Artificial Intelligence's Relevance for Energy Optimization, Companies and Business Internationalization

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Abstract

This paper presents and analyses the relevance of artificial intelligence for energy optimization companies and business internationalization, the mega-trended combination between digitalization and globalization impacts directly business internationalization. The methodology of research relied on a literature review and data analysis in quantitative qualitative way by focusing on a case study as well using bibliographic data from Scopus and operating the steps using VOSviewer to go further with research. The research question is" How relevant and connected or useful artificial intelligence for business internationalization, companies and energy optimization?". The results show that embracing artificial intelligence could speed so far business operations and processes. Moreover, since the world is moving towards industry 5 and the economy of the future, artificial intelligence has become an important instrument for all the economic sector including energy that is related to business opportunities and companies' internationalization and operations, energy is a business as well since it is about supply and demand and it always needs optimization and AI has been useful for that taking the example of smart grids, smart cities and houses, AI for renewable energy (solar and wind), industry and electrical vehicles. In conclusion, business internationalization relies on the use of digitalization that connects business operations and relationships. AI is important for business internationalization, companies and energy optimization.

Keywords Business, company, artificial intelligence (AI), energy optimization, implications, internationalization

Introduction

The world of energy and global energy map have been undergoing major changes and challenges from time to time since energy sources and commodities are considered world engines. All the changes and challenges are directly associated with business opportunities and economic processes which many companies use and consider to advance and consolidate their internationalization process. AI is a vast and expanding area that is penetrating all scientific fields. It is currently being used in many areas, including marketing, banking, agriculture, healthcare, security, robots, speech recognition, chatbots, manufacturing, and many other areas (Faisal *et al*, 2021). Digitalization and internationalization of business helps the firms promote and sell their products at affordable cost. This mechanism is not working if they are operating in an export market without a non-digital oriented and infrastructure readiness (Gregory, Karavdic, & Zou, 2007).The changes appear mainly in the perspectives of supply and demand. On the supply side, there important factor to consider such as the resurgence of oil and gas production in the energy market. The decision to reduce nuclear energy in many counties and the speed up to renewables have been challenging facts globally. Since energy has moved the world to more consumption and production, global energy and demand has been controversial and significant to fight against energy poverty as a main goal economically and energetically. Although artificial intelligence is a great invention in technology, it could provoke some difficulties in the same sectors where it is relevant and more. The fact that Artificial Intelligence implements and makes decisions as well bases on big data by defining the goal for that, it has become more relevant and important in the energy sector and industry. Its potential for the energy system and its future design have become very compatible and big. Especially, in some fields such as smart grids, electricity, trade, transport and heating.
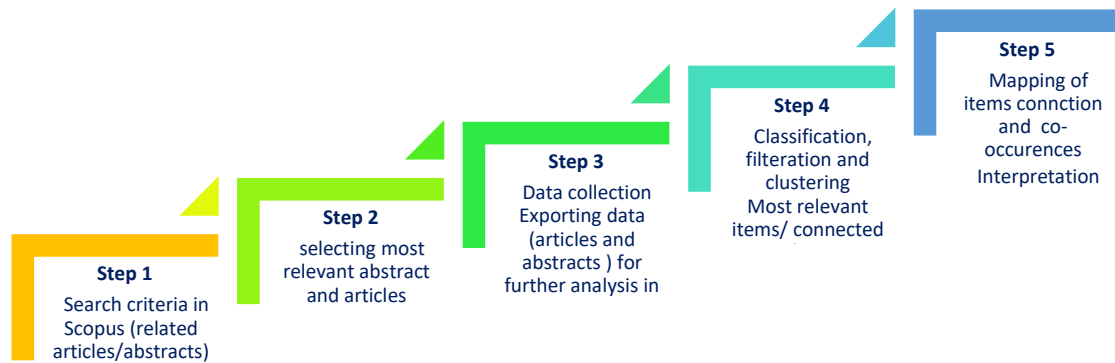
It has made the energy industry more efficient by processing and analysing big data. Artificial intelligence has become able to process and evaluate power trading to help improve forecasts for weather data, historical data and electricity trading. Supply security needs better forecasts that increase and rely on grid stability. Therefore, it helps speed up the integration of renewables and enhance forecasts in the energy industry.

1. Literature review

The first use of "Artificial intelligence" (AI) was by computer scientist McCarthy in 1954 (Cukier, 2019). In the conference organized by him and his colleagues, he stated that every aspect of learning and intelligence could be described in a way that a computer can simulate. AI is the ability to mimic the cognitive functions of humans, such as learning and problem-solving which are distinct features of the human mind (Schalkoff, 1990). AI is a vast and expanding area that is penetrating all scientific fields. It is currently being used in many areas, including marketing, banking, agriculture, healthcare, security, robots, speech recognition, chatbots, manufacturing, and many other areas (Faisal *et al*, 2021). In recent years AI applications in energy systems have gained more focus (Forootan *et al*., 2022). (Ang and Lee, 1994) proposed that the optimal restructuring of industrial structure transformed heavy industries into light industries, which greatly reduced energy intensity. (Feng *et al*. 2009) studied the long-term relationships among energy intensity, economic structure, and energy consumption structure and suggested that the energy structure dominated by coal consumption largely constrains the improvement of energy efficiency, and the government should fully consider the effects of energy consumption structure and economic structure on energy intensity. Economic development and raising welfare are always entangled with the rising consumption of energy resources. Increasing energy generation as the default answer to how to cope with this additive energy consumption may not be the best answer. From an energy justice perspective, it's not acceptable to deplete energy reservoirs that belong to the next generations (Sari *et al*., 2017). One area in Artificial intelligence and machine learning usage is buildings energy consumption modelling (Amasyali and El-Gohary 2018). Building energy consumption is a challenging task since many factors such as physical properties of the building, weather conditions, equipment inside the building and energy-use behaving of the occupants are hard to predict (Platon, 2015). Controlling and modelling the combustion processes (Kalogirou, 2003) optimizing the distillation tower (Ramchandran and Russell Rhinehart,1995) or even more specific processes such as "shell" heavy oil fractionator are examples of usage of Artificial intelligence in this industry. AI and ML can be implemented in renewable energies that has recently gained a lot of focus (Zahedi, 2022). AI may be implemented in energy storage ML is very able in data classification and other related tasks. Mainly, AI and ML can efficiently may use energy storage in the energy grid to shave peaks or use the stored energy when these sources are not available. ML methods have recently been used to describe the performance, properties and architecture of Li-ion batteries. (Kauwe *et al*., 2019). Digitalization and internationalization of business helps the firms promote and sell their products at affordable cost. This mechanism is not working if they are operating in an export market without a non-digital oriented and infrastructure readiness (Gregory, Karavdic, & Zou, 2007). Similar to the impact of technology turbulence (Kaleka, 2012). Digitalization facilitates and boosts knowledge acquisition and enhances business networking. It creates a business environment in which young exporters can learn fast and makes early and rapid internationalization possible (Johanson and Vahlne, 2009).

2. Research method and research questions

The methodology of research relied on a literature review and data analysis in a quantitative qualitative way by focusing on a case study, the steps for the case study are mentioned below using bibliographic data from Scopus and operating the steps using VOSviewer to go further with the research, (See figure no. 1) VOSviewer is a software for creating and visualizing maps of network data, it was suitable in this study, analysis and research to run a bibliometric analysis so the maps of common items and their co-occurrences could be successfully visualized using the relevant data. The research question is" How relevant and connected or useful artificial intelligence for business internationalization, companies and energy optimization?"

Step 1

Search criteria in Scopus (related articles/abstracts)

Step 2

selecting most relevant abstract and articles

Step 3

Data collection Exporting data (articles and abstracts) for further analysis in

Step 4

Classification, filteration and clustering Most relevant items/ connected

Step 5

Mapping of items connction and co-occurences Interpretation

Figure no. 1. Research criteria and steps of case study
*Source: Author's design and research, 2023*

3. Results and discussion

The use of artificial intelligence promises great benefits for global society. One of the current topics of this time concerns global warming, which can be attributed to the energy consumption of fossil fuels. On the one hand, artificial intelligence helps understand the effects of emissions on climate change, on the other hand, company processes and consumption in households can be optimized through its use.

The use of AI on Energy Demand and Markets

The use of artificial intelligence has a fundamental relationship to the energy sector, especially in the extraction of hydrocarbons, the search for water for the construction of wells and the identification of new ways of generating energy, ways are always being sought to make the use of natural resources more sustainable without sacrificing productivity. Artificial intelligence helps in the efficient, fast and safe extraction of resources and deals with the distribution and regulation process. The two main goals are therefore lower costs with the associated more competitive prices and a more sustainable use of resources. An example of an artificial intelligence technology is known as a "smart grid" artificial intelligence network. This network makes it possible to analyse the level of supply and demand analysis and troubleshoots the supply chain and detects consumption peaks. AI may help generate insights in energy and market by going through the following steps: (See figure no. 2)

- **Decentralization:** Transition from customer to prosumer, each being an active element of the ecosystem
- **Decarburization:** Integrating more sustainable energy sources through Distributed Energy Resources (DER).
- **Digitalization:** Generating real-time insights from connected assets from automated remote operations.

Decarbonization: Integrating more sustainable energy

Degitalization: Generating real-time insights from

Decentralization : Transition from customer to prosumer, each being an active element of the ecosystem
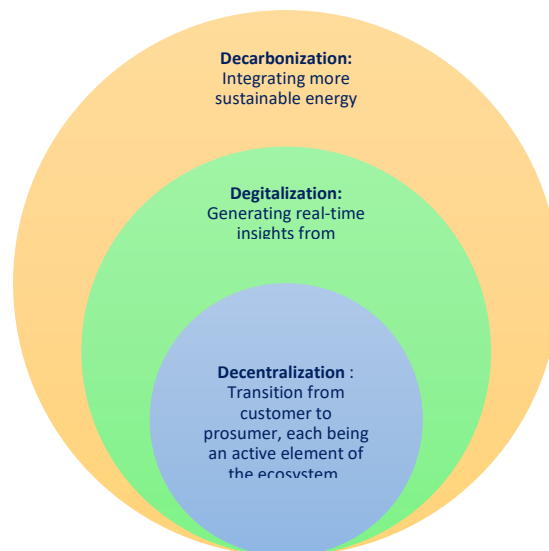
Figure no. 2. Smart Grids and Transformation for Energy Advantage
Source: Author's contribution 2023, Thales 2021

Artificial intelligence is seen as the technology that could dominate the world in the future. Higher or lower carbon deliveries may be something that artificial intelligence may or may not embrace, as the systems can analyze the vast amounts of data at hand and suggest optimization actions. Efficiency can reduce energy demand and emissions, for example by reminding and raising awareness among customers of the need to reduce energy consumption during peak periods by changing and controlling the setting of thermostats. In this way, the energy adjustment will be easier. A hyper-intelligent energy system powered by artificial intelligence could reduce costs and generate further savings. Energy consumption also changes over time in the energy market. With all the advantages, however, the disadvantages of using artificial intelligence should also be considered. The collection and use of consumer data can lead to unequal competition and, in the worst case, disadvantage consumers. The collected data can also fall victim to hacker attacks and be used for fraudulent purposes if not secured properly. In this respect, too, there are a number of things to consider in order to contain the disadvantages as much as possible.

Application and prospects of artificial intelligence in the energy sector

Artificial intelligence generally refers to adaptive intelligence exhibited by a machine on its own. The behaviour is not necessarily predetermined but adapts to the data entered. Most machine methods lend themselves to two main problems and classification problems. Problems of predicting if or when the equipment will fail, while problems of classification involve the difference between customers based on the artificial intelligence data from them. In the energy sector there are several interesting examples in both the retail and commercial sectors. One of the cleanest uses of AI, failure prediction and dynamic maintenance allows operators to predict device failures using sensor data from different devices, significantly reducing downtime and maintenance costs. In the area of energy efficiency, DeepMind, part of Google, has championed the use of reinforcement learning to reduce energy consumption in its data centers by a whopping 15%. The model learned by looking at operational data and then dictated changes to individual units. In trading, Origami Energy uses machine learning to predict asset availability and market prices in near real-time, enabling the company to bet successfully in the retail frequency response markets. Retailers use machine learning to understand patterns in customer behaviour to attract and retain customers, and even predict bill payment or non-payment. Artificial intelligence solutions are on the rise for consumers, and many retailers are offering these systems as part of an integrated package. Devices like "Alexa" allow customers to seamlessly interact with their thermostats and control systems, so increasing customer interaction with the device leads to the development of more personalized usage profiles that lower customer bills and help the utility to accurately predict operations .Indeed, AI aims to make the energy system more connected, intelligent, efficient, reliable and sustainable, and science is the ingenuity of making intelligent machines, especially intelligent computing.

Smart grids and the digitization process for the energy of the future

By analysing the challenges of the energy transition and the importance of digitization in it, artificial intelligence can be considered as a very important and fundamental role in the transition and transformation of the energy model. In fact, artificial intelligence allows and can do something and things that human beings are not capable of doing. Energetically, in the energy field, the truth is that there is a lot of data on the behaviour of people related to the system and meteorology, for example. Tailored insights from the energy sector can be obtained as well-analysed data, energy is consumed and generated with a controlled distribution process. Actually, to know the information that is available, three-tier analytics is applied to simply anticipate production or demand and prescriptive. Technical and non-technical incidents such as energy fraud or, in other words, energy irregularity are detected to optimize energy and the advanced energy model for smart networks, data is worked on in prediction of production and demand with use and implementation of smart meters.

Energy fraud or energy irregularities

The detection of energy fraud is done for different categories such as gas and electricity, to identify energy irregularities in the facilities, analysis of the information or data is carried out by the companies that have them about the user, which means the location of the meters. , rate types and consumption…etc. According to the needs of the distribution company and based on the data or information obtained, the system systematically compiles information on customers with a score for each one, for example, and the data is interpreted graphically to facilitate its compunction in a ranking firm, as well With this, a group of clients that could potentially be committing fraud against the company or the company is detected and shown. So the company can physically inspect the facilities to train predictive models again, so investing to limit energy fraud is very important.

Case study: AI relevance in energy and business

The method and research criteria AI, energy and business connection and items' co-occurrences started from number of relevant bibliographic data from the supported file database "Scopus", there were filtered much data to reach 5 most relevant "AI and energy" and 16 most relevant "AI and business). Using VOSviewer the minimum number of occurrences of an item (chosen) was 1 and the total reached items for AI and energy reached 86 whereas for AI and business the total items co-occurrences were 125 with a full counting method and a relevance score 60 % the final reached items by relevance score for AI and energy were 86 but the final filtered were 56 clustered in 5 clustered but for AI and business the final filtered items by relevance could reach 95 clustered in 10 clustered. (See tables no. 1 and no. 2)

Table no. 1. Method and research criteria AI, energy and business

Research criteria	AI and energy	AI and Business
Number of relevant bibliographic data (documents)	5	16
Supported file types	Scopus	Scopus
Fields from which terms where extracted	Abstracts/papers	Abstracts/papers
Minimum number of occurrences of an item (chosen)	1	1
Total reached items	86	125
Counting method	Full counting	Full counting
Relevance score (%)	60%	60%
Final reached items by relevance score	86	125
Final filtered items by relevance	56	95
Number of clusters	5	10

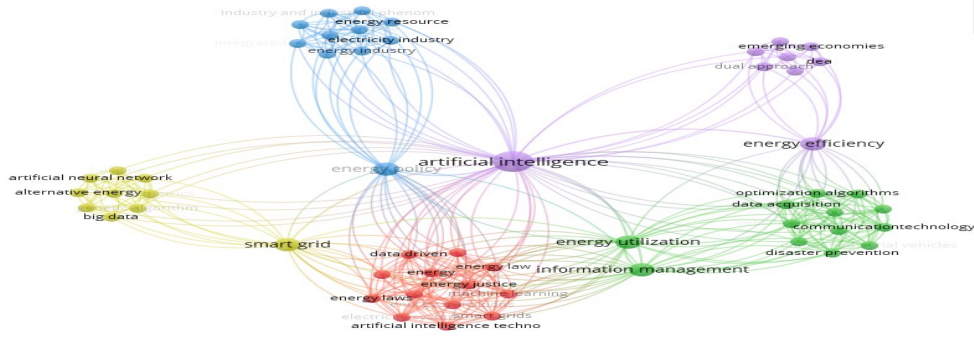*Source: Author's elaboration and research, 2023*

The clusters are mentioned and visualized in various colours on the map of co-occurrences and they represent that prove the common connection between artificial intelligence and energy and business (See figures no 3 and 4).

**Table no. 2. Clustering, research criteria and items' co-occurrences**

Clusters/ Research criteria	AI and energy (items' co-occurrences)	AI and Business (items' co-occurrences)
Cluster 1	13	20
Cluster 2	13	13
Cluster 3	11	13
Cluster 4	10	12
Cluster 5	09	9
Cluster 6	-	8
Cluster 7	-	6
Cluster 8	-	5
Cluster 9	-	5
Cluster 10	-	4
Total	56	95

Source: Author's elaboration and research, 2023

A co-occurrence items' map was visualized between artificial intelligence and energy, so we observe the co-occurrence of items and links between AI and energy are potentially confirmed for the use and relevance of AI for energy in energy efficiency, energy policy, energy sources and industry, smart grids, energy utilization and management. Smart grids are connected through big data and neural network for alternative energy as well. AI is relevant for energy law and justice as observed with a focus on big data. (See figure no. 3). The visualized map of artificial intelligence connection, relevance and relationship with business shows that the clusters are connected directed with AI. Artificial intelligence is relevant for business process, intelligent robots, it has links with business models and management. Ai is related well to business values, benefits and challenges, business process and intelligence by focusing well on adaptive algorithms. (See figure no. 5)

Figure no. 3. Artificial intelligence connection with energy
*Source: Author's elaboration and research, 2023*
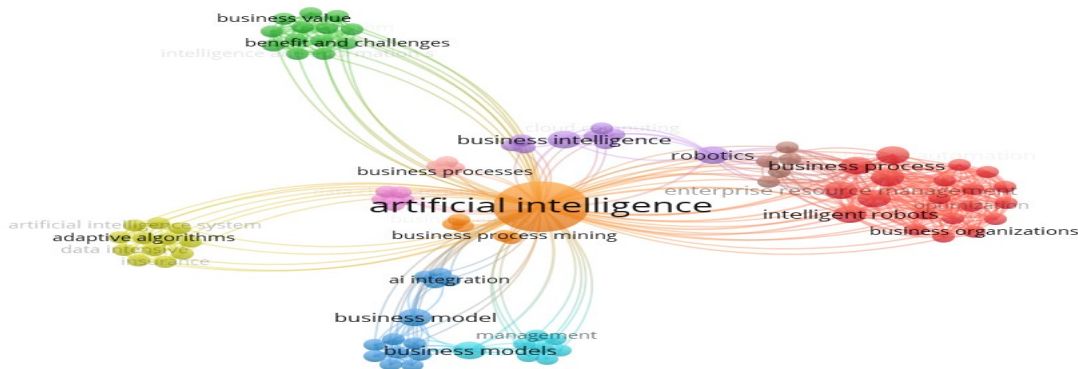
Figure no. 4. Artificial intelligence integration and connection with business
Source: Author's elaboration and research, 2023

In fact, the smart grid technology market size world changed from 49.7 billion US $ (2022) to 58.38 US billion $the first quarter of 2023 and according to Statista forcast by 2028 it will have reached 130.2 billion US dollars.(See figure no.5).
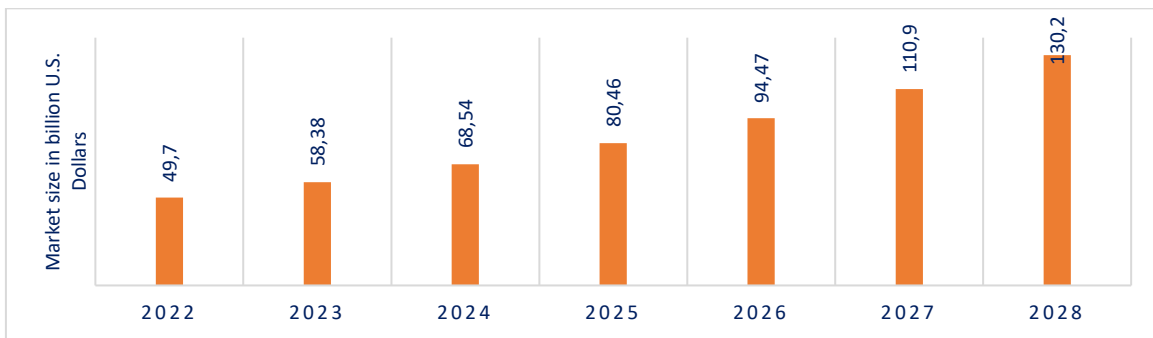
Figure 5 Smart grid technology market size worldwide from 2022 to 2028 (in billion U.S. dollars)
*Source: Author's contribution 2023, Statista data 2022*

By analysing the artificial intelligence Startup company funding at the global level by quarter, since 2020 it has been going through various ups and downs it the first quarter of 2020, the funding value was 6.4 billion US dollars and increased to reached the top with 18 billion US dollars in the third and fourth quarters of 2021 then it decreased to reach 8.3 billion US dollars in the third quarter of 2022. (See figure no. 6).
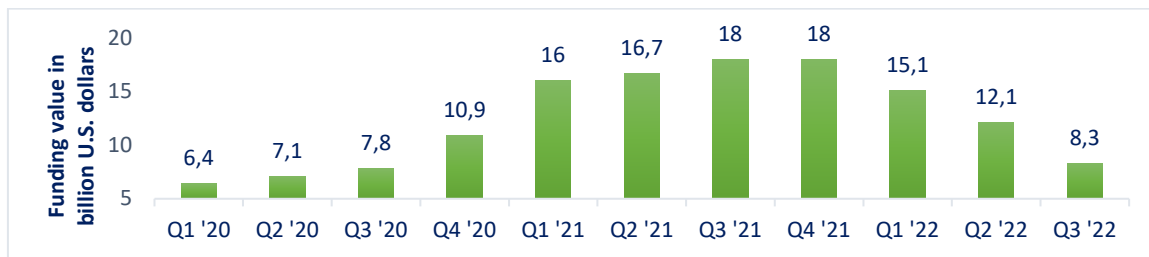
Figure no. 6. AI startup company funding worldwide 2020-2022, by quarter
Source: Author's contribution 2023, Statista 2022

Energy is a business as well since it is about supply and demand and it always needs optimization and AI has been useful for that taking the example of smart grids, smart cities and houses, AI for renewable energy (solar and wind), industry and electrical vehicles. In conclusion, business internationalization relies on the use of digitalization that connects business operations and relationships. Artificial intelligence is important for business and companies since the use of social media, applications, machines and digital operation has become very useful. (See figure no. 7).
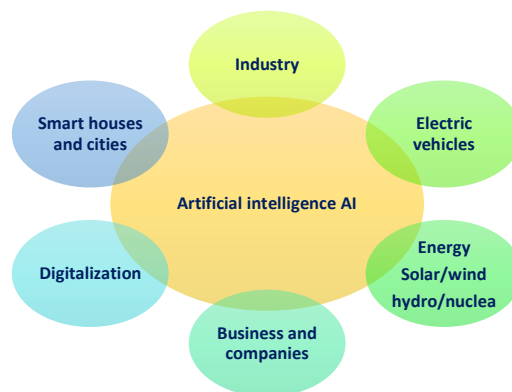
Figure no. 7. Artificial intelligence use and integration
Source: Author's elaboration, 2023

Conclusions

Embracing artificial intelligence could speed so far business operations and processes. Moreover, since the world is moving towards industry 5 and the economy of the future, artificial intelligence has become an important instrument for all the economic sector including energy that is related to business opportunities and companies' internationalization and operations, energy is a business as well since it is about supply and demand and it always needs optimization and AI has been useful for that taking the example of smart grids, smart cities and houses, AI for renewable energy (solar and wind), industry and electrical vehicles. In conclusion, business internationalization relies on the use of digitalization that connects business operations and relationships. AI is important for business internationalization, companies and energy optimization. Although the use of artificial intelligence itself is energy-intensive and, as a result, emissions are caused (the more data is processed, the greater the computing effort and associated energy use), the benefits of this technology far outweigh this. The big advantages lie in the processing of huge amounts of data and the detection of patterns, which would probably remain hidden without the use. With regard to global warming, AI can help to better understand the causal relationships and effects of emissions on the climate and to use energy more efficiently within the company or household. The technology should therefore be used to lower the cost of one's own energy needs and reduce emissions.

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