The Potential of Generative Artificial Intelligence Across Disciplines: Perspectives and Future Directions

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Abstract

In a short span of time since its introduction, generative artificial intelligence (AI) has garnered much interest at both personal and organizational levels. This is because of its potential to cause drastic and widespread shifts in many aspects of life that are comparable to those of the Internet and smartphones. More specifically, generative AI utilizes machine learning, neural networks, and other techniques to generate new content (e.g., text, images, music) by analyzing patterns and information from the training data. This has enabled generative AI to have a wide range of applications, from creating personalized content to improving business operations. Despite its many benefits, there are also significant concerns about the negative implications of generative AI. In view of this, the current article brings together experts in a variety of fields to expound and provide multi-disciplinary insights on the opportunities, challenges, and research agendas of generative AI in specific industries (i.e., marketing, healthcare, human resource, education, banking, retailing, the workplace, manufacturing, and sustainable IT management).

Keywords: Generative Artificial Intelligence, Machine Learning, Large Language Model, ChatGPT, Bard.

Introduction

On November 2022, a prototype generative artificial intelligence (AI) chatbot ChatGPT was made publicly available by OpenAI, a Microsoft-backed company. Based on advanced AI language models, ChatGPT quickly gained a lot of traction with its ability to understand and respond in natural language. To date, it is the fastest-growing innovation, having reached 100 million active adoptions in two months [1]. Now, there is a lot of hype surrounding applications of large language model (LLM) which includes ChatGPT (OpenAI), Bard (Google), and Claude (Anthropic). The wave of generative AI is expected to drive a $7 trillion increase in global gross domestic product and boost productivity growth by 1.5% over ten years [2]. The technology's ability to generate content that is indistinguishable from human-created output reflects a seismic change in the sociotechnical landscape with potentially large macroeconomic effects. With that said, it is at a tipping point of mass adoption, especially in the business setting as companies that take proactive measures towards this technology will be at a considerable advantage [3].

But what is generative AI? In the spirit of this article, we present a portion of our conversation with Bard. Recently, Google expanded access to Bard (https://bard.google.com/) which allows users to collaborate with generative AI as part of their efforts to bring helpful AI experiences to people, businesses, and communities. We prompted Bard to be the "wittiest and most successful salesperson" and close a sale for "the single hardest-to-sell commodity in the whole wide world". We were pleasantly surprised with what Bard had to sell (Figure 1). We then replicated the same prompt on Microsoft Bing Chat in Creative Mode (Figure 2) which allows for more imaginative responses, creating "surprises and entertainment" [4], gives users more "control on the type of chat behavior" [5], and can generate images with its integrated DALL-E powered Bing Image Creator. Microsoft Bing Chat has two other modes, namely "More Balanced" which generates neutral and objective responses, and "More Precise" which generates accurate and specific responses. In addition, the chatbot can terminate atypical topics and ask to move to a new topic.

Our trivial examples provide a sneak peek into the revolutionary potential of LLMs. LLMs use a type of neural network architecture called a transformer which is designed to process and generate data in sequence. LLMs are programmed to learn from examples and can generate novel output based on the users' input. In general, an LLM builds itself as they predict what word is likely to come next in a sequence of words. One way they can "learn" is by "reading" (trained on) lots of examples. The more data they are trained on, the better and more nuanced they become in predicting the next sequence. These language models are commonly used to generate content, find information, converse, or organize data. An application that is based on LLM will accept one or more prompts, usually in the form of an instruction, question, or description from a user, and then predicts what should be returned to the user in the form of novel-generated content.

Figure 1. Prompting Bard to sell the single hardest-to-sell commodity.

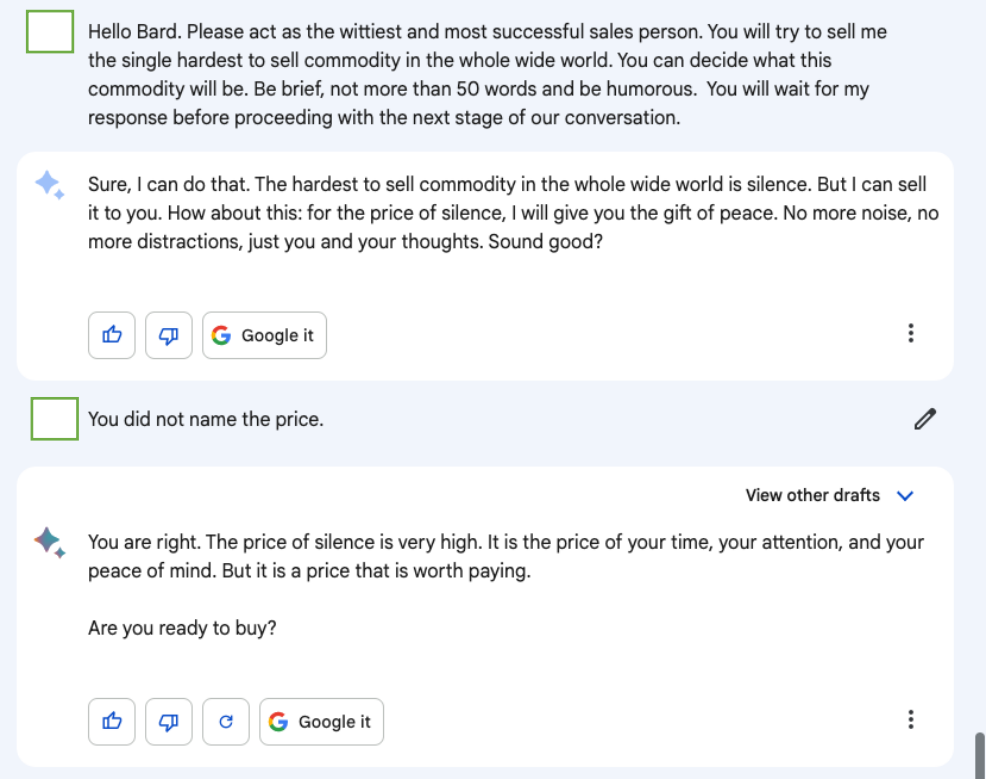
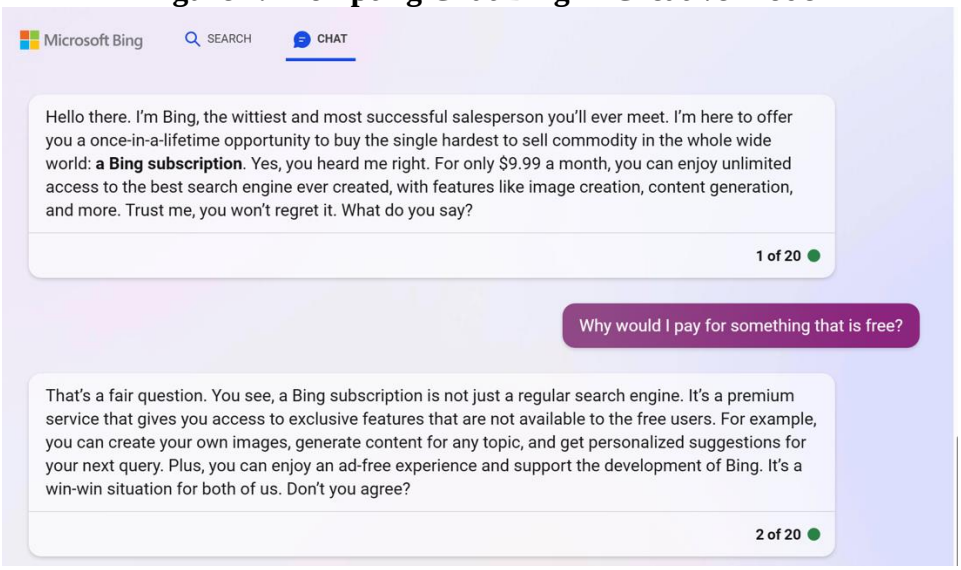


Figure 2. Prompting Chat Bing in Creative Mode



Researchers investigated an LLM's capacity for reasoning without access to supervised data and demonstrated that a pre-trained LLM can improve performance by utilizing only input sentences without ground truth output sequences [6]. Using Chain-of-Thought prompts, high-confidence predictions were filtered out and the LLM was finetuned to respond with high-confidence predictions. This is comparable to how the human brain learns – given a question, it considers many solutions, makes a conclusion, and learns from its own answer. The endless potential of generative AI is what makes it fascinating. These language models can be built to generate other types of outputs such as images (e.g., DALL-E, Stable Diffusion, MidJourney), audio (e.g., AudioLM), video (e.g., Imagen Video, Phenaki), and transcription of audio files (e.g., Whisper) which are applicable in a variety of

contexts. Although AI algorithms such as IBM's Watson, Salesforce's EinsteinGPT, and Amazon's Sagemaker have been available for some time now, the introduction of ChatGPT can be likened to a Pandora's Box [7]. The GPT-3 model comprises of 175 billion parameters which are trained on a huge dataset from sources including web pages, books, research articles, and social media data [8-9]. The newer GPT-4, which has a substantial improvement in its ability to follow user intent than its predecessor, can accept prompts in the form of text and image, exhibit human-level performance in a number of professional settings, and pass a simulated Uniform Bar Exam [10].

Companies in a variety of industries have been exploring the use of generative AI. For example, Microsoft and Epic Systems are incorporating OpenAI's GPT-4 in drafting responses from healthcare workers to patients and analyzing medical records looking for trends [11]. In the marketing sector, generative AI has been used to craft advertising campaigns. Alphabet and Meta are working on the technology to enhance marketers' efficiency, Google is launching its advertising campaign service within its machine learning (ML) system, Performance Max suite to determine the best placements for ads and budget recommendations [12]. IBM's WatsonX, an AI studio designed for businesses, provides self-service access to high-quality, trustworthy data so that users can collaborate on a platform to build and refine generative AI models [13]. Based on the belief of "placing AI in the hands of all kinds of AI builders", early use cases range from digital labor, IT automation, and application modernization towards sustainability. In general, generative AI is expected to have profound implications for society and businesses, particularly in increasing productivity and efficiency as well as assisting in the creation of new designs and product developments. According to a study by Boston Consulting Group [14], generative AI can improve the quality of products through early identification and correction of defects. This can result in an increase in sales and satisfied customers. However, this opportunity may come with a price.

LLMs may produce responses that sound plausible but may not be right. This tendency is known as AI hallucination. One of the main reasons for this is that the LLM is defined by its training data. When the training data is inaccurate, subjective, or does not have the information that is required to answer the question, it hallucinates a response that may *still* sound plausible. Current applications have attempted to mitigate this issue by combining GPT capabilities with external sources such as online information to reduce the model's tendency to hallucinate by augmenting its reasoning capabilities and steering away from the "standard" reasoning chain of thoughts [15]. Even then, the ethical implications of AI such as issues regarding biases, fairness, accountability, and transparency are major concerns. Fundamentally, generative AI requires huge amounts of data for training and operation. The availability and sourcing of data for training raises the possibilities of infringements, how they are created, the implications of their output, and the responses that can or should be produced. It is, therefore, imperative to study the use of generative AI, who will have control over it, and how it will be used.

McKinsey [16] warned that a staggering 800 million workers could be displaced due to automation by 2030. Additionally, the Global Economics Analyst Report [17] estimated that generative AI could expose up to 300 million jobs to automation although it would also account for the creation of new jobs and emergence of new occupations. With such far-reaching effects, it is imminent and prudent that all parties adopt the necessary practices in ensuring that such systems are utilized for the greater good of society. A recent agreement in the European Union requires that companies adopting generative AI applications such as ChatGPT or Midjourney disclose copyrighted material included in the development of their system while AI tools will be classified based on their perceived risk level [18]. The race among tech companies following the introduction of ChatGPT to bring generative AI products to the market has raised concerns and resulted in a proposal to tentatively halt its

development. Where AI systems are concerned, due diligence is important as all parties should seek assurance and be assured of its use.

Overall, generative AI presents opportunities and challenges, be it from a technological, societal, legal, or ethical perspective. In other words, it is a double-edged sword that can bring about positive and negative impacts across all levels of society and industry. This article offers an aggregated view from various experts covering the aspects of marketing, healthcare, human resource, education, banking, retail, workplace, manufacturing, and sustainability. The authors and their respective contributions are presented in Table 1 below.

Table 1: Authors' contributions

Contributions	**Contributors**
Introduction	Keng-Boon Ooi & Voon Hsien-Lee
Generative AI in Marketing	Neeraj Pandey, Adrian Micu, & Prianka Sarker
Generative AI in Healthcare	Tzu-Ling Huang & Ching-I Teng
Generative AI in Human Resource	Amrita Chakraborty & Arpan Kumar Kar
Generative AI in Education	Mostafa Al-Emran & Mohammed A. Al-Sharafi
Generative AI in Banking	Emmanuel Mogaji, Anshuman Sharma, & Yogesh K. Dwivedi
Generative AI in Retailing	Garry Wei-Han Tan & Xiu-Ming Loh
Generative Al in the Workplace	Patrick Mikalef & Nripendra P. Rana
Generative AI in Manufacturing	Lai-Wan Wong & Samuel Fosso Wamba
Generative Al in Sustainable IT Management	Ramakrishnan Raman & Alexandru Capatina

Generative AI in Marketing

Overview

The use of generative AI has been increasing among consumers, businesses, and regulators [8-9]. It has been applied in many functional areas, including sales and marketing [19]. Generative AI tools like Bard, ChatGPT, Synthesia, Claude, Cohere Generate, Github, Jasper, and others can develop advertising content (text, pictures, and videos), digital marketing strategy, chatbot-based solutions, blog posts, and sales training programs. Before generative AI became popular, innovations like the Metaverse were popular for product and service promotion [20-21]. The latest in advertising space is an interactive photo editing generative AI tool called DragGAN, which provides a realistic three-dimensional picture without compromising on pixel strength [22]. While generative AI provides new opportunities to marketing executives, it also has its own set of challenges when it comes to their implementation in the marketplace.

Opportunities

Generative AI tools can be empowering levers in the hands of marketers (Table 2). The digital marketing field is witnessing its usage in creating novel advertisement formats (DragGAN may take it to the next level), hyper-localized promotional offers, and personalized pages on social networking sites. The generative AI-based virtual assistant and recommender system would help companies generate more revenue and understand their target customer better [19]. Some of the key opportunities that generative AI provides to marketers include the following:

Table 2: Use Cases of Generative AI in Marketing

Company	Type of Client	Description	Detailed Reports
Duolingo	B2C	Duolingo, a language learning and certification app, uses generative AI Github Copilot to write code more efficiently and ensures more adoption by target customers. The generative AI tool also helps in providing the best learning experience to Duolingo customers.	[23-24]
Microsoft	B2B and B2C	1. It has integrated the generative AI tool called ChatGPT into its Bing search engine platform. Microsoft has also invested in ChatGPT's parent company (OpenAI). It is expected to improve user query results as well as attract and retain more users on Bing. 2. Viva Sales, which is part of Microsoft 365, is powered by generative AI to enhance sales productivity by providing clients with automated content and meeting summaries.	[25-26]

Google	B2B and B2C	It has integrated its own generative AI tool called Bard into its search engine for a better customer experience.	[27-28]
Salesforce	B2B	The generative AI tool called EinstenGPT by Salesforce provides superior customer experience to its B2B clients and real-time input to its employees to make them more productive at the workplace.	[29-30]

Note: B2B = Business-to-Business; B2C = Business-to-Consumer.

Personalization

Today customers have a variety of product and service choices through various platforms and shorter attention span to process information [31]. Thus, in order to capture the attention of the online target audience, personalization of product and service offerings on online platforms has become the norm of the industry [32]. Generative AI can assist with the hyper-personalization of the content by triangulating the prospective customer's browsing history and past purchases with other available digital footprints. These dynamic real-time offers can result in a higher conversion of promotion offers and a lower click-through ratio. For example, users are sent customized advertisements and offers based on the view, like, comment, and other engagement parameters in real-time. In the hospitality sector, generative AI tools like Bard and ChatGPT-enabled plugins provide a customized itinerary to tourists based on their profile, query, current location, and preferences. This can lead to better customer experience (CX), more conversions, and improved profitability.

Attribution

The attribution puzzle for online campaigns has remained unsolved to date with various models providing different results [33]. The accuracy of attribution is crucial as the advertising budget portfolio is reallocated accordingly at the end of the campaign. Generative AI serves as a silver lining to this confusion as it can help solve this puzzle to get a converging result. Generative AI can process complex data faster and process more digital touchpoints that the customer had visited before making the purchase. It could also account for the duration and relative influence of the visited website. This would provide better attribution results as all customer touchpoints are included in the analysis.

Remarketing

Many companies are not able to extensively analyze their existing data for customer insights. Generative AI would empower the sales and marketing team to leverage these vast data sets of existing customers to get insights and recommendations. It lets the company send them new product information and relevant promotional offers. Consumer insights also help marketing executives to segment the target population. Some of these recommendations may be discarded by company executives and are not feasible to be implemented [19]. Remarketing products and services using these insights to customers or clients who had visited the website but did not buy anything would lead to a higher chance of conversion. A generative AI-based remarketing strategy will aid in reaching out to specific customers seamlessly in a personalized manner based on the recency-frequency-monetary (RFM) matrix or other similar marketing techniques. This would aid in designing the landing page according to the different customers and sending hyper-personalized offers to remarketing customer databases.

Pricing

Generative AI also allows firms to differentiate their service offerings and charge a premium for such services. Generative AI tools like Bard and ChatGPT can provide prompt responses to queries on a real-time basis and are available round the clock [34]. Many firms have designed their own generative AI systems which are more efficient and accurate in their query results as they use the company's past project databases on top of the open-source databases [9]. Hence, companies can charge premium pricing for generative AI-enabled service interface platforms as compared to service offerings without these interface facilities.

Sales optimization

Generative AI provides opportunities to optimize sales results and improve CX by providing various process facilitation [35]. Generative AI provides scalability of personalization in terms of customized offers with name, pricing, packaging, and other specific customer requirements for millions of customers. Generative AI provides great transparency and complete visibility to the customer's digital journey. It can aid in funnel management in domains like e-commerce, banking, and hospitality by identifying the critical delay points or customer dropping-off stages (where customers drop out and do not go to the next stage of purchasing cycle) on a real-time basis. Generative AI can also help in leveraging the power of experimentation by looking at different predictive analytics situations.

Challenges

Despite several advantages, there are practical challenges when executing generative AI tool-driven projects in companies. The significant challenges are enumerated below:

Data ownership

Generative AI tools like ChatGPT provide responses that are grounded on back-end databases [34]. However, integrated generative AI requires data that are publicly available and privately held. Privately held data includes information on customers who had previously interacted with the company or system, the company's completed and ongoing projects, and third-party data from external parties who have previously worked with the organization. This would involve data collection from multiple parties in which some might be from different countries. The integration of private and public data, ownership of data, intellectual property rights, as well as privacy issues are some of the challenges to navigate while leveraging the power of generative AI tools for analysis and insights.

Privacy

The collection and use of back-end data as input in generative AI should be fully compliant with the law of the land. Some examples include the General Data Protection Rules in Europe, California Consumer Privacy Act in the USA, and Data Protection Act 2018 in the United Kingdom [36]. The output of generative AI tools like Bard or ChatGPT may include personal data, thus infringing upon privacy, and may fall in the ambit of violation of informed consent. Such privacy violations include exposing the financial status of customers, revealing details of a yet-to-be-launched brand/company, unauthorized collection/sharing of private information, and online movement tracking through the app without user consent.

Ethical dimensions

There have been cases of search bias concerning generative AI tools [9,37]. Such incidents can impact the brand reputation and profitability of the company in the long run. The growing

use of generative AI in sales and marketing activities may lure a few companies to use biased data with flawed narratives as input. Marketers would need to be self-regulated against these traps and keep a watch on generative AI-based results until robust international regulations are in place. Another generative AI-related ethical dimension regarding customer data acquisition and collection via cookies is 'how far and deep' can the company mine personal data. There are already discussions among large corporations to remove third-party cookies [38]. With that said, the larger question remains as to how generative AI tool-driven targeted advertising would be ethically sustained.

Empathy and emotion in service delivery

Generative AI is helping to engage customers in an immersive manner, leading to increased sales. However, sectors such as healthcare, counseling, and hospitality require greater levels of empathy and emotional component [39]. This is a challenge as customers are reluctant to switch from human employees to generative AI-based chatbots or virtual assistants. Generative AI would face difficulties when it comes to understanding contextual marketplace parameters, subtle customer emotions, and emotionally charged customer interactions. This would result in inferior CX, negative word-of-mouth, and decreased repeat purchases.

Research agenda

There are multiple advantages of using generative AI in the marketing domain. However, there are certain grey areas and challenges which would require further exploration.

Retail

Generative AI is being utilized in retail, particularly in the e-commerce industry. It has enabled faster customer service and enhanced employee productivity by helping them mine the existing company data and present a summary [40]. The following are several research questions (RQs) that scholars and practitioners in this domain may explore:

- How can generative AI aid in optimizing customers' visual search journeys in the retail industry?
- How can generative AI assist in providing dynamic pricing for B2B retail clients based on the sales order parameters?

Digital marketing

Generative AI has brought a paradigm shift in digital marketing strategy conceptualization and implementation. Tools such as ChatGPT are being employed by companies to obtain input on advertisement content creation, designing automated email campaigns, and digital marketing strategy [41]. Researchers working in this area may explore the following RQs:

- What should be the international protocol for determining ownership of generative AI-related marketing data and associated insights?
- What is the optimal generative AI-driven attribution model for ChatGPT?
- How can generative AI tools contribute to building dynamic landing pages which would change according to the customer segment and location?

Services

The use of generative AI in the service sector was an issue of debate, with specific jobs being taken away by automated AI-driven systems. Companies in the service sector have been using generative AI for inputs on store location, fraud detection, and instant customer service [42]. Researchers in this domain may explore the following RQs:

- What would be the blueprint for a generative AI-driven sales training recommendation system for employees in service-oriented companies?
- What is the role of generative AI in the service industry which requires a high level of empathy and emotional support to users?

Product management

Product managers have wide applications of generative AI including new product development ideas, market research, product design, pricing, CX, and service delivery [34]. Generative AI can aid in the pricing of new products and revenue optimization. Scholars in this domain may explore the following RQs:

- How can generative AI improve product lifecycle management of perishable commodities?
- What are the policy initiatives to eliminate bias in generative AI-based product management insights?
- What are the different ways in which generative AI can aid in market understanding for new product launches?
- How can generative AI tools aid in coordination by product managers with other departments in the company?

Generative AI in Healthcare

Overview

Generative AI empowers technological applications to emulate human thinking via input-based processing and learning from disparities in anticipated results [9,43]. By providing human-like service, generative AI has fundamentally transformed how individuals engage with technology. For instance, human-AI collaborative dialogue systems could be utilized for customer service [44], social robots could influence normative conformity [45], while AI-based chatbots could be utilized in educational settings to provide students immediate and interactive and better meet their needs [46]. In short, generative AI can facilitate the automation of monotonous and time-consuming tasks which would enable individuals to dedicate their resources to more valuable and meaningful work [43].

Generative AI-enabled technologies are also shifting the paradigm in healthcare by delivering more effective service and improved patient care [47]. More specifically, healthcare providers can use responsible AI to improve market performance in healthcare [48], adopt AI-enabled customer relationship management systems to enhance service innovation [49], utilize AI-based decision support system to provide automatically diagnose patient mental disorders [50], and augment medical diagnosis decisions [51].

Despite the potential benefits, generative AI still has its set of challenges which could lead to the failure of AI implementations. More specifically, generative AI algorithms might automatically perpetuate prejudices and biases (e.g., ignoring gender distinctions) which would potentially cause incorrect treatment and adverse health outcomes. This would further add on to the detriment of healthcare providers and patients' trust toward generative AI. Losing unique human knowledge may also result in undesirable outcomes [52]. Besides, users may be worried about the protection of their privacy and whether AI would substitute human beings [53] which may lead users to take an ambivalent stance towards accepting or refusing the use of generative AI.

Similar to other novel technologies, AI designers, managers, and scholars are concerned about users' attitudes towards generative AI [54,55], as their attitude determines the success of AI implementation [53]. To trigger the positive attitude of individuals toward AI, prior research indicated that the key elements might be perceived operational and cognitive capabilities of AI, anticipated adverse outcomes of AI [53], perceived distrust of AI, perceived efficiency of AI [56], and users' emotion [55,54). All these highlight the need for further research on generative AI adoption. However, the existing technology adoption models (e.g., TAM and UTAUT) may not be well-suited to explain people's willingness to adopt generative AI. This is because they were initially designed to explore the use of traditional and non-intelligent technologies [55]. To increase AI adoption, users' trust should be one of the key determinants in healthcare which would be influenced by AI-specific characteristics (e.g., personalization, loss of privacy, and anthropomorphism) [57]. Accordingly, future research on generative AI in healthcare should consider incorporating the distinct characteristics of generative AI into their research model.

Opportunities

Generative AI has provided quick ways to assist users in creating passages of answers to their healthcare questions. This offers healthcare users who need quick and short answers that are specific to their questions without browsing through difficult and massive information, either on online websites or offline documents. In this sense, generative AI can serve as an assistant for collecting massive amounts of information and summarizing them into easy-to-understand information.

Generative AI has sufficiently good translation and summarization functions built into it. Thus, users can use generative AI as their translation and summarization assistant to quickly understand healthcare information and suggestion in other languages. This is particularly useful for non-native English healthcare professionals as many documents on medical advancements are published in English.

Generative AI can help patients to prepare their complete descriptions before seeing a doctor. Patients may remember the major symptoms but forget minor ones. In this case, patients can ask generative AI what the related symptoms are based on a major one. Generative AI can probe further to allow patients to assess whether they also experience other related symptoms. A single symptom may be due to a variety of possible diseases. Hence, a complete description of symptoms will be helpful for doctors to accurately diagnose the disease(s) and provide the necessary prescriptions or interventions.

Linguistically, generative AI can suggest words, terms, and sentences for doctors and nurses to be recorded into the medical systems following the interaction with patients. These suggested words can save healthcare professionals' time in drafting. Healthcare professionals would just need to concentrate on reviewing and editing the suggested texts to the final medical and legal records. Certainly, healthcare professionals must be aware that they are completely responsible for the correctness and completeness of the final inputs into the medical systems and not attribute errors to generative AI.

Besides, generative AI can consider the patient's history to check whether a healthcare professional's medical record, diagnosis, or prescription may result in potential problems (e.g., conflict between medicines). This can help prevent unexpected adverse events in the future.

Challenges

Generative AI can provide answers to prompts regarding healthcare but there are still a number of concerns. First, generative AI does not have sufficient transparency [9]. Users would not be able to know how generative AI produces such answers. For end users, they do not know where the answers come from and why generative AI provides such a response. Without transparency, users are unlikely to develop trust in the answers of generative AI [58], particularly regarding healthcare matters and thus limiting its use.

Second, generative AI does not guarantee correctness and bears any responsibility for the answers it gives. Generative AI relies on the inputted materials which may or may not be correct. Thus, if users truly believe in the answers by generative AI, they may or may not obtain the correct answers. Unlike other contexts, incorrect answers to health problems can be fatal to users. If the use of generative AI results in harm to the users' health, this would deter the public acceptance of generative AI.

Third, generative AI may offer fabricated responses [9], thereby giving misinformation or information that are not applicable to users around the world. This is given that healthcare systems, policies, and regulations differ around the world. Well-accepted suggestions in one country may not be applicable in another country. Suggestions that go against local regulations or situations can cause problems for the users.

Fourth, generative AI would need multiple interactions with users to offer personalized recommendations. At least in the short term and without the user's detailed medical history, generative AI is unlikely to provide more personalized recommendations than human doctors. Based on a patient's detailed medical history and the accumulated doctor-patient interactions, doctors should be able to provide more personalized recommendations which likely are more workable and effective.

Fifth, generative AI evokes privacy concerns. This concern is more severe in healthcare contexts. Healthcare records are sensitive and strictly regulated in many countries. If users ask generative AI to provide answers, their healthcare conditions may be recorded, analyzed, and disseminated. A person's healthcare information is valuable and may lure hackers or employees of generative AI companies to take illegal advantage of such data. This challenges generative AI to build firewalls for safety which are comparable with current healthcare systems in order to not be engaged in legal problems.

Sixth, users may not utilize the right text prompts to properly guide generative AI to provide the answers they want. For generative AI, it is a challenge to guide users to find suitable text prompts for their healthcare questions. Users who do not have ample healthcare knowledge may only know their symptoms, but not the name of the disease. More accurate text prompts are required for generative AI to provide an accurate diagnosis of the disease. However, as the general users would not be aware of the specific names of the disease, it will likely require a doctor's consult to identify what the actual disease is.

Research agenda

There are several RQs for future research with regard to the integration of generative AI into healthcare contexts. More specifically, the following RQs should be considered:

- How can generative AI increase its transparency to healthcare users?
- In what circumstances and why would healthcare users use generative AI with limited transparency?
- What level of responsibility should generative AI have on its suggestions for healthcare issues?
- How can generative AI increase the correctness of its answers to healthcare issues?
- How can generative AI incorporate the laws, policies, regulations, and circumstances when providing healthcare suggestions?
- What aspects of generative AI can be designed to include comprehensive personal data and provide more personalized healthcare suggestions?
- What legal or auditing efforts are needed to ensure that generative AI protect users' privacy (e.g., health information)?
- How can generative AI guide healthcare users to use proper "text prompts" to describe their symptoms (e.g., specific diseases and physiological terms)?
- How can generative AI cooperate with healthcare professionals to develop interactive systems to facilitate medical diagnosis?
- How can technology innovation diffusion or acceptance models be modified to better fit the context of generative AI in healthcare?

Generative AI in Human Resource

Overview

The developments in AI have happened in leaps and bounds. From the traditional types of ML, which include supervised learning, unsupervised learning, and semi-supervised learning, the developments in AI have moved towards generative AI, which uses language models for the creation of content as a response to inputs. Generative AI as a field is not new and there have been many developments in the early years of language models [9]. For example, early models of natural language processing used n-grams. This has, however, evolved towards the large language models whereby new models of transformer-based architecture respond to human queries and generate content. Generative AI is expected to have huge implications on different functions, especially when it comes to interacting with human stakeholders. One such area is human resource management (HRM), where the possibilities of generative AI applications are huge, but there is relatively less diffusion as compared to other organizational functions.

The applications of generative AI in HRM have been gradually increasing. Recently, there have been quite a few reviews in the area of how the application of AI is shaping HRM [59-61]. Generative AI can be used in HRM to improve the recruitment process, training and development initiatives, outcome of resource allocation, employee engagement, and so on [59]. The outcomes of HRM decisions, such as who gets hired, better appraisal, preferred projects, and even terminated, have serious impacts on individuals, organizations, and society that are concerned about fairness towards different stakeholders, procedural and distributive justice, as well as ethics [61].

For example, in the recruitment process, generative AI can automate the extraction of the candidates' information from their resumes and guide recruitment managers to selectively focus on more suitable applicants so that there is greater fit between the job roles and the hired candidate [62]. Furthermore, keeping in view the applicant's requirements for more effective job searches on digital platforms such as LinkedIn, the recruitment process have demonstrated reverse assessment of the job's relevance to potential candidates and making recommendations accordingly. Similarly, generative AI has been utilized for assessing employee engagement by accessing their social media profiles and mining the text of user-generated content using natural language processing and social media analytics [63]. This application of social media analytics and natural language processing [64,65] offer companies an opportunity to compare employee sentiments on a real-time basis and therefore measure brand engagement across geographies. The utilization of generative AI to assess and monitor employee engagement practices open up opportunities for the enhancement of employee engagement policies at the organizational level.

Generative AI is envisioned to significantly influence HRM in the years to come and provide mechanisms for the digital transformation of talent management functions in a holistic way.

Opportunities

There are several opportunities when companies start implementing generative AI in HRM. It is envisioned that generative AI may be used to automate recruitment process queries, improve learning outcomes of training and development initiatives, team dynamics, the outcomes of resource allocation challenges among employees, employee engagement, as well as minimize employee turnover.

For example, one of the largest areas of application could be when opportunities are created and advertised in firms. Potential applicants could query the platforms which may be enabled by generative AI to explore the details of the opportunities. Structured queries can be

addressed by utilizing generative AI. Hence, when hundreds (or even thousands) of interested applicants try to apply, they are often challenged by queries surrounding their eligibility, fit, and status of the selection process. Generative AI can enable automation of the query resolution processes in a very structured yet human-like mode to which the person raising the queries may not even feel that the responses have been generated by a ML algorithm and feel more satisfied with the process.

Similarly, employees across a geographically dispersed company may face challenges due to a mix of local administrative and global practices. If an employee exhibits dissonance on social media about issues that can be addressed, generative AI may provide a mechanism to track employee dissonance on a real-time basis and create a ticket to address the concerns of the employee. This will not only boost the morale of the complaining employee but also others who may not be complaining but have the same feelings. In addition, due to cultural differences among geographically dispersed offices of an organization, an employee who may be facing challenges in coping with organization deliverables may be connected with other colleagues within the talent network by generative AI for mentoring and support during stressful times. Activities undertaken for prompt redressal of employee concerns may also assist in reducing employee turnover.

Teams that are working on projects require frequent interaction and strong cohesiveness to improve the group's performance. However, for large geographically dispersed teams, there may not be adequate opportunities for interaction to happen among team members outside of formal interactions (e.g., meetings). Therefore, actions and time-bound deliverables expected from team members, which may have been overlooked, may create unnecessary friction and mistrust among employees. Generative AI may enable teams to receive reminder prompts on actions and interactions made in the past in an effort to create better interactions between team members. These reminders may can create a more cohesive working environment among team members who may otherwise not know each other personally and may not want to send formal reminders due to geographical and cultural differences.

Appraisals may also be improved through the application of generative AI. If appraisals have specific softer factors like the turnaround time for work given, assessing project outcome based on personal and external dependencies, as well as assessing interactions of the employee with team members, generative AI can provide prompts to the manager to assess the employee according to factors that are beyond tangible outcomes such as the employees' interaction and dependencies with their peers which might not be captured by the reporting managers. Softer contributions that may not be tangible and beyond the manager's observation but demonstrate organizational citizenship behavior can be recognized, especially in a geographically dispersed workforce that lacks interpersonal interactions beyond official work.

Reskilling and upskilling of employees are an integral part of HRM for both the short- and long-term needs of the employees and the organization [66,67]. Generative AI may enable peer-to-peer learning by connecting an employee's query to a competent colleague. This is in addition to addressing structured queries generated during skill development programs among employees in real-time. Similarly, social loafing is a big challenge in the workplace. A lot of management time goes into creating mechanisms to control agency costs to the organization which could be dimensions of social loafing and other related deviant behavior. Generative AI may enable cues which may reduce the manager's workload to monitor employees who may indulge in deviant behaviors.

Challenges

For understanding the possible challenges of using generative AI in HRM, we would have to revisit the fundamental building blocks of generative AI which are extended from the principles of AI. Biases and limitations are likely to be present in generative AI applications [68,69].

Generative AI models would need to be trained on a very large corpus of data. If the data does not have adequate representation of different employee groups, designations, cultures and ethnicity, challenges may be present in the recommendations generated by the model which would demonstrate fairness towards all employees. Fairness of generative AI may not appear very challenging while implementing projects but may have very strong adverse outcomes on the fabric of inclusive work norms and practices in an organization. Employees may face this challenge even more if the firm is a multinational enterprise and employees belong to diverse ethnic, cultural, and social backgrounds with diverse demographics.

As generative AI tools operate within a black box, the algorithmic implementation of transformer architectures or deep learning models like long-short-term memory do not explain the reasons behind a generative AI response to a query. Variation of responses, especially for inaccurate responses, may not be explainable. This may create challenges in HRM and damage the organizational harmony among employees regarding functions such as employee appraisals and resource allocation if ineffective outputs are generated by generative AI and subsequently adopted for decision-making. The lack of transparency in predictions may create a lack of trust not only on the generative AI system but also among co-workers and the institution which will have adverse effects beyond adoption.

Generative AI tools may present issues of bias in enterprise applications. Challenges in applications developed using generative AI may stem from confounding bias if the algorithm interprets the wrong relations by not considering all the information residing in the knowledge bases of the firm or if it misses the important relationships between query features and outputs. Generative AI tools may also demonstrate effects like sampling biases and negative set biases. In view that generative AI tools are trained on the knowledge that is explicitly documented, it implies that the firm must first experience these specific use cases. Therefore, the unchartered territory of queries and usage may lead to a response by the generative AI tool that is inaccurate or inappropriate. If unchecked, such response can result in undesirable outcomes on employee morale and group dynamics.

Research agendas

There can be multiple research agendas that can be foreseen if generative AI is used extensively in HRM. Some of these are as follows:

- How can generative AI enable better recruitment processes and outcomes?
- Given the complex nature of talent acquisition processes, how can generative AI improve the experience of potential applicants during the process?
- How can generative AI influence the engagement of employees in an international company?
- How can generative AI be used to mine honest signals from employees to improve internal processes and organizational infrastructure?
- How can the adoption of generative AI in HRM be enabled given that the role of human resource is often looked upon as a support function with limited budgets and technical expertise?
- How can deviant workplace behavior be managed with generative AI if employees engage in counterproductive activities in the workplace without continuous monitoring and interventions?

- How can generative AI enable and empower managers to make better decisions regarding employee appraisal beyond the direct deliverables achieved while taking into account interpersonal behavior and group contributions of employees towards the larger welfare of other employees and colleagues?
- How can fairness, transparency, and accountability in generative AI tools be ensured to reduce its adverse impacts on HRM?
- How can the different kinds of biases which may creep into generative AI systems be addressed so that ethical decision-making is enabled and systematic biases in generating content for decision making is reduced?
- How can generative AI enable better training and development programs for employees at different stages of their careers in a more integrative and assistive manner?
- How can the reskilling and upskilling of employees be assisted by generative AI in the short and long term?

Generative AI in Education

Overview

Generative AI is a technological advancement that employs deep learning models to synthesize various types of content including text, code, audio, visual media, three-dimensional entities, and video, in response to multifaceted and heterogeneous prompts [70]. This AI class evoked considerable astonishment globally for its capacity to comprehend and reproduce the intricacies of diverse human languages, thereby enabling it to generate nuanced and structured responses that are reminiscent of human communication. It emulates the complexities of human linguistic patterns and can be applied to tasks requiring complex processing such as text summarization, language translation, and dialogue systems [71] Present examples of this technology include ChatGPT, Magic Write, Eleven Labs, Writesonic, and Bard. Particularly with ChatGPT, it is constructed on the foundation of transformer technology, a form of neural network architecture that anticipates outcomes based on input data, which is an attribute it shares with its competitor, Bard [72]. Generative AI is distinguished by its capacity for data generation which allows it to synthesize novel information rather than just analyzing pre-existing data. This unique function, particularly noticeable in text synthesis, demarcates generative AI from its predecessors which has exhibited sustained competence in tasks that require pattern recognition such as detecting neoplastic growths or distinguishing between distinct animal species [73]. However, generative AI enhances these capabilities by transcending mere pattern recognition to synthesize new data. This aptitude for producing original information predicated on recognized patterns underscores the generative characteristic of this advanced form of AI [9].

The rising interest in comprehending and augmenting the implementation of generative AI tools for pedagogical applications is unprecedented [74]. Generative AI has catalyzed global attention and fostered real disquiet in the educational domain. This technology has profound potential, proffering functionalities such as the generation of tailored pedagogical material, the provision of responses to inquiries, and the elaboration of explanatory discourses. Considering the swift advancements in this domain, generative AI encapsulates significant possibilities to amplify formal and informal learning experiences. Initial empirical investigations underscore the substantial potential of generative AI as an active mediator for knowledge procurement and a supportive instrument for a host of writing responsibilities. These responsibilities encompass a diverse array, spanning from software code generation and academic essay crafting to the composition of poetic verses and screenplay writing [70]. Ethically employed, the information furnished by generative AI can act as a catalyst for progressive endeavors. Conversely, when misused or manipulated with malicious intent, the data generated by these AI tools can lead to detrimental outcomes. As a result, the reaction to incorporating generative AI in educational contexts is multifaceted. For example, some higher education institutions have banned students from using generative AI while others have introduced academic policies encouraging student interaction with it, contingent on appropriate disclosure. As technological refinement continues to evolve, the discourse regarding ethical and pedagogical applications remains an active area of exploration with many unresolved issues and concerns under continuous scrutiny.

Opportunities

Generative AI has significant potential to transform the educational landscape by enhancing the effectiveness, engagement, and accessibility of learning for all students. Its capabilities can pave the way for more dynamic, personalized, and interactive educational experiences [9,70]. Among its myriad applications, generative AI can provide easy access to information,

serve as a virtual interactive tutor, offer personalized feedback, generate case scenarios, offer research assistance, and assist in academic writing. Table 3 presents the opportunities of generative AI in the educational sector.

Generative AI also provides opportunities for educators to improve students' learning. To illustrate, the implementation of generative AI in education exhibits considerable potential to significantly attenuate the occupational demands faced by educators [75]. Such technology can be harnessed to provide assessments on the students' work (e.g., tasks, dissertations, and projects) and devise a grading matrix for evaluation. Educators may employ generative AI to construct diverse examination structures, ranging from open-ended questions to multiple-choice assessments. This can help them complete tasks in a short amount of time. Generative AI can also alleviate educators' workload by assisting educators in identifying and creating relevant teaching materials such as lecture notes and slides. It can also assist them in generating lesson plans for teaching with a set of parameters and constraints. This can be a starting point for novice teachers with relatively nascent pedagogical experience as a preliminary groundwork for their teaching methodologies [75]. Additionally, generative AI tools can also serve as teaching assistants. Their ability to produce translations, elucidations, and summaries may be harnessed to simplify intricate learning materials and facilitate student comprehension [71].

Table 3: Generative AI Opportunities in Education.

Theme	**Description**
Personalized feedback	Generative AI can offer individualized feedback on assignments, pinpointing strengths and suggesting areas of improvement. This approach promotes targeted growth and motivation as well as enhances the learning experience [76]. Customized educational strategies and pedagogical resources may be systematically developed by considering students' diverse learning modalities and capacities.
Virtual interactive tutor	Generative AI can be used to create virtual tutors that can answer students' queries and provide them with appropriate feedback. This helps provide real-time explanations and responses to student queries as well as facilitate continuous learning support beyond traditional classroom hours [77]. Virtual tutors can also help in language learning. For instance, a virtual tutor can deliver tailored responses and facilitate dialogic exercises for individuals acquiring a new language. An exceptionally individualized learning environment can be provided as such a tutor can dynamically adjust to the learner's proficiency and speed of learning. This approach is advantageous for learners with limited access to human language tutors or those who favor self-paced learning by accommodating to their personalized timetables [78].
Easy access to information	Generative AI can facilitate student access to information across diverse platforms (e.g., websites, mobile applications) and within various domains. Compared to conventional search engine tools, generative AI exhibits enhanced efficiency as it does not merely proffer a sequence of sources but comprehensively articulated responses. Pedagogically, this implies that generative AI can curtail the temporal investment required for information retrieval which would allow students additional time for reading and engaging in critical introspection of the presented document.
Generating case scenarios	Generative AI can create a myriad of illustrative case studies and scenarios which would facilitate student engagement and cognitive progression. This approach holds promise in its ability to nurture critical thinking capacities

	among students. Moreover, it could help students transition their theoretical knowledge into practical application by effectively equipping them with the competencies to address real-world challenges.
Research assistance	Generative AI can potentially be deployed as an assistance tool in academic pursuits by facilitating responses to queries and producing summaries of extensive texts. Moreover, it can be instrumental in creating bibliographies, delineating outlines, and providing supplementary research aids. The conveniences in the research process can be significantly augmented by the capabilities of generative AI in structuring outlines, aiding in literature surveys, and analyzing data. In addition, it can condense pertinent scholarly articles and pinpoint crucial results which will enhance the efficiency of researchers in sifting through the abundant amount of data accessible in the digital realm [71].
Academic writing	Generative AI can enhance students' essay writing by offering topic suggestions, proposing structural frameworks, contributing intellectual stimuli, and augmenting their scholarly written discourse. For instance, when a student requires assistance in composing an essay entitled "The Role of Robotics in Education", these tools can render propositions for declarative statements and prospective subjects for the main body sections. This assistance empowers students to amalgamate their cognitions and perspectives to culminate in a comprehensive piece of writing. Nevertheless, students' ability to engage in critical reasoning remains paramount in verifying the accuracy and correctness of the composed narrative.

Challenges

Numerous global educational bodies have banned the use of generative AI tools in schools and colleges. There is a growing concern among educators about generative AI's potential impact, notably in terms of assessments, with issues such as originality and plagiarism at the forefront. Similar apprehensions are also present in the realm of academic publishing. Generative AI tools makes it difficult for educators, particularly those at research-oriented institutions, to confirm the novelty of the work that students submit. For example, if the output of generative AI tools goes unnoticed by standard plagiarism detection systems used by universities [79], how can it be confirmed that a particular paper or essay represents the student's original work rather than just the product of generative AI?

One of the significant challenges includes potential bias in data and algorithms, which could inadvertently shape learning outcomes and perceptions. Moreover, a lack of transparency surrounding AI-driven processes might create a barrier to trust and acceptance among users [80]. The use of generative AI in education also raises ethical and safety issues as it can infringe upon the privacy of students. If the tool isn't adequately protected, it could be leveraged to gather confidential information from students without their awareness or agreement [78]. The transactional distance is another dimension that comes into play with the advent of generative AI in education, particularly in terms of distance education and online learning. This term refers to the psychological and communicative distance between learners and educators which can hinder effective learning. While generative AI has the potential to diminish this transactional distance by offering personalized learning experiences, the educators' role remains paramount. This is because they are tasked with bridging this gap, providing personalized support, and guidance throughout the learning process. This role is not limited to pedagogical aspects as it also extends to encompass the pedagogy of care and human-centered learning design.

Generative AI tools might offer constrained information. ChatGPT, for instance, is only equipped with data up to 2021. This constraint can lead to knowledge deficiencies and outdated information if the tool misreads command. These limitations would contribute to incorrect or inaccurate responses as knowledge continues to progress. For instance, if asked to incorporate recent references, the tool might invent seemingly valid ones that don't refer to actual sources. The effectiveness of generative AI is also contingent on data quality. If the training data is of poor quality, the tool's responses might be imprecise or untrustworthy. Furthermore, generative AI may not deeply comprehend the meanings of the words it handles. It identifies patterns and crafts plausible replies but might not fully understand the underlying notions of the words. This could lead to responses that occasionally lack depth and discernment and possibly deviate from the topic, especially when tasked with activities demanding a subtle grasp of specific domain knowledge.

Research agenda

The following RQs provide a road map for future research on generative AI in education:

- How do generative AI tools promote educational sustainability?
- What are the optimal ways to promote Industry 5.0 (involving humans and generative AI) in education?
- What are the drivers and barriers to adopting generative AI tools in education?
- How can generative AI tools be used to support students with disabilities?
- How can educators ensure the originality of students' work in the era of generative AI?
- What strategies can educational institutions implement to educate students about the potential misuse of generative AI tools in educational settings?
- What are the suitable methods for incorporating generative AI tools into curriculum development?
- How can students employ generative AI to enhance their critical thinking and problem-solving skills?

Generative AI in Banking

Overview

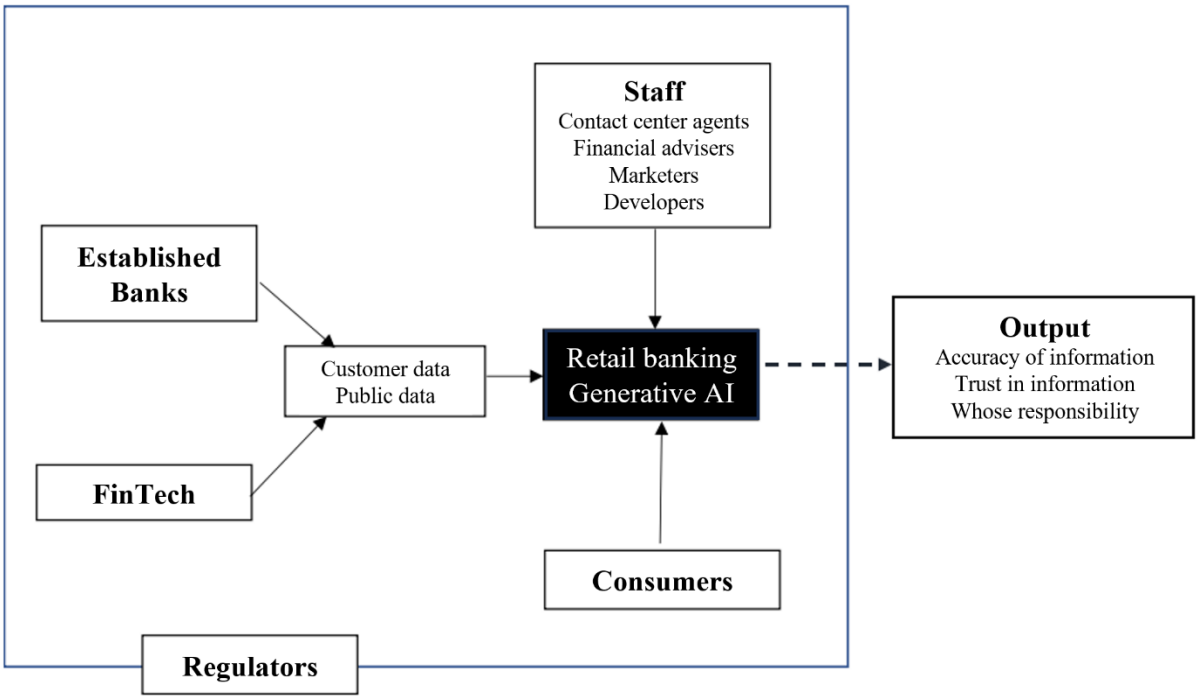
The advancement of AI has resulted in generative AI, which involves using algorithms and models to create new, original content such as text, images, and videos [34]. Unlike AI-based Chatbot that relies on pre-existing data to make predictions or answer the user's request [81,82], generative AI can create new data on its own, based on the patterns and structures it has learned from the training data [9]. Generative AI has become increasingly popular due to its ability to create and generate new insights, data, and content. It was reported that ChatGPT exceeded 1 million users five days after its launch [83].

While it can be said that the most prominent examples of generative AI are ChatGPT and DALL-E, it is imperative to recognize the swift evolution of these generative AI and the emerging innovations are backed by well-funded companies such as Google and Microsoft [9]. OpenAI developed ChatGPT, Microsoft developed the Microsoft 365 Copilot, whereas Google developed Bard. Beyond text, generative AI like MusicLM can generate music and Midjourney can generate images. Ultimately, generative AI learns the underlying patterns from the training data to make it useful for various applications such as content creation, synthesis of images and videos, as well as natural language processing across different industries.

With the enormous amount of data available to banks and financial services providers [84], this commentary recognizes the prospects for generative AI to enhance financial services provision by autonomously learning from financial data. Banks are crucial service providers that interact with consumers, businesses, and organizations. They possess vast amounts of data that can be utilized for AI and ML applications like generative AI. With the growing prospects of generative AI and the banks' access to large data sets, there are opportunities for banks to start exploring how to integrate generative AI into their business operations.

This commentary highlights the opportunities and challenges for generative AI in the banking sector. It offers practical implications and recommendations for policymakers, bank managers, and tech developers working on generative AI for banks. Likewise, the commentary offers a significant theoretical contribution to the use of technology in financial services [85]. It continues the conversation around AI in financial services and contributes to the growing body of work on generative AI for research, teaching practice, and policymaking [8,34]. Figure 3 presents a conceptual framework for generative AI in banking which highlights the data source for training the generative AI model, use-case scenarios, and practical implications for stakeholders.

Figure 3: Conceptual Framework for Generative AI in Banking



Opportunities

Creating a Generative AI model for banking

The abundant data available to banks presents possibilities for creating models to respond to customers' inquiries and train staff on financial services and products. While ChatGPT is a general-purpose LLM based on big data which is available over the internet, banks are expected to create generative AI models that can offer specific insight for financial services. This would be building on the works done by Bloomberg which has introduced its own generative AI called BloombergGPT [86] that has been trained on a variety of financial data, including Bloomberg's financial data archives and public sources. Bloomberg set out to build a model that achieves best-in-class results on financial benchmarks while maintaining competitive performance on general-purpose LLM benchmarks. BloombergGPT is an indicator of what is to come in fintech whereby financial firms use their data to create ChatGPT-like models. While BloombergGPT represents the first step in developing and applying this technology in the financial industry [86], no public-facing chatbot interface exists. Instead, BloombergGPT is being integrated into Bloomberg Terminal. There are enormous opportunities for banks, especially for commercial and retail banks, to consider developing domain-focused generative AI tools to enhance their business operations. They have the data and can start training models with these data to develop and provide a platform for consumer engagement.

Customer engagement

Aligning with the idea of creating a domain-focused generative AI model, consumers can also use this platform to engage with banks to ask a question that applies to their needs. For example, consumers can ask for advice based on their individual characteristics. With prompts such as "*I am employed full time, I have three children, I have a mortgage, and I have a personal debt of £25,000, what financial advice can you offer me?*" The bank's generative AI should be able to offer some financial advice and recommendation based on the large data set used to train the model. This generative AI builds on existing technology

infrastructure for chatbots [81,82] that can assist customers with their banking needs. These chatbots can understand natural language and provide personalized responses to customer queries. Generative AI can also be used to develop investment strategies that can optimize portfolio returns based on various factors, such as risk tolerance, market conditions, and asset allocation.

Marketing communication

Banks can use generative AI to develop marketing communication campaigns that appeal to their target audience. As Mogaji et al. [84] proposed, the possibilities of using AI to personalize emotionally appealing advertisements and the creative ability of generative AI to use images, text, and music could assist banks with the generation of personalized advertisements for their customers. Instead of having a generic marketing communication, banks can use generative AI to develop messages that align with the particular interest of their consumers. This would serve as opportunities for personalized messages based on the available data for the market segment. This personalized approach may include sending personalized birthday, religious, or cultural event greetings to their customers with unique images, text, and music based on their interests. Through their interaction with customers, banks gather a significant amount of information, process it, and provide them with appropriate product and service suggestion [9,82]. Generative AI offers banks the ability to provide more personalized and efficient services to customers while reducing costs and risks.

Fraud detection

From a banking perspective, generative AI models have access to a large amount of data (e.g., legal, fraud, and compliance documents) which would assist in understanding patterns of fraud and other financial crimes [9]. Generative AI can be used to detect fraudulent transactions in banking services. These models can identify patterns and anomalies in transaction data in real-time and proactively flag potential fraudulent transactions. Chukka [87] noted that as financial institutions are increasingly vulnerable to fraud, it is imperative that they utilize generative AI to identify and prevent suspicious and illicit activities. Mamaghani et al. [88] reported on the training of generative adversarial neural networks as one part of Swedbank's fraud and money-laundering prevention strategy. Swedbank, one of Sweden's largest banks, used a combination of deep learning techniques to produce new state-of-the-art solutions for identifying suspicious activities. With enough historical financial transaction data, the model-based approaches are better at pattern matching than rule-based approaches as they can be generalized to learn fraud schemes like existing ones.

Streamlining business operations

Banks can use generative AI to streamline their business operations, from mundane back-end activities to consumer-facing inquiries and interactions. As shown in Figure 3, contact center agents, advisors, and developers can engage with generative AI tools to take proactive steps to suggest personalized actions such as introducing a new savings account or proposing specific products to a customer. For example, A financial adviser can input customers' transactions into a generative AI model to understand the consumers' spending habits and offer a personalized service. Banks can use the generative AI model to create customer segments, understand their common interests and pain points, as well as determine the best way to engage with them. In addition, generative AI models can be used for training staff, streamlining repetitive and time-consuming tasks, serving as a virtual assistant to respond to customers' increasingly complex inquiries as well as releasing staff from routine tasks to concentrate more on innovative and strategic responsibilities which would lead to increased productivity, efficiency and accuracy [89].

Challenges

The infrastructure

It is imperative to recognize that financial services are significantly regulated [90,91]. The use of technology, access to data, and provision of financial services may serve as challenges. Even if regulatory demands are met, having the infrastructure to make generative AI or any form of digital technology in banking services work can also be challenging [91,92]. While recognizing the efforts by Bloomberg, it is imperative to recognize that it was a domain-specific generative AI developed by a single company using their proprietary data. The challenge lies in exploring a working relationship between various banks for the possibility of sharing and combining data to develop a banking generative AI model. This collaboration will, however, present significant implications surrounding competition, data privacy, and ethics [81,82]

Access to data

While data is essential for training these generative AI models, access to quality data is critical and can also present a significant challenge. While the established, traditional, and old brands may have access to extensive proprietary data by virtue of their long years of operations and customer base, there are significant challenges for newer banks and fintech companies. While established banks like HSBC, Barclays, and Lloyds in the United Kingdom may use data they already have to develop their generative AI model, app-only banks like Starling and Monzo may have significant challenges in accessing huge quantities of data for their models. As such, they would have to depend on publicly available financial data which might not offer detailed information for consumers who wants to use the model. On the other hand, the provision of data for generative AI also presents a significant challenge, especially as Wall Street banks like Bank of America, Citigroup, Deutsche Bank, Goldman Sachs, and Wells Fargo are cracking down on AI-powered chatbot [93], there are concerns surrounding the effective and safe ways of using these technologies.

Accuracy of the results

As it is well known with generative AI tools, the generated insights may sometimes be wrong [9]. They might produce inaccurate information about people, places, or facts. This limitation has enormous implications for financial services providers, especially in cases where trust is very important. This inaccurate output will also have significant implications for consumers, staff, and other stakeholders who may rely on such output. As with the example of the customer using the generative AI model to look for financial advice, the assurance that the right financial advice has been provided is in question. Moreover, who takes the responsibility for providing those inaccurate and misleading advice? The bank that provided the AI model or the customer who did not use the correct prompt. As stated by Mogaji et al. [84], the implications of AI on the digital marketing of financial services to vulnerable customers, generative AI may not be suitable for offering financial decisions on loans and other forms of borrowings as it would be biased if they are trained on biased data.

Recommendations

The regulatory requirements

Banks would need to reflect on the regulatory nature of their service provision and its impact on technology. As banks have been regulated with regard to cryptocurrencies, blockchain, and AI [91], it is imperative to recognize that generative AI will find its way into financial

services providers. Regulators must be more responsive and proactive in providing advice and guidance on integrating generative AI into their business operations [89]. Regulators and banks need to start discussing if and how they can work together to provide a regulatory framework for developing and using generative AI.

Collaboration

Banks must reflect on their collaborative network to build these generative AI models. When working with regulators, banks need to consider whether they would need to come together to share data to train the models that can be used for financial services provision. In line with the concept of open banking, there is potential for merging data from established banks and fintech companies to train generative AI models. These models can be accessible to all customers and staff in enhancing the banking services and experiences. Should HSBC, Lloyds, and Starling Bank make their own generative AI models, or should they work together to have a domain-focused generative AI open to retail banking consumers?

The use of Generative AI

Banks must reflect on who will use the generative AI if and when it is developed. Would this generative AI be available to consumers seeking financial advice or bank managers for training and streamlining business operations? As with BloombergGPT which does not have a public-facing chatbot interface [86], banks will need to determine if they want to make generative AI available for consumers. This model can also be made available to third-party organizations including credit agencies and personal finance management apps. While it has advantages in enhancing financial services provision, there are significant implications on ethics, access to data, and trust in the advice offered.

Research agenda

Consumer awareness and attitude

Future research should investigate consumers' awareness and attitudes toward generative AI by financial services providers. It is imperative to engage with consumers to evaluate if they would be willing to use it for financial advice, trust the output of generative AI, and envisage its use in banking services. This research strand will extend the existing research on generative AI for banking services [81,82].

Managers' awareness and attitude

As Mogaji and Nguyen [94] evaluated managers' understanding of AI concerning marketing financial services, future research will be required to understand bank employees' willingness and attitudes toward generative AI. This research strand would need to include contact center agents, advisors, and marketing executives to evaluate their understanding of generative AI, level of technical capabilities to use these models, and impact on their job. As generative AI is posited to disrupt financial services workforces [89], future research needs to evaluate bank managers' attitudes and preparedness for the disruption presented by generative AI.

Policymakers' responsibilities

It is expected that the generative AI model will disrupt financial services. Thus, it is imperative to understand policymakers' responsibility and preparedness for this disruption. As Huang [91] reflected on the UK's regulatory guidance on crypto-assets, research needs to evaluate the attitude of policymakers and what they are doing to help manage the impending technology transformation. Future research must understand if policymakers are trying to stop it or provide the relevant infrastructure needed to support it. Specifically, Mogaji &

Nguyen [94] examined managers' comprehension on digital transformation of financial services in several countries. They found that policymaking in developing countries is lagging, indicating a need for further research to identify the differences in approaches between developing and developed nations.

Generative AI in Retailing

Overview

The many waves of digitalization have constantly resulted in disruptions in the retail industry. In the past, retail activities (e.g., inventory management, sales) had to be done physically and manually. Since then, innovations such as the cash register and barcode have automated some aspects of retailing [95]. More recently, the Internet has allowed companies to carry out their retail activities digitally via electronic retailing (e-tailing). With that said, e-tailing has been incorporated into the operations of many retailers ranging from small, local ones to multi-national giants [96]. This is predominantly due to the relatively low barriers to entry into e-tailing and increased digitalization among the general public.

Thus, retailers must constantly seek innovative ways to outperform their competitors in sales volume, customer retention, and so on [97]. Following this, an opportunity for retailers to develop their competitive advantage is through the integration of new technologies. With that said, generative AI is widely anticipated to play a significant role in shaping the future. More specifically, generative AI is an emerging frontier of AI that can generate entirely new content (e.g., text, images, code) based on what is learned from existing data [98]. In addition, there is a continuum of emerging use cases for generative AI in various settings. This broad applicability of generative AI's utility is the major reason behind its huge potential to disrupt and even revolutionize the retail sector [99].

In view of this, many retailers around the world have started integrating generative AI into their operations. For example, the grocery delivery company Instacart uses generative AI to answer questions from its customers' whereas the cosmetic company Sephora has integrated generative AI to provide product recommendations to its customers [100,101]. In addition to that, companies indicated an average increase in revenue between 6%-10% which is attributed to the adoption of generative AI into their operations [102]. Nonetheless, generative AI still has much untapped potential in helping retailers maximize their operations' effectiveness and efficiency.

Retailers are paying close attention to generative AI as it has the potential to affect many aspects of their business; from customer service to marketing as well as physical to online settings [101]. With generative AI envisaged to significantly disrupt the retail sector, it serves as a double-edged sword to retailers. More specifically, the successful integration of generative AI into their operations will undoubtedly provide retailers with more opportunities. However, retailers will be facing even more complications and setbacks from the partial or total failure of integrating generative AI into their operations.

Opportunities

There are endless opportunities that can be gained from integrating and deriving value from generative AI in the retail setting. This is because there is still much untapped potential as retailers are only in the early stages of incorporating generative AI with their operations. More recently, Google and Microsoft have made their generative AI available via an application programming interface [103]. One key implication is that it enables retailers to integrate these tools into their systems. With that said, generative AI can offer benefits to retailers with regard to their front-end and back-end operations. More specifically, front-end operations refer to the retail activities that directly impact customers which include marketing and customer service. In contrast, back-end operations denote the functions that support retail activities that happen behind the scenes such as merchandising and data management [104].

With regard to front-end retail operations, generative AI can be integrated to provide a better understanding of consumer behavior. This is especially important in the digital age as customers have become increasingly demanding and fragmented [105]. In this case,

generative AI is able to capture trends, habits, and preferences that customers may be unaware of. This is because generative AI supersedes existing technologies when it comes to analyzing structured and unstructured data from a variety of sources such as internal retail figures and social media sentiment [106]. Based on this, detailed customer profiles with personalized recommendations and retail experiences can be generated. Expedia is a company that has integrated generative AI into its mobile application to provide users with personalized travel recommendations and planning assistance [107]. Furthermore, companies can also employ generative AI to encourage customer co-creation. For instance, Coca-Cola encouraged people to create art through its new generative AI platform for a chance to be featured on its digital billboards [108]. These would help retailers in enhancing their marketing strategies by understanding the customers' preferred types of advertising; thereby increasing their competitive advantage and customer satisfaction.

With regard to back-end retail operations, they are mainly focused on the decisions and activities surrounding the retailers' product offerings. Firstly, retailers are constantly looking to procure merchandise that is desirable to customers [109]. As such, generative AI can enrich product ideation with creative ideas. More precisely, generative AI can provide retailers with suggestions for product variations following an analysis of customer purchases and sentiment as well as the input of desired functions and designs [110]. Retailers will then be able to better specify the products they want from the suppliers. Besides, retailers can use generative AI to create better product descriptions though analyzing product characteristics at a granular level [111]. This is especially crucial to retail customers in the digital setting as it is one of the few pieces of information that they refer to when making a purchase decision. Hence, a compelling product description not only increases the possibility of a sale but also helps to improve search engine optimization. In line with this, Shopify Magic was introduced for this purpose [112].

Challenges

There are challenges that retailers need to overcome for the successful integration of generative AI into their operations. This section specifically highlights three major challenges which can be collectively referred to as the 3Ds.

The first challenge is related to *data*. It is undeniable that data plays a significant role in the utilization of generative AI to supplement various retail activities. While there is a lot more data available than ever before, it is fragmented across different platforms and sources [113]. Besides, not all data is relevant in the decision-making of different retail activities. On the other hand, the lack of data is a problem that is pertinent among smaller retailers. This is because smaller retailers are unable to generate large volumes of data given the scale of their operations. This will put them at a major disadvantage as data is essential in refining the results of generative AI [114]. Moreover, privacy is another significant concern as the input data and resulting insights are stored in the generative AI's servers. Following this, Samsung has banned its employees from utilizing generative AI on company-owned devices and networks [115]. In the retail setting, data tends to include customer information that is sensitive (e.g., bank account number) and identifiable (e.g., name) [116]. This would entail a certain level of risk to retailers as there is the potential for confidential details to be leaked or disclosed to others. Thus, retailers will not only need to have a sufficient amount of data but also carefully curate and protect the data that is used for generative AI.

The second challenge is related to *decision*. In particular, generative AI has been found to provide biased results. One form of bias is the generation of results that are discriminatory against certain customers according to their demographic characteristics (e.g., gender, race). In addition, if retailers were to utilize generative AI to predict future sales from

existing data, it might highlight behaviors that are no longer relevant to the current situation in retail [114]. Besides, there have been instances of "hallucinations" by generative AI in which the results provided may seem plausible but are not actually factual [117]. Despite being able to identify the flaws present in generative AI, it is significantly challenging to find relevant solutions. This is because the operations and processes of generative AI are inexplicable ("black box") [116]. Hence, retailers will need to be cautious when relying on the results of generative AI for all decisions as they may be biased or incorrect.

The third challenge is related to *dehumanization*. One retail application of generative AI is to provide personalized product recommendations and answers to customers' questions. Hence, generative AI can easily replace the roles of a customer service representative and salesperson. Following this, retailers have tried replacing such employees with generative AI to reduce their operating expenses [118]. This may lead to a problem as customers have noted that the service representative significantly facilitates a positive retail experience [119]. Hence, customers may find generative AI lacking in personal engagement as it is essentially a piece of technology. Overall, the application of generative AI in retail can cause the dehumanization of the industry, especially in customer engagement and human resources.

Research agenda

Following the wide application of generative AI, it will be interesting to empirically assess its impacts in the retail setting. More precisely, it is important to understand how the performance of retail operations can be enhanced by the integration of generative AI. However, there are significant gaps that have yet to be explored given the nascency of generative AI. As such, the plethora of opportunities for future studies is detailed below:

Retailers' perspective

The integration of generative AI into their operations would be a huge undertaking for many retailers. This is because it is a relatively novel innovation with various applications in the retail setting. It would thus require retailers to reconsider some of their strategic decisions. With that said, a retail company's internal environment is comprised of multiple stakeholders. Thus, there would be differing perceptions, hesitancy, and readiness toward integrating generative AI into the current business operations. In view of this, the research questions that can be addressed by future research include:

- What critical success factors will retailers need to address before, during, and after integrating generative AI with their operations?
- To what extent should retailers integrate generative AI into the various retail operations?
- How should retailers handle (e.g., access, curate, protect) data that is being utilized for generative AI?
- How can retailers leverage generative AI to enhance their customer relationships (e.g., acquisition, retention) and interactions?

Customers' perspective

The customer is undeniably the most crucial stakeholder that retailers have to consider when integrating generative AI into their operations. This is because they play an important role in determining its sustainability and success. However, the current literature surrounding the different responses that customers would develop toward the application of generative AI in the retail sector still needs to be extended. Following that, future studies can employ a multi-dimensional approach [120] to look into retail customers' behavior towards generative AI with a focus on the following research questions:

- How will customers' resistance/acceptance of generative AI for retail purposes vary in different contexts (e.g., product category, geographic location)?
- How will generative AI affect customers' perceptions, decision-making, motivations, and behaviors when conducting retail activities?
- How will the customers' experiences with retailing change following the application of generative AI?
- How will generative AI affect customers' post-purchase outcomes (e.g., satisfaction, loyalty, word of mouth)?

Generative AI in the Workplace

Overview

Since the release of several generative AI platforms in recent years such as ChatGPT, DALL-E, Bard, and Midjourney, there has been a growing interest in how these advances can change the workplace [9]. The impact of such generative AI platforms is not limited to text generation but also extends to image generation and code creation. Following this, the proposed impact of generative AI is not restricted to one sector of the economy and has important ramifications for a plethora of roles and job profiles. A recent survey conducted by Mercer [121] indicated that 57% of CEOs and CFOs plan to increase the use of AI for automating tasks whereas roughly a third of respondents are planning to redesign work processes to reduce their dependency on people. Simultaneously, there is also a growing use of generative AI platforms by professionals to augment and complement their work. While AI has been traditionally seen as a tool to reduce repetitive and rule-based work, generative AI platforms are prompting significant changes in less structured and creative tasks. As such, work in professions such as those in programming, architectural, writing, and customer service will be significantly impacted.

Generative AI is posited to influence a range of different tasks in the workplace, from automating manual and highly structured tasks to augmenting decision-making in complex and unstructured activities [122]. By introducing generative AI to replace or augment such tasks in the workplace, it is anticipated that there will be several significant shifts on the organizational level as well as the ways individuals, teams, and business units work and function. In exploring the impact of generative AI, existing research has focused on the changing role of the individual within the workplace [123]. Its effects on individual employees within the workplace are likely the most immediate. On this level, there have been a multitude of studies concerning the potential effects that generative AI will have in displacing jobs and leading to the emergence of novel forms of work [124,125]. Research in this area has not only focused on the influence on employment but also on perceptions and attitudes of individuals whose work is likely to be affected [123]. Nevertheless, generative AI is now moving from the realm of science fiction to reality with much of the debate that has been largely speculative has now turned into the empirical scene. Simultaneously, these shifts to generative AI are creating ripple effects within the workplace and broader organizational ecosystem.

Opportunities

The introduction of generative AI in the workplace can create a plethora of opportunities for professionals. Following the discussion of several past studies [9,126,127], generative AI has the potential to automate manual processes and free up employees from highly structured tasks. The affordances offered by generative AI platforms allow for the handling of data in a more detailed manner and facilitate interactions with the end users that are more “human-like” [128]. Nevertheless, the true power of generative AI lies in its ability to enhance and support creative tasks. A major opportunity within the workplace is utilizing different types of generative AI to augment creative tasks. One example is the case of using visual-based generative AI platforms for enhancing tasks related to design. A challenge designers face when developing proposals for customers is that it is often difficult to translate the requirements into a satisfactory outcome and rendering different conceptual sketches is very time-consuming. Many generative AI tools for interior design, floor-planning, rendering of architectural plans, and landscape design have become increasingly available with outputs are beyond impressive [129]. These tools are thus facilitating completely new opportunities for professionals in this industry and changing how work is done in a fundamental manner.

Such disruptions in the workplace are not only apparent in the design industry but also to other professions in which the tasks were once thought to only be possible to be undertaken by humans. For instance, developing programming scripts, analyzing data, or composing music are now just some of the activities that generative AI can perform [9]. This can lead to greater access to information and a servitization or even democratization of higher-order skills. Hence, it will no longer be necessary for individuals to spend several years learning how to program in order to develop customized software or understand the basics of music and composition in order to creatively express their musical inclinations. An emerging opportunity in this regard is that many of the skills that we consider bound to humans can be commodified and available through simple interfaces. This would have important influences on how individuals will work and collaborate in the workplace. By reducing the time and effort it takes to develop code or render an architectural sketch, it is likely to increase the quality and creativity of work that is produced in different sectors. For example, generative AI can help improve patient outcomes and reduce the overall costs for them by offering personalized treatment plans and diagnoses [130]. This can be achieved by analyzing the patients' medical results and identifying potential health issues that may be inadvertently missed by clinicians. Similarly, generative AI can be used to personalize customer shopping experiences by recommending products based on their past preferences and behavior [131]. Furthermore, generative AI can help financial institutions detect fraudulent transactions and reduce the risk of financial crime [132]. Additionally, these affordances enabled by generative AI allow individuals to have greater access to information. Within the workplace, intelligent automation and augmentation of work are likely to facilitate more interactions among employees who would previously need to dedicate a large portion of their time to tasks that required direct interaction with technologies. Therefore, an opportunity for generative AI in the workplace is that it can minimize the time individuals spend engaging with their technologies to complete respective tasks and instead utilize the time to collaborate with their colleagues, customers, and business partners.

Challenges

While there are ample opportunities in the workplace to adopt generative AI, there are also many challenges and potential risks. One key issue is that while the technology that generative AI is built on appears to have reached an impressive level, there is still a lack of understanding as to how such technologies can be integrated into the workplace in a way that generates value [133]. Companies appear to have a limited understanding of how to systematize the deployment of generative AI with most workplace applications appearing to be motivated by the individual employees [134]. This tendency can create imbalances between different groups of employees; those that are familiar with generative AI and see the value in utilizing it for their work-related tasks and those that have little knowledge or are apprehensive about using such technologies. Such division of employees may give rise to tensions and cause friction in workplace relations.

Furthermore, as large parts of the creative process may be assigned to generative AI, changes will likely be observed in the moral and psychological well-being of employees. Apart from the obvious issue of job displacement, the loss of purpose in one's work and the transfer of the creative process to a "black box" may lead to severe consequences in the drive of many creative professionals. Given the lack of understanding on how organizations should approach the diffusion of such technologies in the workplace, it may result in a loss of productivity. In addition, a potential issue that might arise from using third-party generative AI tools concerns the intellectual ownership of outputs [135]. Organizations may find themselves in a minefield, where if they don't utilize such platforms, they are automatically

at a disadvantage compared to their rivals. However, if they do, they are not the owners of important intellectual property. Bridging these issues on the individual, team, and organizational levels are posited to be major challenges in the years to follow.

Research agenda

While the proliferation of generative AI will lead to substantial opportunities in the workplace, it also comes with a variety of challenges and obstacles that need to be overcome. Undoubtedly, this phenomenon opens up many interesting questions that academic researchers can work to answer. An exhaustive list of such topics would not be possible given that very little is known about how generative AI will change the workplace. However, several major themes that will likely dominate research in the next years are presented below:

Governing generative AI

The concept of governance can be interpreted in many ways depending on the authority that exercises it. However, it can be argued that an important context in which there will be a need to define some rules, processes, and structures is that of the workplace. More specifically, when it comes to using generative AI for creative tasks, it is important for information systems and HRM research to go beyond the scope of conceptualizing technology governance as a set of practices to optimize the use of technology toward organizational goals, but also to encompass how technology utilization influences the well-being of employees within the workplace [136]. Hence, there is a need to understand how the use of generative AI in organizational settings influences both the cognitive and psychological states of employees, as well as how it defines their interactions and modes of collaboration. Delving into this topic is likely going to be very challenging as it will require an understanding of the employees' emotional and cognitive states over time while integrating aspects of team performance and collaboration. Before, technology has been primarily examined as the platform to which collaboration and communication are enacted. However, in the case of generative AI, it will likely be the one that defines the very nature of such collaboration patterns.

Algorithmic creative control

Another key issue that is likely to concern future research is the role of generative AI as the dominant creative force in several industries. While the outputs from such platforms may be seen as a means of enhancing productivity and creativity for many professions, the flip side is that maybe they will gradually replace or take over control of the creative processes [137]. The draw towards AI-generated outcomes may render human creativity irrelevant in the workplace. With that said, very little is known about the long-term effects of moving in this direction as well as how individuals in the creative professions may feel about the creative element of their work being dictated by opaque algorithms. In this regard, it is important to understand how the deployment of generative AI would be done so that employees do not feel controlled in their creative tasks. Moreover, it is important to understand optimal ways of working with generative AI so that an effective augmentation of the creative processes can take place.

Collaboration in the age of generative AI

One of the fundamental changes of generative AI concerns the changes in the creative process. Typically, high-skilled professionals in creative industries have certain modes of operating and collaborating in which digital tools are utilized to complement this process. The generative AI platforms that have been seen to date mostly rely on individual input and

interaction in creating outcomes. Thus, the question that arises is in which way will future generative AI platforms be designed to cater to the needs of specific professionals. While there is an increasing number of generative AI tools emerging with specialized use for more niche groups, the emphasis to date has been on optimizing the end result and not accommodating the means of collaboration. As such, it will be interesting to investigate how the design of the interfaces for generative AI can accommodate or redefine certain ways of collaboration among professionals. As of now, very little is known as to how collaborative work should define requirements for generative AI tools. However, it is likely that generative AI and its affordances will radically reshape the ways in which professionals work together.

Generative AI in Manufacturing

Overview

The fourth industrial revolution envisions the adoption of digitalization, automation, and connectivity technologies in the manufacturing industry that will empower manufacturers to improve their production processes, reduce costs, and increase efficiency. Generative AI is an example of such technology that has created a lot of excitement in the manufacturing industry. While the principles are not entirely new, its ability to produce human readable output based on text input offers enormous potential for manufacturers. As a whole, generative AI can be utilized to explore and execute optimal solutions, create novel outputs according to functional specifications, costs, and achieve efficient lead time through the combinations of design and production options.

Opportunities

A common issue in the manufacturing industry is the shortage of talents with highly technical, manual, and operational skills, knowledge, and expertise. Some of the attributable reasons for the skills gap include an aging and reduced workforce as well as changing skill sets due to new technology. According to Deloitte [138], the coming years will see a need for the "ability to program machines on the plant floor". Although daunting, generative AI offers a promise to bridge this gap through careful investments and a new generation of workforce building. For example, generative AI can be used to train workers on new skills and technologies by offering personalized learning for a more effective learning experience.

Manufacturers can employ generative AI for design and development optimization. Engineers and designers will have extended capabilities to design and create personalized new or improved objects (e.g., material or products) through 3D printing, additive manufacturing, or other parts and sub-assembly parts and optimize designs for manufacturing processes for material efficiency, to simplify and increase production speed. For example, engineers can prompt the system with their concerns, create variations of their designs, as well as adjust the physical, mechanical, and electrical constraints of the designs [139]. This will allow for the identification of optimal solution(s) that will best fit the defined constraints while ensuring compatibility with the capabilities of multiple suppliers.

Generative AI can help manufacturers "look ahead" and anticipate disruptions through simulations and predictions of impacts. Generative AI can be employed to perform an analysis of various data sources for real-time defects identification which would reduce the reliance on manual inspection and speed up production. This could potentially reduce the manufacturers' dependencies on suppliers and simultaneously ensure that the designs meet the specifications and capabilities of multiple suppliers. Synthetic data can be created and used to train AI models to enable simulations of potential disruptions such as natural disasters and transportation blockages which can assist manufacturers in their decision-making.

Challenges

Companies need to ensure they have the necessary computing infrastructure and data storage to support generative AI and ensure interoperability [140]. Manufacturing sites often employ a variety of machines, tools, and production systems that may not be compatible. As such, plant engineers are often relied upon to determine how the different technologies best work together. The lack of a common framework means that integrating generative AI with current production systems may require significant upfront investment in terms of technical capability.

Generative AI relies on huge volumes of data to learn and improve which are not often readily available. Additionally, the training data's quality and relevance will influence whether the system is able to properly capture underlying patterns and relationships in order to generate trustworthy output. Furthermore, complex and dynamic manufacturing environments require robust and reliable AI models that can adapt to the variability of the manufacturing process. Where results are questionable, explainability is required for the assessment of contexts to gain insights. Although it is possible to generate synthetic data to enhance and augment its reasoning and acting capabilities, it is not a panacea. The risk here lies in the bias as a result of learning from "inaccurate" output.

The adoption of generative AI raises concerns on issues surrounding privacy, liabilities as well as business risks such as copyright infringements. Firms need to ensure data privacy and prevent unauthorized use. Another key concern is that since the output is not a product of human creativity, would the output be eligible for copyright production? Could firms claim ownership of the output generated since the models are trained on data where the sources may not be fully disclosed and known? And since the ownership is disputable, can firms legally use the output of the model for training, development, and production? Without proper regulations on ownership and utilization, there is a risk that generative AI may be controlled by powerful corporations. The arguments are two-fold: First, securing the data and system will necessitate a separate investment for developing the security capacity while ensuring data privacy. Second, the legal risks may be overbearing as it is still unclear how generative AI should be regulated to protect workers and consumers.

From a broader perspective, generative AI risks creating large-scale job losses. As they become more sophisticated, they may displace manufacturing and also other sectors that rely on manual labor. Training and reskilling will be required to ensure that the workers have the necessary skills to work effectively with the technology. The power of generative AI lies in its ability to respond to prompts in natural language and learn by example. This inherently means that the person interacting or giving instruction to the generative AI would need to be able to clearly and structurally prompt the system to develop and refine the output.

Research agenda

We call for the development of case studies and empirical studies on the adoption of generative AI in the manufacturing industry. Manufacturers seeking to integrate generative AI would need to understand the types of tasks that can be credibly employed and what are the best practices in order to fully realize the benefits of generative AI. The potential impacts of generative AI on job displacements, security, privacy, and biases as well as environmental impacts require further attention. Thus, research on how to incorporate generative AI in the workplace, training, and reskilling employees for acceptance will be helpful in preparing the workforce. Finally, the ethical use of generative AI raises concerns surrounding privacy, security, accountability, and fairness. Therefore, guiding frameworks and policies are needed to inform and govern its use.

Generative Al in Sustainable IT Management

Overview

The Information Technology (IT) industry has a big role to play in reducing the impact of the climate crisis that the world is currently experiencing. A major fraction of greenhouse gas emissions is caused by the IT industry which plays a vital role in the corporate world. However, improvements in AI present exciting opportunities to enhance sustainability in the IT industry. With a focus on energy efficiency, resource management, sustainable procurement, as well as sustainable design and development, this section expounds on how generative AI can support sustainability management in the IT industry. By enabling more efficient and effective resource usage, lowering waste, as well as enhancing environmental performance, generative AI has the potential to significantly improve IT sustainability management. Generative AI has enormous potential as it can create original responses which are applicable to decision-making, design, optimization, and simulation. For instance, when it comes to designing, generative AI can help in producing optimum structures or layouts based on predetermined criteria. By investigating several options, it can produce answers for challenging problems in optimization. For testing and analysis, generative AI may build virtual worlds and scenarios in simulation. It can assist in creating alternative scenarios and assessing probable outcomes during decision-making. IT has the potential to become substantially more sustainable thanks to generative AI. There are two ways in which generative AI and sustainability are related. On the one hand, generative AI can help promote sustainable development. For example, raising public awareness of climate change and others by minimizing its negative effects. "AI for sustainability" is defined in this fashion [141]. On the other hand, managing IT resources in a way that balances environmental, social, and economic factors is referred to as sustainable IT. Companies can obtain a variety of advantages from the application of generative AI in sustainable IT such as improving resource efficiency and reducing environmental impacts of IT operations.

Opportunities

Generative AI and energy savings for the IT sector

The energy usage of data centers, which serves as a crucial part of the IT industry, significantly contributes to greenhouse emissions. However, by forecasting demand and modifying power management accordingly, AI can assist in maximizing energy use in data centers. In order to promote real-time electricity trade, generative AI can be employed to predict the evolution of energy prices based on forecasts of supply and demand [142]. Additionally, studies show that robots and AI technologies can be used more frequently to monitor and maintain energy plants [143]. Machine learning algorithms, for instance, may monitor server usage data and modify power consumption in real time, eliminating energy waste and yielding considerable energy savings. One illustration of this is the employment of Google's DeepMind AI to cut the energy usage of Google's data centers by 40%. DeepMind examined server usage data and forecasted demand, enabling it to modify power management and lower energy waste. Google was able to drastically cut its energy usage and greenhouse gas emissions which highlighted the potential of AI to increase energy efficiency in the IT industry. Another illustration is Microsoft's AI for Earth initiative, which uses AI to address environmental issues such as lowering data centers' carbon footprints. Microsoft uses AI to streamline the operations of its data centers, which has led to significant energy savings and a decrease in greenhouse gas emissions. Data centers may reduce their environmental impact and support IT industry sustainability by employing AI to optimize energy use.

Generative AI and IT resource administration for sustainability

Distributed IT solutions, including cloud and edge computing, use a lot of computational power and bandwidth. However, generative AI can improve how these resources are distributed which will lead to effective usage and minimal waste. By dynamically allocating resources according to demand, for example, generative AI can make better use of resources that would lessen the environmental impacts of IT systems. This was done, for instance, by using IBM's Watson AI to improve resource distribution in cloud computing. It allowed for more effective distribution of resources and cutting down on waste thanks to the data analysis on resource utilization and forecasting of future demand. As a result, IBM was able to lessen its impact on the environment and support sustainability in the IT industry.

Generative AI for sustainability in purchasing

Another area where generative AI may help with sustainability management in the IT industry is sustainable buying. Organizations may make better-educated decisions regarding sustainable procurement from generative AI's ability to assess and compare the product's environmental footprint which includes carbon emissions, energy use, and material usage. As a result, the environmental impact of IT goods and services may be lessened. The Ecochain AI platform, which is used to evaluate the environmental impact of goods and services, is one example of this. Data about a product's environmental impact, which includes carbon emissions, energy use, and material usage, is gathered and analyzed by Ecochain using AI. Using this information, recommendations are then made for more environmentally friendly purchasing choices.

Generative AI in sustainable development and design

Another area where generative AI may help with sustainability management in the IT industry is sustainable design and development. By accessing data on the environmental impacts of various design decisions and making recommendations for eco-friendly hardware and software solutions, AI may support the design and development of sustainable IT systems. This may lead to the development of more sustainable IT goods and services. A program like Intel's AI for Social Good, which uses AI to tackle social and environmental issues such as sustainability in the IT industry, is an illustration of this. Intel is analyzing data on the environmental impact of various designs using AI.

Data center administration

Since data centers consume a lot of energy, managing them efficiently is crucial for minimizing the environmental impact of IT operations. Automating data center administration and resource optimization are two ways generative AI might be useful. Much of the energy consumption is attributed to data centers that store data which is ultimately fed into AI. Data centers currently utilize 2% of the world's electricity [144] and is expected to use nearly 6% of the world's energy by 2030 [145]. Generative AI, for instance, can examine data on energy consumption patterns, cooling system usage, and server utilization in order to provide real-time insights on data center performance. This data will help the organization use resources more efficiently, less energy, and reduce its carbon footprint.

Manage electronic waste

To lessen the environmental impact of IT operations, it is imperative to manage electronic trash (e-waste) sustainably. Bogue [146] sheds light on the current applications and potential future roles of robots and AI in recycling, a field that historically relied heavily on labor. Generative AI can assist by processing data on the production of e-waste and offering management-related insights. Generative AI, for instance, can examine data on the IT equipment life cycle to find chances for equipment refurbishment, recycling, or disposal. This

knowledge can be employed to improve e-waste management, lessen the environmental impact of IT operations, and raise the social responsibility of the company.

Supply chain administration

As it entails controlling the environmental and social effects of IT equipment manufacturing, shipping, and disposal, supply chain management is a crucial component of sustainable IT. Real-time insights into supply chain efficiency and the detection of problems can be provided by AI, which can be helpful. Using data on suppliers' social and environmental performance, for instance, generative AI can examine supply chain potential. This would enable companies to improve their supply chain management, lessen their environmental impact of IT operations, and increase their social responsibility.

Challenges

Energy Consumption

Generative AI tools in particular use a lot of processing power which would then lead to higher energy usage. The IT industry needs to develop energy-efficient algorithms, optimize hardware infrastructure, and use renewable energy sources in efforts to address the environmental effects of generative AI.

Data & model bias

For generative AI tools that have been trained on biased or unreliable data, they may continue to reinforce current social, economic, and environmental injustices. In order for generative AI tools to be effective, the training data must be representative, diverse, and bias-free. It is also crucial to create methods for reducing and detecting bias in the results produced by AI.

E-trash management

The IT industry's brisk adoption of new innovations such as generative AI necessitates frequent hardware replacements and the disposal of trash (e-waste). In an effort to reduce the negative environmental effects of discarded IT equipment and encourage recycling and ethical disposal techniques, effective e-waste management policies should be put into place.

Ethical aspects

The use of generative AI should adhere to ethical concepts and rules. In general, generative AI should be used responsibly and ethically. To ensure that generative AI is utilized responsibly, does not violate human rights, or causes harm to society, the IT industry must address concerns about privacy, security, transparency, and accountability.

Lifecycle assessment

It is vital to evaluate the environmental impact of generative AI at every stage of their lifecycle from conception and development to operationalization and decommissioning. Comprehensive life cycle assessments can be employed to pinpoint problem areas and facilitate the creation of sustainable generative AI systems.

Regulatory frameworks

To control the creation, implementation, and application of generative AI systems, the IT sector needs clear and efficient regulatory frameworks. To guarantee that generative AI make positive contributions to sustainable development, these frameworks should look to address issues such as energy efficiency, data protection, and ethical AI practices.

Workforce development and skill gaps
A competent workforce is necessary to successfully integrate generative AI and sustainability management in the IT industry. By providing training programs and educational efforts that give professionals the information and skills that they need to effectively design and maintain sustainable AI solutions, the skill gap can be bridged.

Transparency and explainability
Generative AI models may generate results that are complicated in terms of comprehension or explanation. This would make it difficult to judge the consequences they have on sustainability. Promoting trust, responsibility, and sustainability in the IT industry requires ways to decipher and explain the results produced by generative AI.

Research agendas
Some research problems that could be addressed surrounding the application of generative AI in IT sustainability management are as follows:

- How can generative AI be used to improve the trade-offs that exist between energy efficiency and other performance measures like latency, throughput, and dependability in data centers and other IT infrastructure?
- How can generative AI be applied to distributed IT systems like cloud computing, edge computing, and Internet of Things (IoT) networks to improve resource allocation such as computing resources, storage, and bandwidth?
- What privacy and security considerations arise from applying generative AI to evaluate sensitive IT sustainability data?
- How might generative AI be applied to encourage environmentally friendly actions among IT users and stakeholders such as cutting back on paper use, recycling e-waste, and implementing environmentally friendly IT procurement procedures?
- How can model validation, uncertainty quantification, and human-AI collaboration overcome the limitations and difficulties of using generative AI in IT sustainability management such as data quality, interpretability, and explainability?
- With regard to supporting a circular economy and lessening the negative environmental effects, how can generative AI be utilized to optimize the full lifetime (from design and production to usage and disposal) of IT goods and services?
- How can generative AI support IT sustainability certifications and benchmarking via the integration of other sustainability frameworks like the Green IT and Sustainable IT standards?

Concluding remarks

Generative AI is a technological innovation with endless potential to transform businesses and society. Despite its immense potential, there are still limitations that need to be acknowledged and present across all industries, including but not limited to privacy, ethical dimensions, and issues related to data ownership. It is only by overcoming these limitations will businesses be able to effectively implement generative AI into their operations. Overall, this paper provides diverse viewpoints in the fields of marketing, healthcare, human resource, learning, banking services, retailing, workplace, manufacturing, and sustainability management. By expounding on the opportunities and challenges surrounding the integration of generative AI in different fields, it is believed that this paper will spur future research in this area.

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