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Artificial intelligence and innovation management: Charting the evolving landscape

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ABSTRACT

The excitement surrounding Artificial Intelligence (AI) is palpable. It is rapidly gaining prevalence in academia, business, and personal use. In particular, the emergence of generative AI, exemplified by large language models such as ChatGPT, has been marked by substantial media attention, discourse, and hype. Like most, if not all, aspects of business, innovation processes have been impacted. However, little is known about the degree of impact or the benefits that might be gained. To cut through the hype and understand the use of AI in innovation processes in businesses today, a large-scale survey amongst innovation managers in the USA was conducted, followed by interviews. The findings indicate that the use of AI in innovation processes is high and widespread, with AI being used for more than half of the surveyed firms' innovation projects. Furthermore, AI is used more in the development stage of the innovation process than in the idea or commercialization stages, which counters much of the existing discourse, which focuses on the idea stage. We uncover interesting differences by comparing the use and impact of generative AI with that of more traditional AI. Among these is a significant difference in expected benefits in making employees' jobs more fulfilling — managers believe generative AI is more likely to confer this benefit than traditional AI. This paper offers two valuable contributions. First, it enriches the evolving dialogue at the intersection of AI and innovation management by offering much-needed empirical evidence about practical applications. Second, it provides timely managerial implications by examining relationships between the use of AI and innovation performance and understanding the benefits that AI can confer in the innovation process.

1. Introduction

Artificial Intelligence (AI) has traversed a storied path, sparking both excitement and apprehension. It has long been a contentious topic (Dreyfus and Hubert, 1992; Cao et al., 2021), with continuing debates surrounding its efficacy and implications. Recently, there has been a surge in interest within the business community as AI is poised to become the defining technology of the 21st century (Brem et al., 2023; Magistretti et al., 2019; Brynjolfsson and McAfee, 2017). The development and proliferation of generative artificial intelligence (GAI), exemplified by advanced large language models like ChatGPT, have garnered significant media attention and have been the subject of intense debate. The technology sector, known for its expansive and dynamic nature, often exhibits patterns of excessive enthusiasm. Presently, we are witnessing a surge in excitement specifically centered

around GAI. This phenomenon mirrors the early days of social media, wherein substantial optimism existed regarding its potential commercial applications and significance in the innovation process (Roberts and Candi, 2014). It is a recurring trend in the technology adoption life cycle that initial enthusiasm, often fueled more by hype than empirical evidence, propels the uptake of new technologies.

The media's selection and presentation of news are pivotal in shaping reality and influencing perspectives on various issues. Media consumers not only acquire insights into specific topics but also form judgments about their perceived significance, influenced by the quantity of information provided in news stories and their strategic positioning. To effectively guide developments in theory and practice, it is imperative to look beyond media-driven hype and agenda-setting to gain a nuanced understanding of the practical applications of AI and GAI in the innovation process. Innovation is of paramount importance for

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businesses and society, and the proliferation of AI applications is catalyzing transformations in innovation strategies and processes. However, despite AI's transformative potential and the amplified excitement surrounding GAI, empirical evidence about how AI and GAI are used in real-world innovation processes is scarce. Therefore, we seek to answer the following questions using an explorative research strategy:

- RQ1 How are AI and GAI being leveraged in the innovation process?
 RQ2 How are AI and GAI transforming the innovation process?

We seek to navigate beyond the hype and examine how firms use AI and GAI in innovation management. We conducted a large-scale survey among managers of US firms in late 2022 and early 2023. Unlike prior studies that predominately concentrate on the front-end of innovation (Füller et al., 2022; Bouschery et al., 2023) and digital products (Verganti et al., 2020), our study spans the innovation continuum, from ideation to commercialization, and includes a range of industry sectors. Employing an explorative quantitative approach devoid of predefined hypotheses, we align with a growing trend that marries academic rigor with managerial relevance (Graebner et al., 2023). After completing the quantitative study, a qualitative inquiry was conducted to elucidate and offer deeper insights into the findings (Rose et al., 2024).

The contributions of this paper are twofold. First, it enriches the evolving dialogue at the intersection of AI and innovation management by offering much-needed empirical insights about practical applications. Second, it provides timely managerial implications by examining relationships between the use of AI and GAI and innovation performance and benefits gained in the innovation process. Thus, this work aims to facilitate a deeper understanding of the interplay between AI and innovation management, empowering organizations to navigate the evolving landscape with greater acumen.

Our contributions are based on a large representative survey of managers followed up by interviews with managers rather than on performance tests in experimental settings, which is the basis for most existing papers on GAI. Our findings complement the many white papers that have been published by consulting firms based on surveys of managers with less rigor in data collection and analysis.

This article is structured as follows: section 2 builds a background for the research by summarizing the recent literature on innovation management and AI. Section 3 describes the research methodology, data collection, and analysis. Section 4 reports and discusses the research findings. Finally, Section 5 discusses and concludes the findings and provides practical implications for management and directions for further research.

2. Background and literature review

2.1. AI and generative AI

Artificial Intelligence (AI) is defined as the ability of machines to think and perform tasks simulating human behavioral patterns (McCarthy et al., 2006). Generative AI (GAI) can be said to venture a step further as it can generate new data based on training data.

The history of AI is a rich tapestry that extends from ancient myths and philosophical inquiries into human cognition to cutting-edge technologies that have revolutionized many sectors. The field encountered several "AI winters," characterized by reduced funding and interest due to computational limitations and the complexity of human intelligence (Russell and Norvig, 2010; Von Krogh, 2018). However, there has been a resurgence in interest in AI, driven by advances in machine learning, the availability of big data (LeCun et al., 2015; Mortati et al., 2023), and decreasing costs of computer hardware (Von Krogh, 2018). AI's current status is one of pervasive influence, affecting everything from loan approvals and job placements to scientific research and media consumption (Davenport and Ronanki, 2018).

More recently, the advent of a widely available GAI in the form of

ChatGPT and the media attention that ensued marked a paradigm shift in the discourse about technology's role in society and also in the innovation process. While AI is discriminatory, looking for patterns in data and making predictions about upcoming patterns, GAI is generative in that it not only analyzes data but also has the ability to create new patterns. While both AI and GAI can take on routine cognitive tasks, thereby freeing human cognitive resources for more creative endeavors, GAI offers a tantalizing possibility to go beyond freeing humans of drudgery to engaging in creative endeavors alongside humans. This shift could lead to people having increased time available for exploring new ideas and meaningful human-to-human interactions. While the adoption of GAI brings with it ethical and regulatory challenges that require careful consideration, its transformative potential to augment human skills and creativity and change the innovation process is becoming increasingly evident (Davenport and Ronanki, 2018).

2.2. AI and innovation management

Innovation lies at the heart of organizations' pursuit of long-term, competitive advantage, commanding a prominent position in their business agendas. This dynamic process involves the creation of new products and services, as well as the enhancement of existing ones. The depiction of the innovation process as a series of sequential stages has been a common framework in the management literature (see Tidd and Bessant, 2018). However, the nature of these stages and the activities they entail have evolved in response to dynamic changes in the technical and socio-economic landscape, as well as the growing complexity inherent in innovation endeavors. AI is expected to catalyze a profound transformation of the innovation process from ideation to launch (Füller et al., 2022; Haefner et al., 2023), but empirical evidence is currently sparse. According to Berg et al. (2023), part of the excitement surrounding ChatGPT and similar tools stems from their versatility in various domains. These tools facilitate the production of descriptive or creative written content (Noy and Zhang, 2023), ideation or creative problem-solving (Mollick and Mollick, 2022), and the evaluation of human-generated input (Pekar et al., 2024). Their broad applicability has led to their swift adoption across industries.

A pivotal facet of the innovation process is the generation and application of knowledge (Eisenhardt and Santos, 2002) and incorporating 'the voice of the customer' (Griffin and Hauser, 1993). Social networking sites have provided a new creative and interactive dimension for market research (Roberts and Candi, 2014; Candi et al., 2018), providing a conduit for the 'voice of the customer.' Technological advancements have further enhanced our ability to understand customer needs and have facilitated the practice of 'listening in' to ongoing dialogues with and among customers (Candi et al., 2017). Von Hippel and Kaulartz (2021) discuss the use of AI, specifically natural language processing (NLP) and machine learning, and showcase how AI can provide a novel way to identify and analyze consumer-generated innovations through the vast and growing repository of online textual content. This broadens the scope for identifying opportunities for innovation, thus reinforcing the importance of AI in enhancing the effectiveness and efficiency of innovation management processes.

AI can facilitate knowledge acquisition, novel product development, and decision-making capabilities (Davenport and Ronanki, 2018). While certain applications of AI are expected to yield cost-effective and higher-quality outputs, thereby raising concerns about potential job displacements, AI can not only enhance productivity but also reshape the very essence of work within the innovation process (Cockburn et al., 2018) by making it more meaningful.

Based on an extensive review of the literature, Gama and Magistretti (2023) propose that AI can be adopted in one of three ways. AI can improve existing processes, replace humans, and expedite analysis. *Replacing* is usually motivated to save costs. When AI is adopted as a lever to exploit new opportunities, empower existing processes, and assist (rather than replace) employees, Gama and Magistretti talk about

reinforcing. Finally, they highlight *revealing*, by which AI is adopted to unveil hidden opportunities and provide glimpses of otherwise unforeseeable external situations. [Raisch and Krakowski \(2021\)](#) underscore the importance of acknowledging the delicate balance between two fundamental approaches: using AI to automate tasks (automation) and employing it to augment human capabilities. According to them, a nuanced and integrative strategy for leveraging AI can yield substantial benefits for both organizations and society at large.

[Bouschery et al. \(2023\)](#) provide a forward-looking perspective on the role of AI in innovation management, suggesting that GAI, such as transformer-based language models like GPT-3, can substantially augment human innovation teams by expanding their creative and analytical capabilities. Central to their argument is the notion that GAI can substantially broaden the horizons of both problem identification and solution exploration. By harnessing GAI for tasks such as text summarization and idea generation, innovation teams can bolster their performance across various facets of innovation. This perspective underscores the pivotal role GAI can play in enhancing innovation outcomes, enabling teams to navigate complex challenges more effectively while fostering the generation of fresh and impactful ideas.

Traditionally, AI has primarily been linked with cost and time savings in manufacturing processes. However, [Verganti et al. \(2020, p. 9\)](#) introduced a thought-provoking perspective by suggesting that “AI dramatically alters this pattern by shifting digital automation from manufacturing to the realm of design”. Design can play a pivotal role in the innovation process ([Candi, 2016](#)), and the use of AI can free up valuable time, thereby empowering designers and developers to harness their creative potential ([Davenport and Ronanki, 2018](#); [Verganti et al., 2020](#); [Berg et al., 2023](#)). By automating or assisting with content creation, GAI could reshape the landscape of creative work, potentially altering the demand for specific types of human capital.

Indeed, a growing area of research explores the potential of AI for creativity. AI possesses the capability to synthesize creative concepts, a skill that can accelerate the innovation process ([Ferras et al., 2024](#)). [Gruner and Csikszentmihalyi \(2019\)](#) provide an in-depth analysis of creativity, distinguishing between “Big-C Creativity” (ground-breaking innovations that transform entire fields) and “little-c creativity” (everyday creativity in novel approaches to mundane tasks). They argue that while AI can produce works that mimic human creativity, it does so within the confines of algorithms and data inputs provided by humans and that, therefore, AI’s creativity is ultimately a reflection of human programming and decision-making. The relationship between AI and creativity is examined by [Grilli and Pedota \(2024\)](#), who explore AI’s impact on individuals, teams, and organizations. They argue that through advanced data retrieval and processing capabilities, AI can potentially shift the interplay between convergent and divergent thinking paradigms, reshape group dynamics and skill distributions, and affect an organization’s capacity to absorb and implement creative ideas. According to [Amabile \(2020\)](#), a bold re-evaluation of traditional notions of creativity considering AI’s emerging capabilities is required. Nevertheless, the nexus where AI technology and human creativity coalesce is mostly uncharted territory, offering both challenges and opportunities for innovation management.

According to [Broekhuizen et al. \(2023\)](#), applying AI in innovation brings a new and novel actor into the process. This implies various benefits; for instance, in the early stages of an innovation project, AI can help with the search process to map trends and scan for opportunities. Its use may assist in analyzing documents to help identify opportunities and areas for product and service development ([Broekhuizen et al., 2023](#)). [Gama and Magistretti \(2023\)](#) suggest that AI adoption can trigger partnering agility and multimodal value co-creation ([Verganti et al., 2020](#)) and that AI can help the search process for finding potential partners, making such partnerships more valuable. AI’s capacity to accelerate and augment information flows enables the detection of new, externally relevant data streams that might otherwise elude human perception ([Ferras et al., 2024](#)). Nevertheless, despite the growing body

of research, there remains a notable scarcity of literature specifically addressing the utilization of AI within the domain of innovation.

[Füller et al. \(2022\)](#) conducted one of the few empirical investigations of AI’s role in innovation management. Their findings suggest that organizations perceive AI as a highly advantageous tool for supporting innovation teams in their endeavors, ultimately having the potential to improve innovation performance. According to [Ellingrud \(2023\)](#), AI is reshaping the nature of work and prompting businesses to ponder what can be expected in the future. However, existing research on AI, GAI, and innovation management is sparse, fragmented, and lacks a holistic perspective ([Mariani et al., 2023](#)). Research into how the expected transformations will unfold and how AI can be effectively harnessed for innovation management remains an underdeveloped area, which constitutes the motivation for our exploratory research.

3. Methodology

An online survey of managers in innovation-active firms located in the United States was conducted by a panel data service provider (Alchemer LLC) during the period from November 2022 to March 2023. Screening questions were included at the beginning of the survey to ensure respondents had the necessary knowledge to answer the questions posed ([Pollard, 2002](#); [Skinner, 2009](#)), and only those with innovation management responsibility in firms with active innovation projects were permitted to complete the survey. To help ensure data quality, the last page of the survey included a reverse-coded question (as part of a group of five questions measuring competitive intensity). Responses in which the reverse-coded question was answered with the same value as the previous non-reversed version of the question were dropped.

A total of 560 useable responses were collected. Firm sizes ranged from 1 to 200,000 employees, with an average size of 4855. The firms ranged in age from 2 to 119 years, with an average age of 30 years. The firms operated in a wide range of manufacturing (30%) and service (70%) sectors, as shown in [Table 1](#). Respondents were asked to indicate their job function; 36% indicated they were directors of innovation management or new product development, 26% indicated that they were CEOs or general managers, and the rest indicated other management roles.

The survey was developed using an iterative process with three successive versions reviewed by practitioners, who flagged questions that seemed unclear or ambiguous. In each revision, the wording was adjusted for clarity and precision. The survey was then pilot tested with 20 managers. No problems were identified in the pilot testing.

[Raisch and Krakowski \(2021\)](#) discuss two fundamental approaches to using AI, namely to automate tasks or to augment human capabilities. Our research focuses on the latter, and therefore, the survey included questions about the use of AI as part of the innovation process rather than questions about the inclusion of AI in new products, services, or processes. First, respondents were asked to what extent their firms used artificial intelligence, including machine learning, in their innovation process. The possible answers were “I am not familiar with this method” (0), “Rarely or never used” (1), “Sometimes used (fewer than half of our projects)” (2), “Used for about half our projects” (3), “Frequently used (more than half of our projects)” (4), “Always used” (5). Referring

Table 1
Industries represented in the data.

Industry sector	Proportion of sample
Automotive manufacturing	7%
Electronics	10%
Other manufacturing	13%
Financial services	12%
Health services	13%
IT services	39%
Hospitality services	6%

specifically to half of all projects helps ensure comparability across responses. Respondents were then similarly asked to what extent their firms used generative AI (GAI), including generative modeling and generative adversarial networks, in their innovation process. If using AI or GAI, each of the above questions was followed by questions about the extent to which AI or GAI was being used in each of the three stages of the innovation process: idea generation, development, and commercialization.

Those respondents who had indicated that their firms used AI in their innovation process at least sometimes were asked what benefits they believed they gained by using AI by selecting from a list of options. The options listed were drawn from literature (e.g., Verganti et al., 2020; Babina et al., 2024; Desouza et al., 2020; Füller et al., 2022; Garbuio and Lin, 2021; Gama and Magistretti, 2023) and recent industry publications about AI (e.g., McKinsey, 2023; Marr, 2024). This was then repeated for GAI.

Those respondents who indicated that they used AI (or GAI) were asked to what extent they felt this had changed their innovation processes. Possible answers were “not at all,” “to a small extent,” “to some extent,” “to a large extent,” and “completely.” They were also asked to indicate whether they intended to decrease or increase their use of AI in the future, with the possible answers “stop using altogether,” “decrease use,” “continue about the same level of use,” and “increase use.”

Finally, to enable the examination of relationships between the use of AI/GAI in innovation processes and innovation performance, questions drawn from Griffin and Page (1993, 1996) were included in the survey, see the Appendix. In these questions, respondents were asked to react to statements comparing their firms’ performance with that of their competitors. Possible answers ranged from “strongly disagree” to “strongly agree”. Three performance variables were measured: innovation process performance, innovation performance, and market performance.

The research employs a multi-method design, integrating both quantitative and qualitative approaches. Following the quantitative study, a qualitative inquiry was undertaken to elucidate and provide deeper insights into the findings, as advocated by Rose et al. (2024). Employing purposeful selection techniques (Maxwell, 2013), managers experienced in utilizing AI and GAI in the innovation process (see Table 2) were chosen to offer rich perspectives and nuanced understandings based on their practical involvement.

Semi-structured interviews were conducted, designed to probe the outcomes of the survey. In order to accommodate unforeseen insights, a set of open-ended questions was also incorporated. Managers were presented with the survey results in written, tabular, and graphical formats and prompted to reflect and comment. Interviews were transcribed and analyzed by two researchers through a deductive process, leveraging both the quantitative findings and relevant literature as a framework.

Verbatim quotations sourced from the interviews were employed to furnish insights into the underlying reasons behind observed phenomena, elucidating the “why” behind the “what.” By incorporating these direct excerpts, we aimed to authentically capture and convey participants’ perspectives, thereby enriching the narrative with first-hand accounts.

Table 2
Interview respondents.

Pseudonym	Role	Sector
Adam	CEO	IT Services
Bill	Financial analyst	Financial services
Cathy	Owner	Food manufacturing
Eli	Medical doctor	Health services
Melinda	Manager	Automotive manufacturing
Palmer	General manager	Hospitality
Samuel	General manager	Hospitality
Tyler	CEO	Electronics

4. Findings

Below, we present the findings, starting with managers’ assessments of the impact of AI/GAI on innovation processes and relationships with performance. These findings help us understand managers’ motivations for using AI/GAI in innovation processes. We then move on to the benefits managers expect to gain and the level of use of AI/GAI in the innovation process in general, including by industry sector and across the stages of the innovation process. Quantitative statistics based on the survey are elaborated using our qualitative interview data.

4.1. Impact of AI and GAI on innovation practice

Analyzing managers’ responses about the extent to which the use of AI/GAI had changed their innovation processes, we see that overall, managers agree that the impact has been substantial. See Fig. 1. In the range from 0 (not at all) to 4 (completely), the average response for AI was 3.13, and the average response for GAI was 2.93.

As expressed by Tyler, the CEO of an electronics manufacturer, “AI has revolutionized our innovation process by speeding up our prototyping and allowing us to develop more prototypes cost-efficiently.”

The difference between the use of AI and the use of GAI is statistically significant. This difference may be explained by the fact that GAI is seen as an emerging technology that has not yet made its mark on innovation processes to the same extent as more mature AI technologies.

4.2. AI and GAI and innovation performance

A path model relating the use of AI and GAI with three performance variables was analyzed, and the results are shown in Table 3.

Positive and statistically significant relationships exist between the use of AI and GAI and all three performance variables. The variables for the use of AI and GAI were standardized prior to analysis, so the coefficients are comparable, and we see that all the coefficients are larger for AI than GAI, indicating that the use of AI in the innovation process contributes more strongly to performance than the use of GAI. As discussed above, this could be because AI technologies are generally more mature and have been used for longer, allowing firms to better understand how to integrate them effectively into their innovation processes. This familiarity could lead to more immediate and measurable impacts on performance variables. Finally, it is possible that while GAI offers the potential for more radical innovations, as will be discussed below, these may take longer to develop and may involve higher levels of risk and uncertainty. This could result in a lagged impact on performance metrics, making GAI’s contributions less immediately visible compared to AI’s.

4.3. Benefits of using AI and GAI in the innovation process

Presented with a list of possible benefits of incorporating AI and GAI in their innovation processes, managers were asked to select the ones that applied in their firms. The results are summarized in Fig. 2.

We see that managers are most likely to believe that the use of AI helps them better understand current customers’ needs, opportunities, and trends and speeds up their innovation process. For all three of these, the perceived benefits from using AI are greater than for GAI at statistically significant levels. For GAI, managers believe the biggest benefits are that GAI helps them understand their competitors and develop more radically novel new products or services.

The finding that managers believe AI helps them better understand current customers’ needs, opportunities, and trends could be attributed to AI’s capabilities in data analytics and pattern recognition. Interviewees described this as follows:

“We use it to interpret text data and understand what it means. It augments an individual’s skills. We create images from constructs;

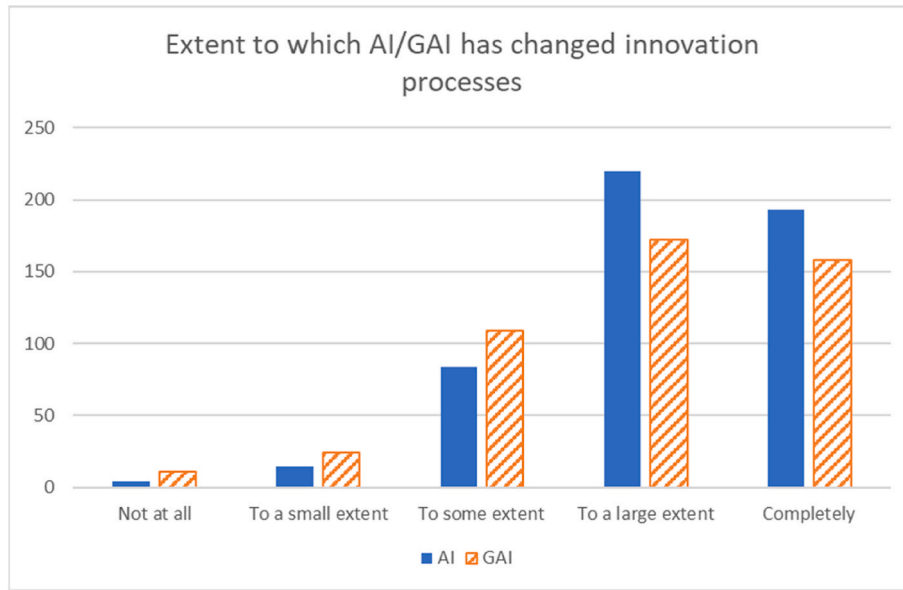


Fig. 1. The extent to which AI and GAI have changed firms' innovation processes.

Table 3
Results of path analysis for performance variables.

	Coef.	Std.err.	t	P > t
Market performance <				
AI	0.18	0.02	7.53	0.00
GAI	0.11	0.02	5.73	0.00
Innovation performance <				
AI	0.20	0.02	8.14	0.00
GAI	0.11	0.02	5.28	0.00
Innovation process performance <				
AI	0.17	0.02	7.86	0.00
GAI	0.12	0.02	6.51	0.00

create visuals of ideas that come from insights" (Adam, CEO, IT Services).

"AI helps us decide what should we produce? To decide who we should we target?" (Cathy, owner, food manufacturing).

"AI is useful for identifying unusual pockets of customers that would be missed with more classical methods" (Bill, financial analyst).

AI algorithms can sift through large volumes of data to identify preferences, behaviors, and emerging trends, thereby providing actionable insights for innovation. This is particularly useful in tailoring products or services to meet customer needs.

The perceived speed-up in the innovation process is likely due to AI's ability to automate routine tasks and speed up prototyping, allowing employees to focus on more complex aspects of innovation. This was mentioned by Tyler, CEO of an electronics development firm: "AI has enabled us to greatly speed up our innovation process, particularly through virtual prototyping." Time is a valuable resource that needs to be efficiently allocated and controlled to optimize efficiency in the innovation process, particularly when considering intensifying competition and the rapid evolution of new technologies, which have led to shorter product life cycles and faster product obsolescence. As innovation tasks become increasingly automated, there is an opportunity to allocate resources in a more cost-effective and efficient manner.

For GAI, the perception that it helps in understanding competitors could be because of its ability to simulate various competitive scenarios or model competitor behavior based on available data, which can confer a strategic edge. The belief that GAI helps develop more radically novel products or services could be due to its ability to generate new ideas or

configurations that human designers might not readily consider. GAI can explore a wider solution space in a shorter amount of time, thereby aiding in radical innovation.

Turning our attention to the bottom of Fig. 2, we see the greatest difference between GAI and AI for the benefit of making employees' jobs more fulfilling and for developing more radically novel new products or services. The latter, as mentioned earlier, could be due to GAI's ability to explore a wider array of innovative solutions, thereby contributing to the development of ground-breaking new products or services. The former could be because GAI can take on more complex tasks that are often considered tedious or difficult for human employees, thereby allowing them to focus on more creative and fulfilling aspects of their jobs. This point was raised by Samuel, a General Manager in the hospitality sector:

"I would like to use AI as a tool for great guest care ... that means I need fewer people. Get AI to do the mundane tasks, such as accounts payable. We're not removing a load of costs from the business but looking at people doing more meaningful business-beneficial tasks that make a greater contribution."

This was also echoed by Melinda, a manager in an automotive manufacturing firm:

"I personally believe the greatest benefits lie with ... making employees' jobs more fulfilling."

However, Melinda later stated that "some people may fear their current job would be at risk of becoming obsolete through increased AI. But this is not apparent within the organization that I work for, however we do see it in the media."

Indeed, the impact that AI and GAI might have on jobs is a much-raised topic in the media, surely influencing people's opinions.

4.4. Current use of AI and GAI in the innovation process

In Fig. 3, we see the distribution of responses to questions about the use of AI, on the one hand, and GAI, on the other, in the innovation process. The average use of AI was 3.63 (std. dev. 1.21), and the average use of GAI was 3.37 (std. dev. 1.47). Thus, on average, AI and GAI are both used for about half or more of firms' innovation projects. The difference between the two is statistically significant; the average use of AI is greater than the average use of GAI. Overall, these statistics

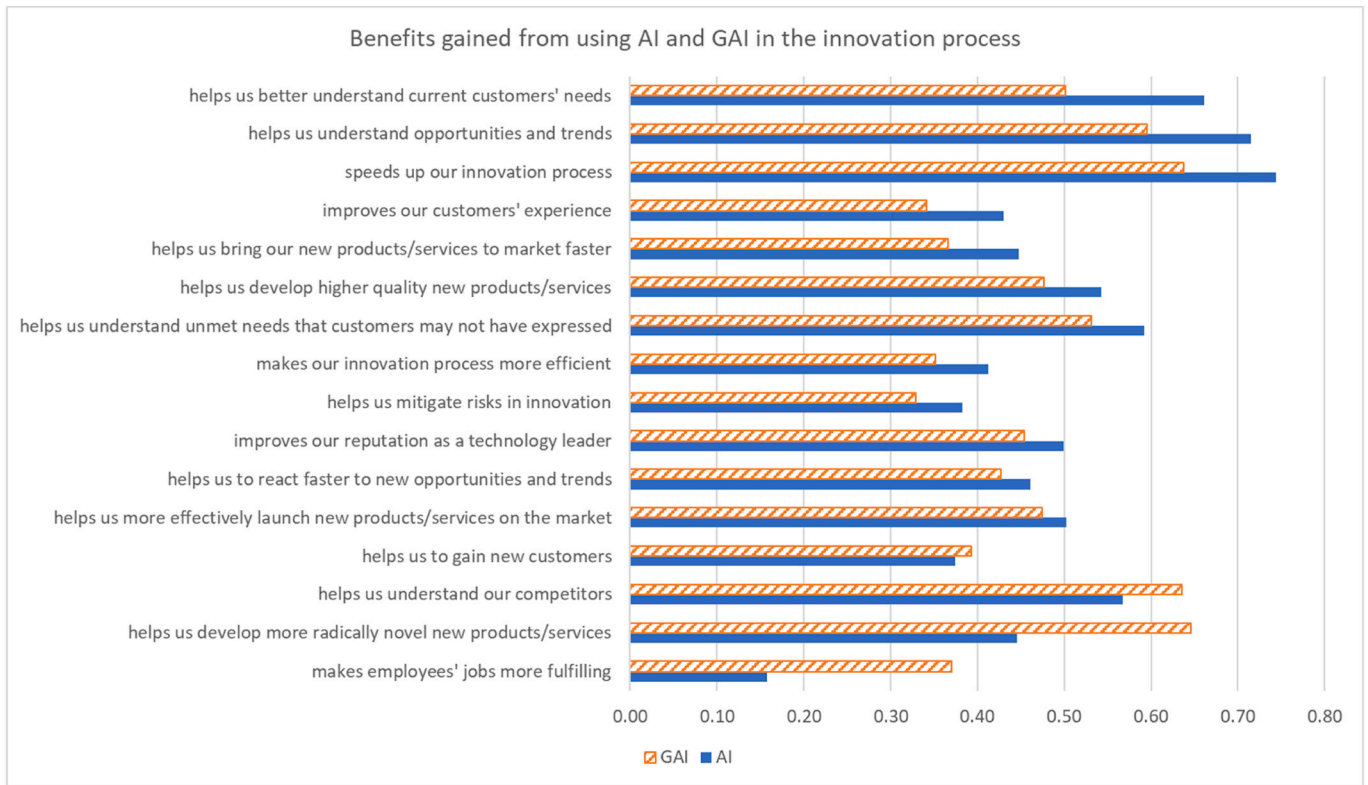


Fig. 2. Benefits managers believe their firms have gained from incorporating AI and GAI in the innovation process. The benefits are sorted by the amount of the difference between the averages for AI and GAI. Thus, the benefits at the top of the figure are ones for which managers believe AI confers greater benefits than GAI, and the benefits at the bottom of the figure are ones for which managers believe the opposite.

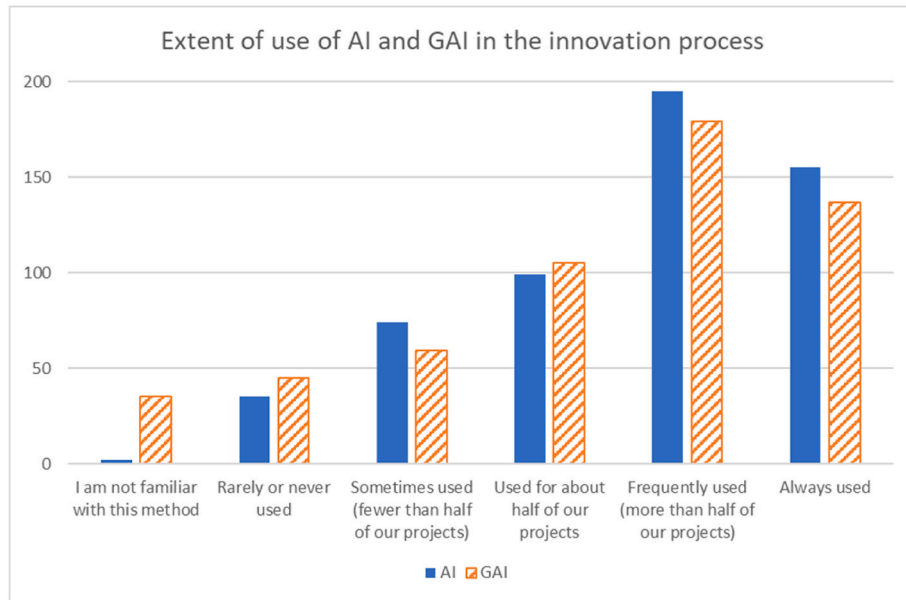


Fig. 3. Extent of the use of AI and GAI in the innovation process.

indicate that the use of AI in the innovation process is widespread among innovation-active firms, with the use of GAI lagging somewhat behind the use of AI.

Melinda a manager in automotive manufacturing stated, “I would agree with the trend, as both AI and generative AI are clearly becoming more popular and gaining momentum and trust within organizations in order to enhance innovation processes.”

The use of AI/GAI varies across the industries represented in the data, as shown in Fig. 4. The use of AI is greatest in the automotive industry, followed by IT services, financial services, electronics, and healthcare. The use of GAI is greatest in the automotive industry and IT services, followed by financial services. The use of both AI and GAI is lowest in the hospitality industry.

Innovation processes in the automotive industry are resource-

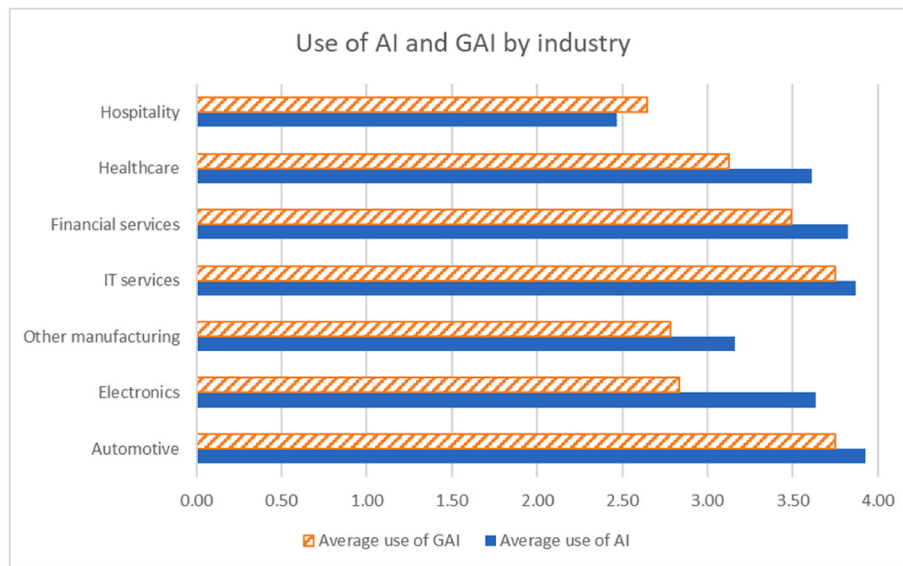


Fig. 4. Extent of the use of AI and GAI in the innovation process by industry.

intensive, and AI/GAI offers opportunities for generative design, where algorithms generate design options based on specified parameters, allowing the exploration of a wide range of design possibilities. Virtual prototyping can simulate how designs will perform under various conditions, reducing the need for costly physical prototypes. Thus, the high level of AI use found in firms in the automotive industry is not surprising. Indeed, Melinda, a manager in automotive manufacturing stated “we currently have a lot of projects in process that use generative AI.” The same is true for IT service firms, including firms that develop and exploit AI technologies and applications — their use of AI is high.

Meanwhile, the high level of use of AI in the innovation processes in financial service firms is interesting. To some extent, this could reflect steep increases in concerns over issues such as fraud and money laundering, both of which can be addressed by AI algorithms designed to detect anomalies in transaction data. Building on these competencies, financial service firms are likely to seek to exploit the deep insights into customer behavior and preferences that can be garnered using predictive analytics and use these to inform service innovations. As expressed by Bill, a financial analyst, “I can see banks using large language models more and more.”

While artificial intelligence (AI) is gaining ground in the hospitality industry, there are reasons why its adoption in innovation processes may not be as widespread as one might expect. The cost of implementing AI can be prohibitive, particularly for smaller businesses within the hospitality sector. Many hotels and restaurants operate within tight margins, and the initial investment required for AI technology, covering hardware, software, and staff training, can pose a barrier to its adoption. This was suggested by Samuel, a General Manager in the hospitality sector:

“Barriers to adoption are cost, time, and aptitude. I generally find that hospital professionals are people-people, and this generates elements of caution and distrust in new technology. There are training needs in our sector. The benefits have not been clearly defined yet. Why spend time and money if you don’t know for what?”

Furthermore, the hospitality sector takes pride in providing human-centric, personalized services, and there may be concerns that employing AI in the innovation process will result in developing services that seem robotic. This was expressed by Palmer, a General Manager in the hospitality sector:

“Hospitality is about being hospitable, and robotics and machine learning is almost the opposite of this. There is a debate at the

moment within hospitality, which centers around which jobs/processes can AI contribute to or replace a human from doing, and still do it to the desired level or better. However, without losing the human touch, which makes hospitality experiences what they are.”

The use of AI/GAI is not correlated with firm size (number of employees), but it is negatively correlated with firm age, meaning that younger firms are more likely to use AI than older firms. This holds for both AI and GAI. There are several reasons why younger firms are more likely to use AI in their innovation processes than older firms. They tend to have a culture that is more open to experimentation with new technologies, and they usually lack the bureaucratic layers that can slow down the adoption of innovative solutions. Younger firms are also more likely to have modern IT systems that can easily integrate with AI technologies, compared to older firms that may be burdened by outdated legacy systems (Petruzzelli et al., 2018). Finally, younger firms are generally more willing to take risks and adopt more flexible business models (Candi and Kitagawa, 2022) that can adapt to incorporate AI in innovation processes. These views were upheld by many of the interview respondents, e.g., “I agree young organizations use AI more. I would expect them to be nimbler, have less rigid processes, and are looking to grow faster” (Adam, CEO, IT services).

“Older, more established organizations will have legacy systems that were implemented many years ago and still work. Although I am sure these organizations would like to be able to quickly implement the likes of AI, it is not so simple to do. A lot of investment, resources, and a huge mindset change would be required”. (Melinda, Manager, automotive manufacturing)

4.5. The use of AI and GAI across the stages of the innovation process

The use of AI was found to vary significantly across the three stages of the innovation process. Use in the idea generation stage was 4.28 on average, 4.48 in the development stage, and 4.34 in the commercialization stage, as shown in Fig. 5. The averages are all relatively high, but the differences between them are statistically significant, and we should bear in mind that only those respondents who indicated that their firms used AI/GAI at least sometimes were asked about their use by stage. Meanwhile, the use of GAI did not vary significantly among the stages and was lower than the use of AI in all three stages. The differences between AI and GAI are statistically significant.

Based on these findings, we can surmise, first, that contrary to the

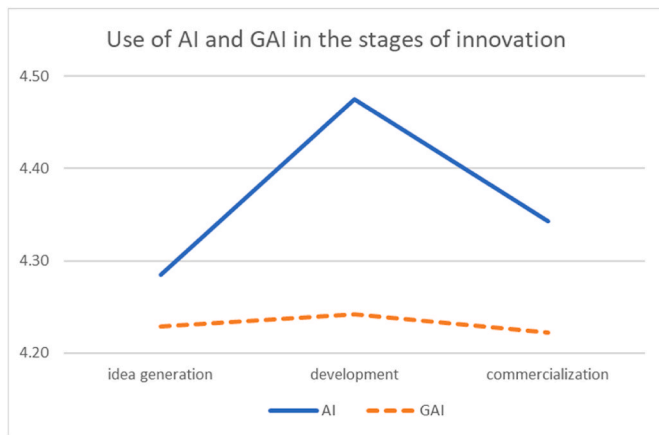


Fig. 5. Extent of the use of AI and GAI in the different stages of the innovation process.

predominant emphasis on idea generation in the present discourse on the use of AI in innovation, firms are actually more likely to use AI in the development stage. This was upheld by Cathy, the owner of a food manufacturing business: “There is far more use in the development stage for creating code, prototypes, anything that isn’t physically real.” This may be seen to resonate with Gruner and Csikszentmihalyi (2019), who take a contingent view of the ability of AI to be creative, but contradict Grilli and Pedota (2024), who take a more positive view.

One reason why firms are more likely to use AI in the development stage of the innovation process than in the idea generation or commercialization stages is that AI is particularly effective at optimizing and improving existing processes, which aligns well with the development stage (Wamba-Taguimdje et al., 2020). Prototyping is frequently a core component of the development stage of the innovation process, and AI can be used to reduce the time and cost of building and testing prototypes through virtual prototyping and digital twins (van Dyck et al., 2023). Additionally, firms often focus on technology acquisition and exploitation during the development stage, which could make it a more natural fit for AI integration (Koc and Ceylan, 2007). Although widely discussed in the literature, the usefulness of AI in the idea generation stage of the innovation process may not be recognized in practice. It was stated that: “AI is not as potent at coming up with new ideas. It is better at refining ideas” (Adam, CEO, IT Services).

A similar sentiment was expressed by Bill a Financial Analysts who stated:

“There are lots of good legal and ethical reasons not to have an automated systems making decisions. When generating ideas our catchphrase is to have humans in the loop to make decisions.”

Second, we see a fundamental difference between GAI and AI, where GAI is used roughly equally across the stages. It could be that GAI is still seen as an emerging technology, and firms may not yet fully understand how to integrate it into their innovation processes (Hutchinson, 2020). According to Adam (CEO, IT Services), “Once GAI gets better we may see more of its use in the ideation stage.”

Currently, firms may be experimenting with it uniformly across all stages until they better understand its capabilities and limitations. For example, Samuel, a General Manager in the hospitality sector stated that “we used ChatGPT to generate ideas, and they compared well with humans’ ideas.” At the same time, there may be skepticism about the usefulness of GAI, as expressed by Adam, CEO of an IT Services firm: “It’s been suggested that adverts won’t be needed. That ChatGTP will provide us with all the answers for market research. It will change the world! This was hyped beyond reason by industry folks and the media.”

4.6. Projected future use of AI and GAI in the innovation process

Managers were asked about their projected future use of AI and GAI in the innovation process compared with their current level of use. The average response for AI was 2.68 and 2.53 for GAI. The possible answers were (0) stop using altogether, (1) decrease use, (2) continue about the same level of use, and (3) increase use. Thus, both averages indicate projections for increased use of AI and GAI. The difference between the two means is statistically significant at the $p < 0.00$ level, so firms expect to increase their use of AI more than their use of GAI.

5. Discussion of results and implications

We conducted our survey during a period of growing excitement surrounding AI, particularly GAI. The media has the potential to influence the prioritization of issues, including shaping perceptions of the importance of AI and GAI, thus playing a pivotal role in establishing the agenda for both management and public discourse. Our objective was to cut through the media hype by mapping the evolving landscape of the use of AI and GAI in innovation management. To achieve this goal, we examined the current utilization of AI and GAI and projections for the future. Our analyses reveal widespread utilization of AI in the innovation process across industries, with the adoption of GAI lagging slightly. Despite the excitement surrounding the launch of ChatGTP—a widely discussed example of GAI and the reason for much of the current hype—the use of GAI is less prevalent in the innovation process than that of AI. We speculate that the possibility of using GAI in the innovation process is something that firms may not have explored yet, and this is reflected in lower adoption numbers.

5.1. How AI is being used in the innovation process

Innovation is frequently portrayed as a staged process, the first stage being ideation. Our findings show that AI and GAI are being utilized in the idea stage, where they can be used to analyze vast amounts of data, such as market trends and competitor analysis, helping firms focus on ideas with higher market potential. For instance, Natural Language Processing (NLP) techniques can extract and summarize information from a large volume of textual data, enabling the detection of patterns and trends (von Hippel and Kaulartz, 2021; Pekar et al., 2024). AI can significantly enhance the ability to understand customer needs by providing data-driven insights, personalization, and real-time feedback, ultimately leading to more customer-centric and successful innovations (Gama and Magistretti, 2023). Furthermore, AI can be employed to flag unusual or unexpected events, such as sudden surges in online mentions, which may indicate the emergence of a new trend or market disruption.

However, our findings call into question the dominant narrative, which places a strong emphasis on idea generation when discussing AI’s role in innovation (Verganti et al., 2020; Grilli and Pedota, 2024). Contrary to popular opinion, our findings show that AI is being used in the ideation stage to a lesser degree than the development stage. A potential explanation may be that the ideation process necessitates the infusion of creativity and a ‘visceral feel’ (Roberts and Palmer, 2012), which is innate, emotionally driven awareness firmly grounded in the instincts and sentiments of humans. This connection between creativity and visceral feel is closely tied to intuition, defined as “*affectively charged judgments that emerge through rapid, non-conscious, and holistic associations*” (Dane and Pratt, 2007, p. 40). Thus, ideation relies heavily on human experiences, insights, and emotional intelligence, which AI may lack (Gruner and Csikszentmihalyi, 2019). Ideation also involves understanding subjective elements such as personal preferences and customers’ social and cultural backgrounds, which often involves understanding the nuanced needs of people. Moreover, AI relies on historical data to make predictions and generate ideas, but in the ideation stage, the focus is often on envisioning something new for which there will not be historical data.

A planned approach to ideation (Busch and Grimes, 2023), facilitated by new technologies like AI, involves problem identification followed by a quest to find a new or improved solution to the problem (Verganti et al., 2020; von Hippel and von Krogh; 2016; Jeppesen and Lakhani, 2010). According to Verganti et al. (2020), innovation theory mainly focuses on problem-solving. However, with an increasing allocation of problem-solving tasks to machines, designers are poised to shift their focus toward more profound engagement in problem discovery, collectively determining which questions are worth addressing. Meanwhile, as debated by Busch (2022) and von Hippel and von Krogh (2016), innovation is not always a result of planned efforts, and serendipity can play a role. Thus, problems and solutions can emerge by surprise, which may be difficult for AI to replicate.

We find that AI is currently being used more in the development stage of the innovation process than in the idea and commercialization stages. Several compelling reasons may underpin this shift. As discussed above, AI can reduce the time and cost associated with physical prototyping. AI can optimize resource allocation, ensuring that manpower and resources are utilized cost-effectively. Repetitive tasks can be automated, liberating humans to focus on creative endeavors (Cockburn, 2018). AI's predictive modeling capabilities can pre-empt potential problems and bottlenecks in the innovation process (Agrawal et al., 2019), accelerating time-to-market. Additionally, recognizing the importance of satisfying customer needs, integrating AI into the development process can facilitate customization to align with customer requirements (Huang and Rust, 2018).

Commercialization is the final and costly stage of the innovation process. AI excels in its capacity to analyze data, which can be helpful for customer segmentation and devising precise targeting and positioning strategies needed for product launch. Moreover, AI can be used to analyze customer feedback and interactions, enabling prompt adjustments to marketing strategies. Informing customers about a new product or service and generating anticipation or excitement through advertising play fundamental roles in the commercialization process. AI, and particularly GAI, can prove valuable in this endeavor by producing marketing materials encompassing advertising copy, articles, and social media posts. Furthermore, AI's capabilities can extend to identifying and reaching the target audience by automating and fine-tuning advertisement placements, thereby maximizing returns on investment. Finally, AI can help track competitors' reactions to a new product launch and monitor their competing promotional activities and pricing strategies. Despite these potential capabilities, our findings indicate that firms' use of AI is more widespread in the development stage of innovation than in the commercialization stage. They may, therefore, be missing an opportunity to harness AI (and GAI) in this crucial and costly stage of the innovation process.

Based on our findings, managers anticipate to increase their use of AI and GAI in their innovation processes. It is evident that managers are increasingly inclined to view AI as a tool that benefits them as it enhances their understanding of current customer needs, uncovers opportunities and trends, and expedites their innovation processes. Referring to the three ways that Gama and Magistretti (2023) propose that AI can be adopted, we can see that managers see the potential for all three. Replacing through AI is reflected in managers' beliefs that the use of AI in the innovation process can expedite the innovation process. Reinforcing is reflected in their beliefs that the use of AI can improve the understanding of customer needs and revealing in their beliefs that AI can help uncover otherwise obscure opportunities and trends.

Emphasizing creativity in innovation management is a common perspective (Amabile, 2020; Grilli and Pedota, 2024; Bouschery et al., 2023; Ferras et al., 2024). The advent of AI holds the promise of not only diminishing but potentially eradicating the mundane aspects of many jobs, fundamentally changing the nature of (at least some) work (Chui et al., 2023). According to Verganti et al. (2020) and Garbuio and Lin (2021), AI can be a valuable tool for innovators in streamlining time-intensive tasks, alleviating cognitive burdens, and accelerating the

process of abductive hypothesis generation. Our findings underscore a prevailing belief that AI, particularly GAI, has the potential to enhance jobs and make people's jobs more meaningful. For decades, the narrative surrounding computers and technology has been one of promise: that these tools will make our lives easier, more efficient, and ultimately more fulfilling. Nevertheless, while we have witnessed significant strides in convenience and capability, the dream of technology truly enriching day-to-day lives has remained elusive. We are potentially at the juncture where this promise begins to be realized. With its ability to handle complex tasks and generate new data, the advent of GAI may finally be the key to unlocking this long-awaited potential. In automating not just the mundane but also the intricate, GAI could elevate human work to previously unattainable levels of creativity and fulfillment.

Our research aimed to chart the innovation landscape and found a tone of optimism among managers about the potential of harnessing AI and GAI in innovation processes. This involves transformation, which implies doing and creating something fundamentally different. Thus, our findings initiate a broad reconsideration of the fundamental axioms and assumptions that shape the theories and foundations of the innovation process. For instance, we concur with Verganti et al. (2020) in asking how we should apply concepts such as incremental and radical innovations when change is perpetual, and solutions are in a constant state of evolution. Our findings resonate with arguments presented by Fuller et al. (2022), who question the traditional staged model of innovation management and suggest a need for a reevaluation of the process. They are also consistent with the view of Haefner et al. (2023), who propose the need to adopt new business logics — meaning innovative modes of thinking — in response to the introduction of new technologies such as AI and GAI, which help firms remain competitive in a constantly changing marketplace. Our findings are also consistent with Berg et al.'s (2023) contention that GAI tools are versatile and applicable to a range of domains.

5.2. Managerial implications

The traditionally distinct disciplines of innovation management and computer science can be said to be converging around AI (Hopf et al., 2023) as the use of AI and GAI transforms the innovation landscape. To unlock value and capitalize on the benefits of AI and GAI, organizations must adapt their innovation processes and undergo a mindset shift, recognizing that traditional modes of operation are gradually fading away and new capabilities are needed.

Our findings indicate that AI currently contributes more to performance outcomes than GAI. We speculate this is because firms are more familiar with AI and, therefore, more adept at using it to their advantage. However, our research also suggests that GAI is more useful than AI for understanding competitors, developing radically novel innovations, and making employees' jobs more meaningful. Therefore, managers are advised to harness GAI in their innovation processes to improve their firms' competitiveness and attractiveness to employees.

GAI's ability to generate new ideas and configurations can drive radical innovations. Innovation managers should encourage the use of GAI to explore unconventional solutions that human teams might overlook. GAI can simulate competitive scenarios and model competitor behaviors, providing strategic insights that can inform innovation strategies and help firms stay ahead of the competition.

According to our findings, AI is predominantly used in the development stage of the innovation process rather than in the idea generation or commercialization stages. Therefore, innovation managers should exploit opportunities to integrate AI in development activities, such as prototyping and testing, where it can significantly reduce time and costs. Venturing into using AI and GAI in the idea generation stage is also recommended. AI can analyze market trends, customer feedback, and competitive landscapes to identify high-potential ideas and opportunities (Verganti et al., 2020). AI's strength in data analytics and

pattern recognition can help firms better understand customer preferences, needs, and emerging trends, which is crucial for tailoring products and services to meet market demands and, indeed, to determine what products and services should be developed in the first place.

A critical aspect of integrating AI and GAI in the innovation process is their interplay with human creativity. While AI excels in data processing, the nuanced realms of human intuition and creativity are less traversable. Therefore, AI should be harnessed to complement rather than replace human ingenuity, particularly during the ideation phase of innovation. It should augment and amplify human thought, not overshadow it. Meanwhile, there is untapped potential in AI and GAI, especially in areas like problem discovery. Innovators should be cognizant of the role of serendipity (Busch and Grimes, 2023; Busch, 2022) and maintain an open mind towards ideas and configurations generated by GAI, which could help uncover new innovation pathways.

Agility is essential in the current fast-changing technological environment (Candi et al., 2013). Innovation managers need to continuously reassess and adjust their innovation strategies, balancing forward-thinking with adaptability. This calls for a reevaluation of workforce competencies, as highlighted by Iansiti and Lakhani (2020). Firms will increasingly seek individuals with the skills to efficiently manage and leverage AI and GAI. They should invest in training programs to equip employees with the necessary skills to work effectively with AI tools. This includes both technical training and education on the strategic use of AI/GAI in innovation. Encouraging collaboration between AI specialists and innovation teams to ensure seamless integration of AI technologies into the innovation process is of paramount importance.

Ethical considerations are increasingly important as AI becomes more integral to innovation processes. Managers bear the responsibility for ensuring AI's responsible use, focusing on transparency, accountability, and bias mitigation (Gama and Magistretti, 2023). This ethical stewardship is vital for maintaining trust and integrity in AI-driven innovation processes.

5.3. Limitations and directions for future research

Our data provide a snapshot in time, which is valuable when little is known about how AI is being used in real-life situations. However, to gain a better understanding of the implications of AI for innovation, longitudinal research is called for (Perks and Roberts, 2013).

There is a gap in understanding the barriers to AI and GAI adoption in innovation processes. Future research should explore the organizational, cultural, and technological factors that hinder or facilitate the integration of these technologies into innovation practices.

Further study into how AI can be utilized as a new and novel actor in open innovation (Broekhuizen et al., 2023) is warranted. Such research could explore questions about how AI can enhance open innovation practices and what the barriers to adoption are.

As AI reshapes the landscape of work and innovation, traditional performance metrics rooted in market and economic factors may prove insufficient. Therefore, there is a growing imperative to expand research efforts toward developing new metrics and performance measures that encompass considerations of sustainability, social impacts, ethics, and human well-being. Not only is there a need for a strong vision for the use of AI in innovation, but also in society in general.

Expanding the research to include more diverse sectors and organizational types, such as non-profits and NGOs, would provide a more comprehensive view of the potential impact of AI on innovation across different contexts.

In conclusion, while our study sheds light on the current state of the use of AI in innovation, there remains a vast evolving landscape to explore. Even now, less than two years after the release of ChatGPT — a technology with a very steep technology adoption curve — we might see different patterns. Future research should aim to delve deeper into these uncharted territories, continuously updating and expanding our

understanding of AI's role in innovation.

CRediT authorship contribution statement

Deborah L. Roberts: Writing – review & editing, Writing – original draft, Validation, Resources, Project administration, Conceptualization, Data curation, Formal analysis, Funding acquisition. **Marina Candi:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Data availability

The authors do not have permission to share data.

Appendix. Survey items to measure performance

Market performance

- We increase our market share more than our competitors.
- We gain more new customers than our competitors.
- We increase sales to existing customers more than our competitors.
- Our revenue growth is greater than our competitors' revenue growth.
- Our market share is greater than our competitors' market share.

Innovation performance

- We introduce more new products/services on the market than our competitors.
- We adopt more technological innovations than our competitors.
- We are more innovative than our competitors.
- The new products/services we launch are more innovative than our competitors'.

Innovation process performance

- The quality of the new products/services we launch is better than our competitors'.
- The financial performance of our new product/service development is better than our competitors'.
- We develop new products/services faster than our competition.

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