The Innovative Impact of Generative Artificial Intelligence on Digital Business Transformation[1]

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Abstract. *In the context of intensifying competition and evolving market dynamics, the deployment of cutting-edge technologies has become not merely a discretionary choice, but an indispensable imperative for any enterprise aspiring to achieve successful growth. Generative artificial intelligence, with its substantial potential for automation, personalisation and optimisation of business processes, is emerging as a highly promising avenue of digital transformation. This study is dedicated to investigating approaches and delineating strategies for aligning generative artificial intelligence with the requirements of digital business transformation. The research examines the development of artificial intelligence, with a focus on symbolic artificial intelligence, machine learning, deep learning and generative artificial intelligence. In addition, it considers the impact of these developments on business processes. The article identifies the potential benefits and challenges associated with the adaptation of generative artificial intelligence to the needs of modern business, in the areas of marketing, sales and data analysis. The utilisation of diverse methodologies and techniques, including prompts, fine-tuning, and the incorporation of interactive guidance systems, can enhance the efficacy and precision of generative AI in a business setting, thereby facilitating optimal outcomes in a multitude of tasks. The authors put forth the proposition of employing generative artificial intelligence technology in conjunction with Retrieval-Augmented Generation, with the objective of enhancing the quality and relevance of responses to user queries. Additionally, they advocate for the utilisation of agents or orchestration tools to provide guidance to models. The successful implementation of generative artificial intelligence hinges on three key factors: the clear definition of objectives, the selection of suitable tools and technologies, and the assurance of managerial and staff support. The implementation of generative artificial intelligence will contribute to increased efficiency through the automation of routine tasks, enhanced competitiveness through personalisation and innovation, optimised cost structures that increase profitability, and expanded opportunities for research and development.*

Keywords: *generative artificial intelligence, business, digital transformation, machine learning, data analysis, innovation.*

JEL Classification: *O32, O33, Q55*

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1 Introduction

The modern evolution of AI is characterised by the interplay and development of symbolic AI, machine learning, deep learning and generative AI. The machine learning period proved that instead of programming rigid rules, scientists began to teach computers to determine rules based on large amounts of data. Machine learning allowed systems to adapt to new situations and improve their performance over time. Deep learning has become a key area of machine learning, using multi-layered neural networks (deep neural networks) to automatically identify abstractions and features in data. This has led to significant advances in pattern recognition, natural language processing and other areas.

One of the areas of artificial intelligence that has undergone considerable advancement in recent years is generative artificial intelligence (GenAI). This field employs neural networks to generate novel content in the form of images, music, and texts. The surge in investments in start-ups specialising in GenAI reflects a keen interest in this technology, particularly in contexts where creativity and the capacity to generate new elements are paramount, rather than merely adapting to existing rules. The transition from traditional programming to a probabilistic approach, in particular supervised learning, has become a pivotal aspect of the contemporary development of artificial intelligence and machine learning. It offers novel avenues for the deployment of generative artificial intelligence, facilitating the optimisation of revenues, reduction of costs, enhancement of productivity and effective risk management. The adoption of generative artificial intelligence by enterprises is redefining various aspects of business operations, including practices, processes, business models and innovation. This has the potential to lead to a new era in employment and work (Budhwar et al., 2023). The advent of generative artificial intelligence presents a host of opportunities for businesses, yet it also gives rise to a number of challenges that must be addressed. The integration of GenAI within a business context represents a significant challenge that necessitates the development of innovative strategies and methodologies to ensure its optimal utilisation.

2 Analysis of Recent Research and Publications

An analysis of recent research and publications reveals a wide range of concepts for implementing GenAI in various fields such as marketing, design, advertising, education, medicine, entertainment and others. Academic discussions around GenAI emphasise its role in promoting innovation and agility, which are necessary qualities to maintain a competitive advantage in today's digital marketplace (Jovanovi & Campbell, 2022). Generative artificial intelligence is increasingly recognised as a key component of evolving business strategies.

The view is held by researchers such as Fostolovych (2022), Drynyov (2023), Zahorodnykh (2023), Zinchenko (2023), Gevchuk (2023) and Shevchuk (2023) that generative artificial intelligence represents a key tool that can be used to create unique technologies for specific companies, situations and environments. In a similar vein, Gupta, Nair, Mishra, Ibrahim, and Bhardwaj (2024) posit that ChatGPT has the potential to transform marketing practices by facilitating the development of virtual sales personnel capable of providing real-time, personalised recommendations, which could ultimately foster enhanced customer loyalty and sales. The integration of ChatGPT with other technologies, such as augmented reality and virtual reality, has the potential to enhance the efficacy of marketing strategies by facilitating the convergence of the physical and virtual realms.

The present study employs the scientometric database Scopus to examine the adaptation of generative artificial intelligence to the processes of digital transformation in business. The selection of relevant publications was based on the combination of the keywords "generative artificial intelligence" and "digital transformation". A cluster analysis of 42 scientific publications indexed by the Scopus scientometric database during the period 2004–2024 was conducted using the VOSviewer analytical platform. The software employed the method of relationship density to group 35 keywords into four clusters, which are indicated in Figure 1 by the colours red, blue, green and yellow. The size of the circle is indicative of the frequency of use of the respective term, with a larger diameter denoting a higher frequency of mention. The content and contextual analysis of the groups enabled the identification of principal areas of research concerning the role of generative artificial intelligence in the digital transformation of business.

The largest cluster, in red, comprises 11 keywords. This line of research is concerned with the core GenAI technologies that are employed for the purpose of digital business transformation. The cluster includes terms such as "generative artificial intelligence", "business", "chatbot", "ChatGPT", "machine learning", "neural networks", and "product design". The second cluster, delineated in green, encompasses ten concepts and pertains to research in the domain of generative artificial intelligence. The keywords included in this cluster

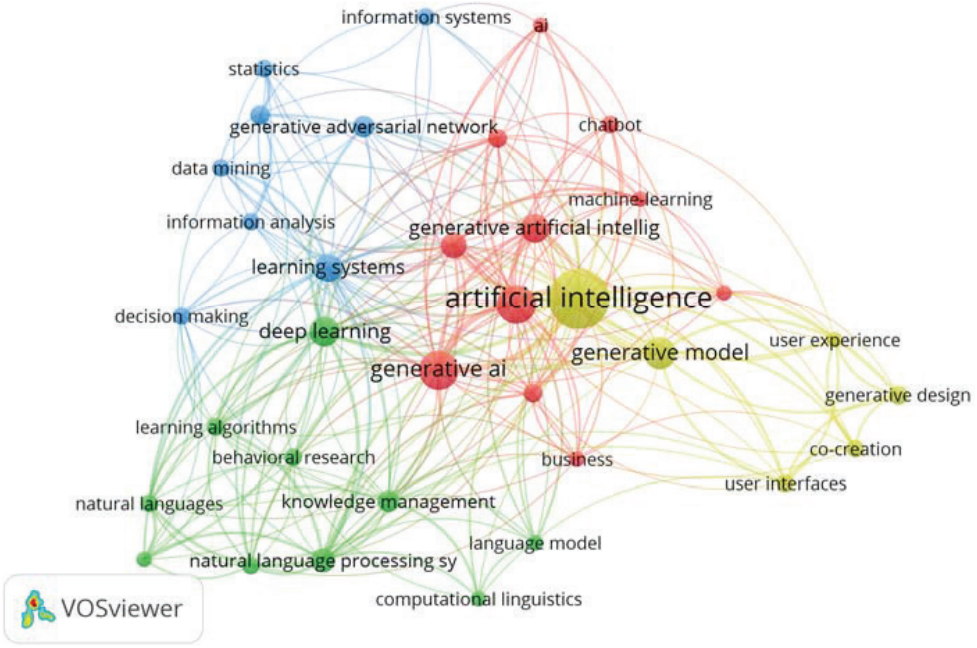

Figure 1 Bibliometric map of keywords to the topic

Source: built by the authors on the basis of the Scopus database

are "computational linguistics", "deep learning", "knowledge management", "language model", "learning algorithms", and "natural language processing systems". These keywords relate to behavioral research, computational linguistics, and machine learning algorithms that are used to create and improve GenAI systems. The third (blue) cluster is characterised by the frequent use of eight categories. The most frequently occurring categories are "decision making", "generative adversarial networks", "information analysis", "learning systems", "statistics" and "data mining". This cluster describes the utilisation of GenAI for the analysis of large data sets, forecasting and the identification of patterns. The fourth (yellow) cluster explores the application of generative artificial intelligence to product design and user interaction. This cluster is based on 6 keywords: "co-creation", "generative design", "generative model", "user experience", "user interfaces". These clusters overlap and are interrelated, emphasising the complex nature of GenAI and its potential to transform different aspects of business.

The results of the bibliometric analysis demonstrate a notable increase in the number of publications over the past two years, which serves to illustrate the relevance of the problem for the scientific community.

3 Purpose of the Article

Despite the considerable body of research in the field of generative artificial intelligence, several key issues remain unresolved with regard to its adaptation to the requirements of digital business transformation. In particular, the issue of the current limitations of using generative artificial intelligence in business requires further investigation. The objective of this article is to identify and analyse the potential benefits, challenges and opportunities of utilising generative artificial intelligence in the context of digital business transformation, with a particular focus on its adaptation to the specific requirements of different industries and tasks. It is anticipated that the findings of this study will prove invaluable to businesses at various stages of digital transformation, as they will assist in the more effective utilisation of GenAI to enhance competitiveness and achieve sustainable development.

4 Presentation of the Primary Research Material

According to a McKinsey&Co study (2021), nearly 60% of organisations are using machine learning in at least one business function. Machine learning approaches fall into three broad categories that correspond to different learning paradigms. These categories are based on the type of "signal" available to the learning system: supervised learning, unsupervised learning and reinforcement learning. A supervised learning method employs a data set comprising labelled input and output values, with the objective of training a model to

identify relationships between them and to predict new data. In contrast, unsupervised learning permits the model to discern and learn patterns and structures in the input data independently. The unsupervised learning method of clustering is used to group data according to similar characteristics. Partially supervised training represents a hybrid of supervised and unsupervised learning, whereby the model is exposed to both labelled and unlabelled data during the training phase. Reinforcement learning is employed to train agents in dynamic environments, with rewards being offered for correct actions and punishments for errors.

The following will present a number of illustrative examples of machine learning, demonstrating its considerable potential and the diversity of its applications.

A clustering technique may be employed for the purpose of detecting instances of fraud. This is achieved by grouping transactions or data within a system based on a number of different dimensions and data attributes. The initial stage of the process is to cluster transactions or other data in order to group items with similar characteristics together. This process has the potential to detect anomalies that may be indicative of fraud. The second stage is the evaluation of anomalies within each cluster. Transactions that deviate from the typical behaviour exhibited by their respective cluster are regarded as suspicious. The third stage is to identify any fraud patterns or unusual behaviour that may indicate fraud by analysing any anomalous transactions. The fourth stage is the continuous updating of the model in order to adapt to new fraud methods. The utilisation of data clustering for the detection of fraud enables the establishment of a dependable and effective monitoring system that is capable of responding promptly to alterations in the characteristics of fraudulent activities.

Reinforcement learning can be used to detect fraud. The first step is to create an agent that performs actions in a certain environment. In this context, the agent represents the system that executes transactions, and the environment represents the financial system. The agent analyses the transaction data and chooses the optimal strategy to maximise the chances of detecting fraud and minimise the risk of financial loss. Depending on the outcome of the actions, which include performing transactions, the agent is rewarded or penalised. For example, a successful transaction is rewarded and a fraud attempt is penalised. The next step is for the agent to learn an optimal strategy that helps it avoid fraud and maximise rewards. This approach allows the system to learn from its own experience and adapt to changing conditions to effectively detect fraud.

A supervised learning method may be employed to categorise incoming customer service requests. The machine learning model receives the incoming requests and categorises them into designated categories. The user then corrects any misclassifications. The corrected data is then used to retrain the model. The utilisation of user feedback in supervised learning facilitates the learning process of the models, enabling them to make more accurate predictions.

The use of artificial intelligence can help customer service agents to process enquiries received via email or a web form on the company's website more quickly and efficiently. The system classifies the received data and offers possible categories such as "product return", "product complaint", "service request". Agents can customise the suggested categories and use the data to improve call analytics.

Generative artificial intelligence is based on neural networks that learn from large amounts of data and apply a self-directed learning goal to perform a variety of tasks. Large language models are basic models that are trained on large amounts of text with the goal of self-monitoring. The purpose of self-monitoring is to use extensive data where each element has a label indicating the next word in the sequence. Generative AI uses underlying models to create new output by responding to user input and generating a response based on the learned context. Future GenAI may evolve towards multimodal models that work with different types of data. This will help to understand how large language models are used in AI and how they affect text processing and response generation in dialogue systems.

Basic generative AI models have no state-preserving properties and do not improve through interaction. Their functionality is limited to generating a response to input data, without storing or assimilating information. The performance and capabilities of these models scale with size, allowing them to reach new levels of efficiency and functionality. The development of generative AI is moving from the supervised learning paradigm, where models are trained to perform well-defined tasks, to self-directed learning. Scaling and labelling are determined by the data provided by the model, not by predefined labels. Models that were previously restricted to specific tasks now have the potential to develop unexpected functions. For example, in classic natural language processing tasks, models can perform a variety of tasks such as classification, feature and keyword extraction, text, music, video, and even computer code generation. Growing and learning from large amounts of data, such as GPT, expands the capabilities and reduces

the limitations of these models. This new approach opens up broad prospects for the development and use of artificial intelligence, providing greater flexibility and capabilities.

The capability of GPT models has increased significantly over time. The release of GPT-3 in 2020 saw the model possess 175 billion parameters. Subsequent generations, such as GPT-4, have demonstrated a considerable enhancement in processing power, data volume and the number of parameters, resulting in increased accuracy. These models have been observed to perform sentiment classification, key named entity extraction and text generation for a range of tasks with notable efficiency. In addition, they successfully generate functional code based on textual task descriptions, simplifying software development. Large language models can easily adapt to different scenarios and learn from large amounts of data, making them flexible and future-proof. The development of artificial intelligence, in particular language models, includes trends towards increasing their size, transition to self-learning, and expanding their ability to generate text and multimodal content. Such models have demonstrated significant progress in text classification, extraction and generation, as well as code generation, which is expanding their application in various fields, including software development and analytics.

The advent of generative artificial intelligence has opened up new avenues for businesses in the context of digital transformation. It has the potential to influence customer experience, optimise processes and gain competitive advantages in the market (Sterne, 2024). AI has the capacity to generate personalised content for each customer, which can lead to more effective marketing campaigns and advertising materials. Furthermore, it can assist in increasing sales efficiency and productivity by automating routine tasks, providing sales teams with accurate analytics and customer information to better understand demand. Through data analytics and automated content generation, companies can respond to customer requests faster and more efficiently (Kalota, 2024). For example, AI can automatically respond to customer queries via chatbots, providing information or solving problems without direct human intervention. By automating and analysing data, generative artificial intelligence can identify efficient ways of performing tasks, reducing costs and increasing productivity. AI can analyse production and supply data to predict product demand and optimise inventory levels (Zavrazhnyi & Kulyk, 2023).

The application of AI in a business context enables companies to become industry leaders through innovation and competitive advantage. However, as AI is still in its infancy, there are certain limitations that should be considered when implementing it (Zavrazhnyi & Kulyk, 2023). Table 1 illustrates the current limitations of the models and strategies for solving business problems.

Generative AI models are a powerful tool, but their limitations require caution and adaptation. To increase the accuracy of responses, it is necessary to train models on data that reflects specific business scenarios, and to use systems with interactive guidance for control and correction. Adapting generative AI to a business context requires careful work to identify limitations, develop strategies and apply best practices. This ensures the effective use of these powerful tools, which can help businesses in areas such as personalising marketing campaigns, developing new products and services, automating tasks and improving efficiency. Using different approaches, such as suggestion, advanced generation and fine-tuning, can improve results and meet the specific needs of users in a business context. Ensuring the ethical use of AI involves involving people in the development process, technical means of verifying results, testing and ongoing monitoring. When using rapid engineering methods, following instructions and learning in context allows the model to be consistently adapted to achieve specific business goals.

Prompts play an important role in AI text generation. In a business context, they can be used to generate a variety of text formats, such as job descriptions, marketing copy, reports and more. Increasing the amount of information can lead to higher costs and resource consumption, but it can also improve the quality of the results. The use of Retrieval Augmented Generation (RAG) as a methodology for combining generative models with information storage and retrieval systems makes it possible to combine the ability to generate text with the ability to extract information from pre-stored data. RAG allows specific data or context to be extracted from sources such as the Internet, documents or databases to improve the quality of the generated text. It provides access to the most up-to-date and reliable information, allowing users to verify the claims made by the model. To improve the quality of responses generated by large language models, RAG uses external knowledge sources to complement the models' internal representation of information. This reduces the likelihood of confidential information being leaked, as well as the need to constantly train the model on new data and update its parameters as circumstances change. The use of RAG can minimise the computational

Table 1 Limitations and strategies for improving generative models

Limitation	Strategy
Model knowledge can be fixed during training, making it difficult to incorporate relevant or specific data.	Active management and completion of answers by the user, with a review of new data for corrections and updates. Allowing the model to access external information and extend it through search. The ability to continuously improve the results by using different hint formats, including examples, to improve model understanding and performance.
Models can produce plausible but false answers, or even information that looks structured but is fictitious (hallucinations).	Additional verification and validation of answers before they are used in critical tasks, and providing information and context that may not be present in the model output. Avoid use cases that may cross ethical boundaries. It is important to involve people in the design cycle, especially when working with large language models where hallucinations and inconsistencies can occur.
The models may misunderstand or incorrectly answer mathematical tasks.	Additional checking and translation of answers is required, consider limitations in mathematical ability and the use of external tools to confirm the accuracy of answers in mathematics and current events.
Answers may vary depending on the wording of the question or the language used.	Review and analyse the responses to consider different formulations. Use technical tools to verify that the model's responses are correct, especially in cases where the recommendations could have an important impact.
Large language models can generate correct answers to questions, but they can also create fictional facts or alter information.	Careful verification of sources and elimination of fictitious or inaccurate data is necessary. Use human feedback to improve the model's response. Involve experts to confirm and evaluate the accuracy of the information. Additional processes and strategies for managing a large language model are important to optimise use in a corporate context.
When using generative models, the issue of confidentiality and security of information arises.	It is important to develop effective strategies for protecting confidential information, especially in critical business areas. Use security protocols and encryption to protect confidential information.

Source: compiled by the authors

and financial costs associated with deploying chatbots based on large language models in an enterprise environment.

The use of artificial intelligence technology in combination with RAG allows to increase the relevance and quality of answers to users' questions. For example, consider the process of answering a question about adapting business processes to calculate VAT:

1. The user asks a question: "How can I adapt my business processes to calculate VAT?"

2. The question is transformed into an input model, i.e., a vector representing its semantic meaning.

3. The RAG method is used to obtain relevant information on the adaptation of business processes for VAT calculation.

4. The information obtained is entered into a hint that is used by the model to generate an answer.

5. The model generates an answer based on the prompt, vectorised information, and its own knowledge.

Thus, the answer is generated not only based on the model's knowledge, but also by integrating relevant information from external sources. Contextualisation makes the answer more informed and useful. Including references to the source material used to generate the answer allows the user to check the sources and obtain additional information. This process of interacting with models can improve the quality and relevance of responses, as well as increase transparency and trust in the user's interaction with the system.

Another technique that uses agents or orchestration tools to provide instructions to large language models can improve the interaction with these models in specific tasks and increase their performance. Allowing models to access tools through APIs or libraries can simplify reasoning structures and facilitate efficient problem solving.

The main stages of use:

1. The user enters a task or question through the interface.

2. The agent receives a task and builds a solution plan, which may include the use of APIs and specifications based on user input.

3. The agent calls the API in accordance with the specifications and receives the necessary information, which is returned to the user as a response to the initial request.

This technique not only makes the API call more understandable for the model, but also allows agents to interact with different tools, supporting structured and efficient task solving. It is important to be able to adapt prompts and instructions to a specific task, ensuring effective interaction with models.

When analysing the issue of model fine-tuning, it can be seen that this technique is key to improving the performance of models in specific tasks. The main objective is to adjust the model parameters to optimise its functioning for a specific task or a new data set, which can improve accuracy and efficiency in general. Before investing in model fine-tuning, it is necessary to conduct experiments and verify its suitability for specific tasks. This approach allows for an optimal balance between performance and resource consumption, but requires care and attention in the configuration process.

Generative Artificial Intelligence is having a significant impact on business. It offers new and revolutionary ways to increase revenue, reduce costs, improve productivity and better manage risk. A study by McKinsey&Co (2024) predicts that the impact of generative AI on productivity could add trillions of dollars to the value of the global economy. In the 63 scenarios analysed, AI could add the equivalent of up to 4.5 trillion USD per year by 2040.

5 Conclusions

Based on the results of the study, the following conclusions can be drawn.

Generative artificial intelligence, together with deep learning models, demonstrates significant potential for practical application in various business areas. The result shows that GenAI, together with the Retrieval Augmented Generation technique, can be an effective tool for solving various business problems that require deep understanding and processing of information. Its successful application can be seen in such areas as text generation for content, automated processing and analysis of large data sets for management decision-making, customer support via chatbots, and the creation of personalised offers and recommendations for users. The use of agents or orchestration tools allows models to access external resources and tools to better solve problems. Fine-tuning methods can improve model performance, but require caution and an experimental approach. In addition, generative AI can be effective in solving various tasks, such as forecasting demand for goods, analysing market trends, and identifying potential strategic advantages. However, there are certain challenges, such as hallucinations, lack of knowledge, and ethical issues that require careful consideration.

In future research, it is important to focus on addressing ethical issues related to the use of generative artificial intelligence in business, improving the accuracy and expanding the possibilities of its application in economic activities. Collaboration between researchers, developers, and experts is a key factor in the successful development and implementation of effective solutions for the use of generative artificial intelligence in business.

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