inquiries made by customers through eliminating the role of representatives of human customer service in order to concentrate on more complex responsibilities. This automation is basically disrupting traditional business models and coercing business companies to reconsider about their processes and procedures to continue to be competitive.

It can, therefore, be said that artificial intelligence and machine learning are powerful enablers and useful dynamics for disruptive technologies to provide advanced technical tools and techniques for data processing and analysis in order to make disruptive technologies become more accessible and affordable, to drive innovation to create more new financial streams and business models and to transform business industries to automate their responsibilities and tasks of daily routine and to optimize their operations. Artificial intelligence and machine learning are continue to develop more and more disruptive technologies are predicted to be emerging more and transforming more business industries and shifting innovation to new horizons through exciting ways.

METHODS AND ANALYSIS

Content analysis method has been adopted in the current study to examine the role of Machine Learning and Artificial Intelligence as enablers for disruptive technologies. Content analysis methodology is a systematic analysis approach to examine, analyse and interpret the, visual, audio or textual data. In this study, content analysis method is employed to analyse industry reports, academic and news articles related to the topic of artificial intelligence and machine learning as enablers for disruptive technologies.

The current study is qualitative research and is covered in three main phases; first, qualitative data collection; second, themes extraction; three, conducting thematic analysis. During the qualitative data collection phase, a total of 570 articles which were published during 2013 to 2023 have been gathered from different industry reports, academic databases and news sources. The mentioned articles were selected on the bases of relevancy, authenticity and validity where machine learning and artificial intelligence were discussed in the context of disruptive technologies. Those articles which were not relevant to the research question were excluded.

The selected sample of articles then has been imported into a software program to conduct text analysis. During the data coding phase, a coding scheme was developed and applied on the bases of the research statements and research objectives. The said coding scheme was categorized into different categories and subcategories in which the key themes were abstracted and concepts were captured that were relevant to artificial intelligence and machine learning as enablers for disruptive technologies. These coding categories were included efficiency, innovation, accessibility, network effects, scalability and disintermediation. In developing the coding scheme, two



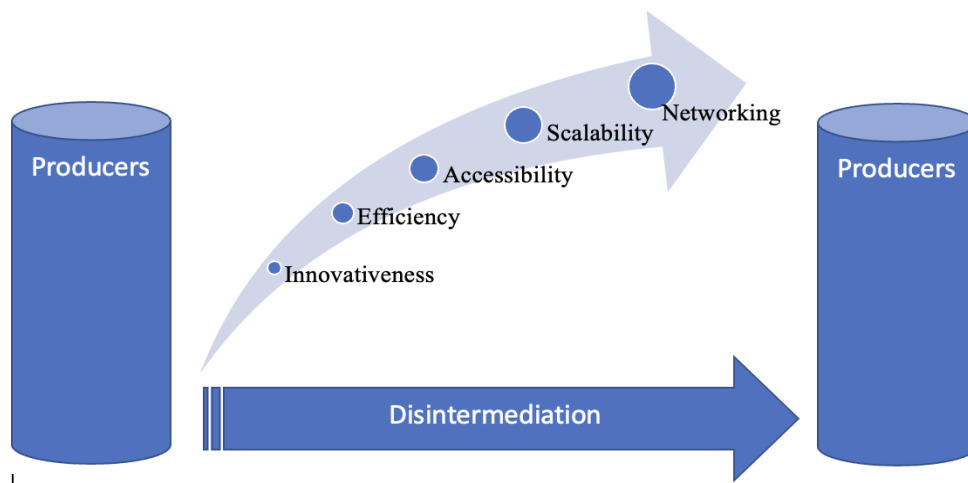
independent coders were enabled as well to perform the coding of the articles. The inter-coder reliability has been measured with Cohen's kappa coefficient, and the reliability was found to be satisfactory.

During the data analysis phase, the content analysis method was used based on the literature review and inferential analysis which were completed on the bases of interviews. The analysis has been carried out to investigate the level of relationship among categories and subcategories the type of the publication whereas it is industry report or academic article, or news source.

Overall, content analysis provided a rigorous and systematic approach to analyse the textual data and investigating the role of machine learning and artificial intelligence as enablers for disruptive technologies. To support the existing literature review, and counter check, we conducted interviews. To investigate the role of Machine Learning (ML) and Artificial Intelligence (AI) as enablers for disruptive technologies, we employed a qualitative research methodology that involved conducting in-depth interviews with experts in the field. The purpose of these interviews was to gather rich, detailed insights into the ways in which artificial intelligence and machine learning are driving innovation and transforming various industries.

The sample consisted of 27 experts who were selected based on their expertise and experience in the fields of machine learning and artificial intelligence. The analytical technique used to analysed data was purposive sampling in order to ensure that the sample was demonstrative of a range of industries and perspectives. The interviews were conducted in person or via video conferencing and were semi-structured in nature. A set of open-ended questions was developed that allowed the researchers to explore the participants' views on the impact of artificial intelligence and machine learning on their respective industries, as well as the opportunities and challenges associated with these technologies. The interviews were firstly recorded and secondly transcribed verbatim, and then thematic analysis approach was incorporated to analyse the data. A coding framework has been developed based on the research questions and identified recurring themes and patterns in the data. The developed themes were used to develop a set of findings and conclusions that provide insights into the role of machine learning and artificial intelligence as enablers of disruptive technologies. The use of interviews as a qualitative research methodology allowed the researchers to gather rich and detailed insights into the ways in which artificial intelligence and machine learning are driving innovation and transforming various industries. By speaking directly with experts in the field, the researchers were able to gain a deep understanding of the opportunities and challenges associated with these technologies and their impact on different sectors. Overall, this qualitative approach provided valuable insights which can assist future research and policy decisions makers to relate to machine learning and artificial intelligence. Based on the existing literature and the feedback from experts, various themes emerged and the following framework is put forth.

Fig. 1 Conceptual Framework





Disruptive technologies can change industries and markets in a big way. There are a few things that these technologies often have in common:

1. **Innovativeness:** Disruptive technologies usually come up with new ideas, products, or services that challenge the way things have always been done. They often find new solutions to problems or create new opportunities.
2. **Efficiency:** Disruptive technologies often work better and faster than existing technologies. They might use new materials, processes, or software to be more efficient than traditional approaches.
3. **Accessibility:** Disruptive technologies might be easier to use or need fewer resources. This can make them available to more people, even individuals or small organizations who didn't have access before.
4. **Scalability:** Disruptive technologies can grow quickly and disrupt entire industries. They might be able to change to meet new market conditions or customer needs more easily than traditional technologies.
5. **Networking:** They create network effects. When more people use a disruptive technology, it can become more valuable. This can be a big advantage over competitors.
6. **Disintermediation:** Disruptive technologies can cut out intermediaries or middlemen in the supply chain or distribution channels. This can make things less expensive and more efficient.

Overall, disruptive technologies are stimulating because they can bring new ideas and solutions, be more efficient and accessible, and change industries and markets in a big way.

DISCUSSION AND FUTURE RESEARCH

There are many studies completed previously which focused on the role of machine learning and artificial intelligence to enable disruptive technologies. Wang et. al. (2018), for example, have explored that the potential of artificial intelligence to disrupt traditional business industries and financial institutions through providing more personalized and efficient services to customers. Li et. al., (2020) concluded that machine learning and artificial intelligence have evolved as significant enablers of disruptive technologies and transforming different business industries through innovation (Xue et al., 2021).

Vitiello et. al. (2019) have, similarly, examined the role of machine learning in enabling disruptive technologies in the healthcare industry. Their study established that machine learning has the potential to transform healthcare facilities through predicting disease progression, identifying new treatment choices and enhancing diagnosis accuracy. The content analysis approach and qualitative interviews method have been applied to analyse the components and elements of disruptive technologies which are enabled by artificial intelligence and machine learning. The findings of current study were consistent with prior conducted studies that highlighted the role of efficiency, innovation, network effects and scalability in enabling disruptive technologies (Christensen, 1997; Christensen and Raynor, 2003). On the other side, the current study also contributed towards providing new comprehensions on the role of disintermediation and accessibility in enabling disruptive technologies. This study discovered that machine learning and artificial intelligence can make disruptive technologies more accessible to the audience at larger level, play its role to reduce costs and enhance efficiency by eliminating intermediaries in supply chains systems of business companies.

CONCLUSION

Based on the results and findings, the study contributes to the body of literature and knowledge by identifying innovative horizons and specific components and elements of disruptive technologies that are enabled by machine learning and artificial intelligence. The results of the study also provide glimpses and insights upon the potential impact of machine learning and artificial intelligence on different industries and may guide the creation of new business models and developing new strategies to utilize these disruptive technologies

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