Journal of Business Research 192 (2025) 115320

Contents lists available at ScienceDirect

Journal of Business Research

journal homepage: www.elsevier.com/locate/jbusres

Generative AI for growth hacking: How startups use generative AI in their growth strategies☆

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ARTICLE INFO

Keywords:
Generative AI
Growth hacking
AI capabilities
Large Language Models
Startup

ABSTRACT

This study explores how startups and scaleups in Europe and the US use generative AI in their go-to-market strategies across product-led, sales-led, and operational efficiency-driven growth. Through interviews with 20 cases spanning pre-seed to Series E funding stages, we 1) analyze generative AI's role in growth strategies, 2) identify large language model use cases for tackling growth challenges such as customer churn, and 3) develop a framework for AI capabilities that guides managers in building, refining, and reflecting on their knowledge of using generative AI for growth hacking. Key findings include the implications of generative AI for technical and non-technical content creation in product-led growth, promotional content creation and repurposing, and customer experience personalization in sales-led growth, and market research, market entry strategies, and customer engagement in operational efficiency-driven growth. Findings empower managers to develop effective generative AI-driven growth hacking strategies while proactively managing unintended organizational, competitive, and societal consequences.

1. Introduction

As Shane (2003, p. 6) noted, growth is essential for startups as "most new ventures start very small […] [T]herefore, to differentiate high and low performing entrepreneurial efforts, one must capture the improvement over time in the effort to exploit the entrepreneurial opportunity, which growth does." Especially for startups that lack resources, it is necessary to use creative, yet resource-light and cost-effective marketing practices to achieve rapid business growth (Sanasi et al., 2023). To this end, new marketing approaches have emerged, such as "engineering growth", also known as "growth hacking", defined by Sean Ellis, founder and CEO of GrowthHackers, as "a process of rapid experimentation across the full customer journey to accelerate customer and revenue growth" (Holiday, 2017). Growth hacking is important for startups because it enables them to find every bit of growth potential through continuous testing of a product, its features, the messaging to users, and how to acquire, retain, and generate revenue over time (Ellis and Brown, 2017).

The pain of resource scarcity for startups can also be alleviated by digital transformation technologies, such as Artificial Intelligence (AI) (Kulkov, 2023; Volkmar et al., 2022). In particular, generative AI—"a type of machine learning capable of generating data in a range of formats […] and adapting to new tasks in real time, following simple text-based prompts" (Morley et al., 2023, p. 1)—is transforming business operations by enabling differentiation through uniqueness, improving decision-making through information completeness, and increasing efficiency through convenience (Kumar et al., 2025). At the same time, using generative AI to rapidly experiment with the most practical and cost-effective ways to grow a business is still a relatively new and under-researched area. An example of generative AI's potential for growth hacking is its use in creating highly personalized advertising by analyzing user data and tailoring content to individual preferences. For instance, prior research shows how generative AI tools can create a high-fidelity digital avatar of a company's brand ambassador using pre-recorded template videos, followed by text-to-video generative models, to personalize the ambassador's messages in the videos — thereby tailoring the content to each user's historical data (Kumar and Kapoor, 2024). While considerable academic effort has been devoted to understanding the impact of traditional subsets of AI, such as machine learning, on business processes (see Loureiro et al., 2021 for a review),

☆ This article is part of a special issue entitled: 'Application of Machine Learning and AI in Marketing' published in Journal of Business Research.

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https://doi.org/10.1016/j.jbusres.2025.115320
Received 1 April 2024; Received in revised form 22 February 2025; Accepted 9 March 2025
Available online 21 March 2025

or the nexus of generative AI and innovation management (Mariani and Dwivedi, 2024), little attention has been paid to generative AI-enabled growth practices. Even less attention has been given to the implications of these practices for early-stage enterprises, especially those seeking growth hacking.

Growth hacking offers significant benefits for achieving rapid growth, but it also presents challenges because recruiting and retaining experienced growth hackers is costly (Bohnsack and Liesner, 2019). Generative AI, on the other hand, has demonstrated the ability to outperform humans in certain use cases, to augment human intelligence, and is readily available at low cost (Binz and Schulz, 2023), thus potentially being able to alleviate some of the challenges presented by the growth hacking methodology. Despite the promise of combining growth hacking (Conway and Hemphill, 2019) with generative AI (Wei et al., 2022), there is currently a lack of understanding of how these two can enhance one another. This paper therefore addresses this gap by exploring the potential of generative AI as a tool for startup growth. Consequently, the guiding research question of this study is, "*How can startups use generative AI in their growth hacking strategies for effective competition and development?*".

Employing a qualitative multiple case study design, we included 20 startups from the USA, Germany, and Portugal in our sample. Face-to-face semi-structured interviews (one interview for each startup) were used to collect data until theoretical saturation was reached. Data coding and analysis following the Gioia methodology led us to explore the promise, required capabilities, as well as limitations of applying generative AI technologies to growth hacking.

Five key findings emerge from this research. First, we identify business-related drivers and barriers to growth hacking and generative AI use cases. Drivers include resource constraints, agility, resilience, and deep customer understanding in a specific niche, as well as the need for rapid growth and achieving a sustainable competitive advantage. Barriers include data privacy, over-reliance on AI model providers and platforms such as OpenAI and Hugging Face, and competitive pressure from peers to be the first to introduce generative AI-based offerings for dominant positions. Second, we apply the results to three startup growth approaches: product-, sales-, and operational efficiency-driven growth. Third, we develop two frameworks, the AI Wheel and the AI Capabilities Framework, to explain how to best leverage generative AI technologies to acquire, activate, and retain potential customers. Fourth, we identify three sets of generative AI-driven risks and unintended consequences associated with growth hacking: competitive, organizational, and societal. Finally, we identify the most important use cases of Large Language Models (LLMs) for startup growth and innovation.

This study contributes to field by advancing the generative AI and growth hacking literature through the lens of growth trajectories, including product-led, sales-led, and operational efficiency-driven growth. As a result, we identify generative AI use cases across the four key pillars of growth hacking—resource optimization, experimentation, rapid and exponential growth, and data-driven decision-making—as well as within the three focused growth approaches. The integration of well-established concepts such as product-market fit, category design, and startup success frameworks such as the Pirate Metrics Funnel provides a useful theoretical foundation to guide future development of the literature. With respect to managerial contributions, we identify innovative use cases and real-world examples of startups using generative AI technology for product-led, sales-led, and operational efficiency-driven growth. More specifically, the paper outlines how LLMs can be adapted to tackle startup growth challenges such as over-reliance on paid marketing channels and the need for product or service differentiation. The AI Wheel and AI Capabilities frameworks are introduced to illustrate how startups can build AI knowledge and skills to accelerate growth. Last but not least, we highlight the unintended organizational, competitive, and societal consequences of using generative AI technologies in startups.

2. Theoretical background

While there are relatively few empirical studies on growth hacking, an analysis of the literature suggests a lack of a robust theoretical lens or perspective (Bargoni et al., 2023). Existing studies have primarily centered on theories of entrepreneurial opportunity recognition for early venture creation, such as technology entrepreneurship (Sanasi et al., 2023) or digital entrepreneurship (Cavallo et al., 2024); the theoretical understanding of big data analytics and data-driven decision-making in the early stage of a startup (Troisi et al., 2020); modern marketing concepts such as lean or agile marketing (Conway and Hemphill, 2019); the dynamic marketing capabilities and resource perspective (Bargoni et al., 2023); business model innovation in the scaling of startups (Cavallo et al., 2024); and data-driven approaches for innovation models (Bargoni et al., 2024b). While these perspectives offer valuable insights, they may be limited in their ability to explain the influence of emerging technologies such as generative AI. This study takes a different approach by drawing on growth trajectories and the business lifecycle model, which allows for a deeper examination of the multifaceted aspects of growth hacking as a tool for the transition from startup to scaleup. The application of growth trajectories and business lifecycle theories allows for a more nuanced and comprehensive understanding of the role of generative AI as a growth hacking technique and helps move the concept beyond "an internet-born digital marketing buzzword" (Herttua et al., 2016, p. 151).

2.1. Growth trajectories: From product-market fit to scaleup success

The trajectory from startup to scaleup and eventually becoming a corporation is long and risky. Startups have high failure rates—only a few become successful and influential after they reach product-market fit (PMF) (Katila et al., 2012) and subsequently turn into scaleups.[1] Investors often define a scaleup as a startup in the development stage with consistent and significant revenue and headcount growth (Isenberg and Onyemah, 2016). To set the stage for such growth, achieving PMF is a necessary first step (Lee and Lévesque, 2023). Andreessen, co-founder of Netscape, defined PMF as being in a good market with a product that is able to satisfy that market (Andreessen, 2007). Many startups see PMF as creating a "minimum viable product" (MVP) that solves a clear pain point for a specific customer segment (Lee and Lévesque, 2023). It is important to note, however, that this does not necessarily have to be an existing market. Some of the most successful startups grow through the creation of a new market segment or product category that did not previously exist, called "category design" (Cleveland, 2019). For example, Starbucks reinvented the concept of the coffeehouse by creating the category of infinitely customizable espresso-based beverages (Lombardi et al., 2021). Category creators typically captivate their consumers with significantly better benefits, experiences, economics, and a smart combination of business and profit models (Yoon, 2011).

One way to reach PMF is to address the customer's pain points rather than highlighting the offering as a customer gain. For example, Deeb (2014) suggests that to capture customers' attention and scale the business, startups should build "painkillers" (focusing on customers' urgent needs) rather than "vitamins" (nice-to-haves for customers). With this approach, startups usually create a bigger market opportunity and increase their chances of fundraising (Deeb, 2014). In this sense, it is essential to address a pain point of a specific customer segment in order to build the foundation for a sustainable growth engine and a working go-to-market strategy (Friedman, 2002), and to enter the scaling phase where startups have reached PMF and defined their growth engine. This is when startups move from experimentation to optimization, investing

[1] The definition of a startup lacks consensus (Luger and Koo, 2005), yet we define the startup phase until they reach product-market fit and subsequently become a scaleup.

in the growth engine and becoming a scaleup.

Throughout their process from startup to scaleup and eventually to corporation, ventures adopt different growth strategies (Bohnsack, 2023). These strategies, whether focused on product, marketing, or sales, determine the spatial and strategic boundaries between organizations and customers (Ainamo, 2007). In this sense, the two main strategies are product-led growth and sales-led growth (Libert and Davenport, 2022; Papasolomou-Doukakis, 2002). In addition, growth is supported by operational efficiency (Dholakia and Kshetri, 2004; Liu et al., 2022). Product-led growth, rooted in delivering superior user experiences and often used for non-complex Software-as-a-Service products, paves the way for organic and lasting growth trajectories, thus cultivating a loyal user base (Olson, 2020). Illustrating this growth strategy, Libert and Davenport (2022) point to companies like Zoom and Slack that put the products at the center of their business models and adapt other marketing strategies accordingly. They identify three key characteristics of this growth approach: free or very low introductory prices, rapid and desirable customer adoption, and ease of use and convenience of payment and delivery.

Unlike product-driven growth strategies, companies can focus on sales as the core of their marketing efforts. Often chosen for more complex software offerings, sales-led growth centers around a proactive sales model harnessing a sales team and building strategic alliances to drive expansion and additional product sales (Papasolomou-Doukakis, 2002). Blythe (2009) highlights some of the key sales-led growth strategies: empowering salespeople to better understand customer needs and wants, emphasizing sales terms when measuring performance, and reaching out to potential customers with creative sales ideas. According to Ainamo (2007), sales-led growth functions particularly well when customer needs and preferences change rapidly and unpredictably, and when relevant new technologies are constantly evolving and improving.

Apart from product-led and sales-led approaches, startups can grow through optimizing operational efficiency (Liu et al., 2022). As a foundation for both, operational efficiency focuses on streamlining business processes, such as production and control assurance, supply chain management and inventory control, ordering, delivery, and payment processing, and marketing and customer relationship management (Dholakia and Kshetri, 2004). The emphasis on efficiency is particularly important because as companies transition from the scaleup phase to established businesses, optimizing operational processes and reducing costs become critical to remaining profitable and competitive with limited resources and infrastructure (Choudhary et al., 2019).

The above review suggests that linking growth trajectories with developments in generative AI can set the stage for novel, accelerated pathways, such as faster iteration of product offerings, hyper-customization of sales strategies, and improved efficiency driven by data. In the next section, we will explore growth hacking and how generative AI tools and solutions can accelerate and sustain startup growth.

2.2. Growth hacking in the age of generative AI

The concept of growth hacking was originally developed to explain how companies use digitally enabled experiments to guide the new product development process and acquire new customers rapidly (Bohnsack and Liesner, 2019). Prime examples include IKEA (Bargoni et al., 2024a), Dropbox and Airbnb (Bohnsack and Liesner, 2019), and Hotmail (Kemell et al., 2019), all of which experienced significant growth through the implementation of growth hacking methodologies. In the context of startups, it helps them focus not only on Top-Of-the-FUnnel (TOFU) metrics such as Customer Acquisition Cost (CAC), which are prominent in most prevailing marketing approaches, but also on Bottom-Of-the-FUnnel (BOFU) metrics, such as Customer Lifetime Value (CLV).[2] With the advent of generative AI technologies, this has become even more relevant due to their ability to augment human capabilities by generating original and creative content that helps to provide insights into business growth and to generate new ideas for product development and customer needs assessment (Doshi et al., 2025; Ritala et al., 2023). Generative AI offers new opportunities for business growth and innovation, driven by LLMs—advanced deep learning algorithms trained on massive amounts of data to learn the patterns and relationships within language (Dencik et al., 2023).

The potential of generative AI for growth hacking is rooted in its natural language processing (NLP) ability to process, augment, or transform natural language so that it can be represented for computation (Sarmet et al., 2023). Furthermore, generative AI's "transformer architecture" (a system of deep learning models capable of transforming an input sequence into an output sequence) (Bandi et al., 2023) and "self-attention mechanisms" (mechanisms for identifying and weighting the importance of different parts of data, allowing the AI model to attend to different elements of the input simultaneously) (Vaswani et al., 2017) facilitate a deeper understanding of patterns and relationships, leading to more efficient handling of the large data sets required for growth hacking.

Despite these technological developments, the practical applications and startup growth potential of generative AI remain largely unexplored, especially for business use cases, which are still in their infancy. Equally important, little is known about the potential misuse or risks of generative AI, such as copyright issues related to inputs and generated outputs (Mariani and Dwivedi, 2024). This is important as the development of generative AI-enabled new products and services has become imperative for the survival and growth of some tech startups, which face a high risk of failure due to a lack of resources and turbulent external conditions (Dencik et al., 2023). Businesses are increasingly leveraging AI-powered tools and techniques to fuel growth hacking and streamline processes, such as new product development (e.g., optimization of design parameters and personalized features), prototyping and manufacturing (e.g., optimization of production conditions and quality indices), human resources management (e.g., optimization of recruitment and personalized training), supply chain management (e.g., optimization of logistics and inventory management), and sales and marketing (e.g., personalized customer experience and automated promotion of products/services) (Kirk and Givi, 2025; Loureiro et al., 2021; Volkmar et al., 2022). Generative AI is used both to develop new products, services, and processes, or improve existing ones (Doshi et al., 2025), and to optimize marketing efforts such as automated communication messages for product promotions and personalized customer experiences (Madhavaram and Appan, 2025; Mariani and Dwivedi, 2024).

Our review identifies four main pillars of growth hacking that can be streamlined by generative AI solutions. First, growth hacking focuses on resource optimization, with growth hackers prioritizing high-impact strategies and tactics that maximize growth while minimizing resource allocation. Generative AI automation (the application of generative AI

[2] The argument is based on the Pirate Metrics Funnel, also known as the AARRR Funnel, which highlights the five key stages of customer interaction with a company: Acquisition, Activation, Retention, Revenue and Referral. Stages at the top of the funnel (Wider) focus on customer acquisition and activation strategies, while the bottom of the funnel (Narrower) focuses on retention, revenue, and referrals for active and paying customers (Maurya, 2016).

models to automate repetitive tasks and high-volume processes such as content creation, customer interaction, and data analysis) (Dwivedi et al., 2023) enables startups to achieve significant growth with minimal time, cost, and human resources. For instance, Bargoni et al. (2024a) illustrate the case of IKEA's use of scale-free AI systems (including pre-trained models capable of performing a wide range of tasks without significant modification and with minimal additional resources) in formulating its growth hacking techniques, namely viral marketing, A/B testing, referral programs, content marketing, social media engagement, and optimizing conversion funnels.

Second, growth hacking is often characterized by experimentation – running experiments to test the market effectiveness of a new product. Sanasi et al. (2023) view growth hacking as "a managerial approach to experimentation […] to reduce failure in technology-based startups and find novel combinations of knowledge" (p. 2). Their study proposes a process model of experimentation that begins with building a scaling roadmap and continues with running the experiment, analyzing the results, and revising the initial growth hacking strategy. Generative AI streamlines the 'experiment for scaling' process through content generation, enabling startups to quickly create and test variations of marketing campaigns, product messaging, landing pages, or templates, e.g., product rollouts. In addition, generative AI-powered data analytics tools such as Microsoft Power BI can improve scaling efforts by measuring marketing campaign performance, analyzing user patterns and behaviors, and using scenario modeling to predict future growth trajectories more effectively.

Third, growth hacking is verified with rapid and exponential growth. Scholars identify various techniques and methods to accelerate the process of growth hacking. Conway and Hemphill (2019) find it useful to create an MVP to quickly test business viability and seamlessly assess the fit between product and market. Generative AI can support the MVP development process by making product prototypes in a cost-effective and efficient manner and analyzing market fit by emulating customers for automated and immediate feedback (Fischer and Lanquillon, 2024). Bargoni et al. (2023) emphasize the need for a non-bureaucratic decision-making process for growth hacking success "to facilitate iterations in experimentation and to provide the necessary resource base to hire or train personnel" (p. 12). In addition, generative AI analytics tools like Qlik can streamline other stages of product development, including ideation and conceptualization, by suggesting design concepts or product ideas based on company data such as previous product designs, customer data including feedback and reviews, behavioral data and market research reports, trend reports, patents, employee insights, manufacturing and operational data, and additional sources such as social media content.

Fourth, scholars refer to data-driven decision-making when defining growth hacking. This involves the ability to quickly collect, process, analyze, and learn from big data, "data sets whose size (in terms of volume, velocity, value, variety, and veracity) is beyond the ability of typical database software tools to capture, store, manage, and analyze" (Yin and Kaynak, 2015, p. 143). Big data analytics capabilities enable informed decisions at low cost and high speed, minimizing the possibility of failure in growth hacking implementations (Bargoni et al., 2024b; Troisi et al., 2020). To optimize this data-driven decision-making, generative AI-powered data analytics, capable of identifying and analyzing thousands of data attributes simultaneously, are used to detect non-obvious patterns in the data required for effective strategies and decisions (Thakur and Kushwaha, 2024). Focusing on operational needs, for example, startups can use tools like Athenic AI to improve their operational systems, such as ERP (Enterprise Resource Planning). These tools improve forecasting by accurately predicting inventory needs, sales trends, and cash flow by analyzing historical data and external market conditions. They also enable advanced scenario planning by simulating different operational scenarios to help companies evaluate potential outcomes and make informed, proactive decisions.

As reflected in the above review, growth hacking in the age of generative AI can be better explored by focusing on the business lifecycle and corresponding growth approaches. Therefore, following an overview of the study's methodology, we present the findings from a multiple case study, which explain how startups and scaleups are integrating generative AI, with a special focus on growth trajectories. In addition to exploring the methods and implementation structure of generative AI solutions in startups, we also highlight the unintended consequences, since the introduction of such digital technologies can create entirely new paths that were not originally intended (Bohnsack et al., 2022). These pathways are crucial for addressing the social and environmental butterfly effects of generative AI on enterprise data-driven decision-making processes, particularly its key elements: data, drivers, and decisions (Pinkse and Bohnsack, 2024).

3. Methodology

3.1. Research design

The objective of this study was to explore "How can startups leverage generative AI as a growth hacking strategy for effective competition and development?". A qualitative design was chosen for its ability to explore the multifaceted and dynamic nature of the relationship between generative AI and growth hacking in the context of startups, allowing for deeper understanding, flexibility, and contextual insights (Bouncken et al., 2021). Therefore, rather than testing surface-level knowledge, such as the general use of tools like ChatGPT for content creation, we seek deeper contextual insights through interviews and probing questions about how generative AI technologies are and can be used by startups for growth hacking. A case study approach is adopted on the grounds that: (I) our main research question is an exploratory "how" question; (II) contextual conditions (startups integrating generative AI technologies into their processes and operations) were of fundamental importance in our research; and (III) the boundaries between the phenomenon (startups' growth hacking strategies) and context (generative AI solutions) were not evidently distinguishable (Yin, 2003).

3.2. Sampling and data collection

The research population included businesses based in Europe and the US that incorporated generative AI into their products and processes. This geographic context was chosen because of the large and diverse startup ecosystems that house a significant number and variety of startups across industries, allowing us to explore a wide range of AI business implications. The geographic focus aimed to capture diverse and dynamic startup ecosystems (Grilo et al., 2017) by including a combination of the US as an early adopter and leading ecosystem (Ellingrud et al., 2023), Germany as one of the European early adopters and established tech hubs due to its rapid technical automation adoption rate, i.e., the share of work time that could be automated (Chui et al., 2023), and Portugal as a growing and dynamic ecosystem in generative AI solutions that are transforming many domestic sectors, such as language service providers (Tavares et al., 2023). Consistent with previous research on AI in the context of the US and the EU (Cath et al., 2018), this focused geographic context allowed us to include a diverse AI startup ecosystem on the one hand, and to gain a more nuanced understanding of the different regulatory and legal environments, market dynamics and consumer behaviors, and technological infrastructure aspects on the other hand. More specifically, within the EU, insights from German startups as early adopters with a rapid adoption rate of work automation, alongside those from Portuguese startups that follow a latecomer and catch-up strategy, allowed us to better understand generative AI-enabled growth hacking in startups across leading, early adopter, and follower geographic contexts.

We used a combination of two purposeful sampling methods, namely intensity and snowball. This allowed us to first identify "excellent or rich examples of the phenomenon of interest, but not highly unusual cases"

(i.e. intense cases) (Patton, 2014, p. 234), and secondly, minimize sampling error by tapping into the word-of-mouth recommendations of detected intense cases (Creswell, 1998). To select the intense cases, we solicited advice from several relevant experts and tried to align the sample with our research objectives (Patton, 2014), so that we included startups that exemplified the use of generative AI for growth hacking. To avoid the risk of selecting highly unusual cases that may not be representative (Fletcher et al., 2018), we were careful not to include startups that underwent significant organizational disruption and restructuring, as they may have added biased data reflecting their own unique circumstances rather than their use of generative AI for growth. Although the findings of case study research are mostly applicable within the selected context, "to best generalize, however, the inquirer needs to select representative cases for inclusion in the qualitative study" (Creswell, 1998, p.74). Therefore, as highlighted in Table 1, we tried to include businesses of different sizes and funding classes in our sample.

Data were collected through in-depth semi-structured interviews. The questions were refined over the data collection process based on the feedback from participants (the interview guide is included in Appendix 1). Follow-up questions and probes were then formulated to bring more clarity to the statements. Carried out in English, and lasting from 23 min to 34 min, all 20 interviews were conducted face-to-face, tape-recorded, and then transcribed, with the exception of two interviews that were conducted via messages and voice memos. Conducted in February and March 2023, we continued interviewing until a theoretical saturation indicated by data replication or redundancy was achieved (Bowen, 2008). All in all, 20 participants were recruited from different positions, including CEOs and founders, CMOs, VPs of Marketing, Sales Executives, VPs of Growth, Managing Directors, Expansion Leads, and Principal Data Science Managers. A list of the interviewees, along with their respective affiliations and roles, is provided in Table 1. Respondents work or previously worked in senior executive roles ranging up to C-level management positions at Techstars, N26, Pitch, Soundcloud, Dubsmash, McKinsey & Company, Tesla, Mercedes Benz, GrowthHackers, IBM, Nutrium, Indie Campers, Seismic, Infosys Consulting, Johnson & Johnson Technology Group, PwC, Dubsmash, and L'Oréal among others.

3.3. Data analysis

First, we organized all the transcripts into a single structure and style to begin the data analysis process through initial coding and classification. The data was further coded following the Gioia Methodology (Gioia et al., 2013) and a three-step coding process: open, axial, and selective coding (Strauss and Corbin, 1998). The three main pillars of the methodology, which focus on data structure, data-driven model development, and systematic reporting of results (Magnani and Gioia, 2023), helped us guide the analysis from the initial general research goal of

Table 1
Sample profile.

Case	Current position	Previous position	Company size *	Funding stage	Location
Interviewee 1	VP Marketing	VP Global Marketing	Large	Investor/ Accelerator	Colorado US
Interviewee 2	CEO & Founder	Founder	Medium	$9.3 M Series C	New York US
Interviewee 3	VP Growth	CMO	Medium	$5M Seed	Lisbon PT
Interviewee 4	Co-Founder	Data Scientist	Small	$120 K Pre-Seed	Berlin DE
Interviewee 5	Head of Growth & Co-Founder	VP Global Sales	Small	$7.2 M Seed	San Francisco US
Interviewee 6	CEO & Co-Founder	Lecturer Marketing	Small	$120 K Pre-Seed	Tel Aviv IL
Interviewee 7	CMO	CEO & Founder	Small	Startup Incubator	Faro PT
Interviewee 8	Founder & Principal Data Science Manager	Managing Data Scientist & Member of Technical Expert Council	Large	Technology Consultancy	Munich DE
Interviewee 9	Founder & CMO	General Partner	Small	No funding	Copenhagen DK
Interviewee 10	Co-Founder & CEO	CPO	Small	$1M Pre-Seed	Berlin DE
Interviewee 11	Co-Founder	Head of Customer Success	Small	$800 K Seed	Paris FR
Interviewee 12	CEO	VP Strategy & Deployment Technology Group	Medium	Data and Technology Consultancy	Lisbon PT
Interviewee 13	CEO & Investor	General Manager	Small	Investor	Santa Cruz US
Interviewee 14	CEO & Co-Founder	Project Manager	Small	$120 K Pre-Seed	Zurich CH
Interviewee 15	Senior Mid-Market Sales Director	Team Lead Sales Development	Large	$170 M Series G	Bremen DE
Interviewee 16	Managing Director	COO	Large	$900 M Series E	Berlin DE
Interviewee 17	CTO & Co-Founder	CTO	Small	No funding	Hamburg DE
Interviewee 18	Expansion Lead	Senior Strategy & BD Specialist	Medium	$9M Series A	Lisbon PT
Interviewee 19	Director & Co-Founder	Co-Founder	Small	Startup Consultancy	Bengaluru, IN
Interviewee 20	Co-Founder	Partner	Small	No funding	Nashville US

* Note: Small businesses are defined as those with fewer than 100 employees, medium businesses as having 100–500 employees, and large businesses as having more than 500 employees.

exploring generative AI for growth hacking to the more specific goals of LLM-enabled growth hacking use cases across three startup growth approaches, required organizational capabilities, risks and challenges, and generative AI integration strategies for startups. We therefore began with an open coding to extract key concepts as first-order codes. A precise word frequency analysis of all interview transcripts (see Appendix 2 for the resulting word cloud and text mining analysis) helped us to better navigate the data and support the thematic analysis. This was followed by axial coding to identify the relationships between the initial codes and classify them into second-order themes. Eventually, the selective coding led us to refine the data by creating aggregate dimensions for further categorizing the identified second-order themes. The data structure was first created based on a preliminary analysis of the interview transcripts and then refined through a more in-depth analysis that included rereading the interviews with more attention to context and data patterns, memo writing and sorting, pattern identification, thematic mapping, and cross-case analysis (Fig. 1).

The results of the coding process are described in detail in the sections that follow.

4. Results

4.1. Emerging paradigms in startup growth: The nexus of product-led and sales-driven approaches with generative AI integration

The results of the data analysis revealed that in the rapidly evolving startup environment, generative AI is used under two main growth strategies: product-led growth and sales-led growth. In addition, we found that startups and scaleups use generative AI to enhance operational efficiency across the organization. Advanced AI models and tools offer a range of applications tailored to growth hacking approaches. In particular, based on a cross-case analysis for identifying best practices and context-specific factors, we arrived at the top use cases in each of the three categories (see Table 2). We found that for product-led growth, startups tap into generative AI for technical (eg., code development and organization) and non-technical (e.g., product documentation) content creation for rapid and cost-effective growth. When it comes to sales,

Table 2
Cross-case analysis for growth drivers and generative AI use cases.

Growth Strategy	Top 3 Use Cases and Examples
Product-led growth	– Personal coding assistant (GitHub Copilot) as a personalized coding co-pilot and intelligent helper to code as the user writes, including suggesting code completions, generating pull requests to share code changes with collaborators, and creating knowledge bases from technical documentation repositories – Code verification and validation (OpenAI Codex), for example detecting and solving code errors and bugs, or verifying that code conforms to Web standards such as security and privacy mechanisms – Non-technical text generation for Q&A, user stories, acceptance criteria, and product documentation (OpenAI GPT-3/4)
Sales-led growth	– Creation of promotional content that includes marketing elements such as SEO backlinks (AdCreative.ai) – Content repurposing for multiple marketing channels (Repurpose.io) – AI sales assistants for hyper-personalized outreach, such as AI chatbots for customer support that are trained on the startup's own custom data (Sirius AI by Insider)
Operational efficiency	– AI-powered ideation through developing, brainstorming, refining, and evaluating new ideas for market entry and growth tactics (Orchidea.dev) – AI market research assistant to characterize market-based indicators for geographic expansion as a growth hacking method for entering new markets (Quantilope.com) – AI assistants for customer event management, such as trade shows, exhibitions, and expos, to maintain close and frequent interaction with attendees in three phases – pre-event, event, and post-event – through activities such as sending reminders, updates, and notifications; capturing, transcribing, and reporting event notes; and follow-up communications (Inkdrop.app)

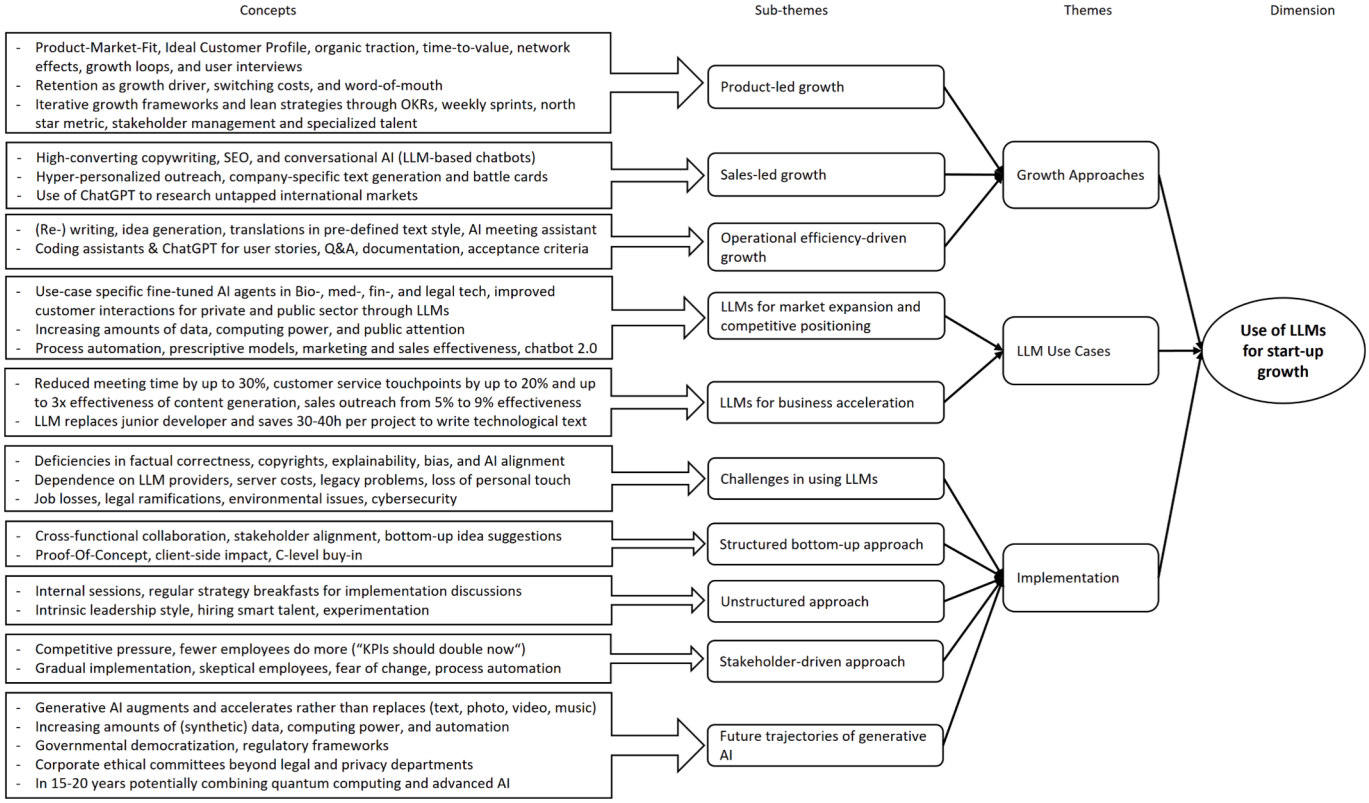

Fig. 1. Data coding structure following the Gioia Methodology.

generative AI helps them create and repurpose the promotional content needed to activate and engage customers, as well as to personalize the customer experience. Finally, generative AI has the potential for startups to outperform in market entry and early growth through market entry ideation, market research and analysis, and customer event management. In the following, we clarify these growth approaches and use cases with reference to the interviews and quotes.

Based on the results of our analysis, *Product-led growth* is the primary growth approach for startups in our sample. As Interviewee 10 highlighted, "the best way to grow in any channel for B2C and B2B is having growth embedded in the business model and in the product itself". Since the critical element of any startup is its product, with the goal of finding PMF, rapid and iterative product development based on user feedback is essential. Generative AI can support this by acting as a coding assistant, for example. This assistance allows faster iteration, followed by faster user feedback, which drives product-led growth. As mentioned by Interviewee 14, the founder of an early-stage tech startup in our sample, it is now possible to produce an MVP within a week using generative AI. The data shows that tech startups can write technical code and text much faster with generative AI. Our analysis also suggests that generative AI can effectively turn software code into product documentation, user stories, and acceptance criteria—essential components in the rapid development of new software products by tech startups. This allows developers in tech startups to automate the coding process and instead focus on more important and enjoyable tasks, such as the design and implementation of new growth hacking methods that best fit the startup's market entry and post-entry operations. However, Interviewee 17 in our sample emphasizes that prior knowledge is essential to using generative AI effectively for coding.

Unlike the product-led approach, *sales-driven growth* is characterized by the strategic use of content in sales and marketing. In contrast to startups, scaleups mainly focus on market expansion to grow. Based on our analysis, startups with a sales-driven approach use content to guide potential customers along the customer journey, often in a B2B context with larger ticket sizes (offerings with higher individual costs) where organic content marketing (creating and sharing valuable, non-promotional content) is needed to close the deal. Interviewee 3 highlighted the use of generative AI tools for targeted marketing and communications: "For high-quality outreach, you can now use one or two demos and generate like 100 personalized emails based on an analysis of all the available information about the recipients in GPT-3 or GPT-4 and generate really interesting content to put in the emails". Content creation and copywriting with generative AI can significantly speed up startups' marketing and sales processes. Interviewee 11 pointed to the use of generative AI to produce more engaging and impactful content at scale: "5% of our articles bring 95 % of the traffic, so the most important work is actually automating the process of finding that specific piece of content and making it very good". In addition, Interviewee 1 emphasized that marketers must embrace the value of generative AI in task automation, service personalization, and intelligent emotion (understanding and responding to customer emotions) to drive business success: "We will see more and more marketers using generative AI content, from blog posts to generating new ideas. Conversational AI will enable seamless and flexible interactions between computers and AI".

A specific generative AI use case for sales-led growth is the creation and rewriting of website content, as discussed by Interviewee 9. This is important as startups' marketing and sales processes need to be agile, cost-effective, and highly personalized to achieve rapid growth with limited resources. According to the interview, a marketer can use generative AI to come up with a list of headlines optimized for a high CTR (Clickthrough Rate). The marketing team can then generate a blog post outline based on the best headline and combine generative AI with human copywriters to write the full promotional article. This step of manual content editing is required to ensure high quality and factual correctness. Using generative AI, the published content can also be rewritten into several social media posts. In the next step, generative AI tools can rewrite the full article, which can be used as a guest blog article to drive backlinks for SEO. This process enables startups to create content up to three times more efficiently. Startups can also utilize generative AI for hyper-personalized content. One use case includes generating the first paragraph of a sales email based on the potential customer's personal information from the internet: "The LLM is mostly used for generating the first one to two lines in an email so that it's super personalized and does not look like a mass outreach" (Interviewee 4).

Furthermore, our analysis suggests that generative AI is pivotal in elevating the lower funnel metrics, particularly customer retention. Based on the results, retention was identified as a main growth hacking driver for startups. Hence, generative AI in customer service opens up new ways to increase these lower-funnel metrics. The selected startups in our sample leverage generative AI in different ways. For example, they use generative AI as the backend engine of their customer service chatbots, which are trained with the customer's own data to provide hyper-personalized purchase recommendations, reviews, and comparisons: "We are working with an accounting and tax service provider to build their LLM-based AI assistant that helps them provide feedback on some of the common questions they receive from clients" (Interviewee 5). This helps startups that suffer from resource limitations to optimize resource use and build strong customer relationships, differentiate themselves in a competitive market, enhance customer experience, and increase engagement, leading to rapid and exponential growth with efficient use of resources. In terms of infrastructure, the chatbot reduces customer service team touchpoints by about 20 % without human intervention. In addition, generative AI is used at the beginning of the customer journey. For example, a digital banking startup is using generative AI to challenge the dominant players and disrupt their traditional service models. Its machine learning automation capabilities improve the customer experience, making it easier and more effective for them to build and maintain credit, manage cash flow, invest, and save more. Furthermore, the startup uses a generative AI-powered chatbot that is trained on customer data such as income and bank account situation to recommend personalized solutions that they can afford. It can also detail possible strategies and steps for applying for loans and mortgages. One of the startups in our sample plans to use advanced chatbots for a 24/7 road service, and new features such as road trip planning and organization tools. According to Interviewee 8, generative AI is increasingly reshaping digital ecosystems: "In the digital ecosystem we want to create, the touch points with humans from the customer's perspective will be reduced to the bare minimum".

Across all these drivers, generative AI holds transformative potential in the customer-facing layer across various industries. According to our data analysis, the technology is expected to drive the development of many new products in the customer-facing layer, helping startups with first-mover advantages, innovation-driven growth, market differentiation, and customer-centric solutions. Wherever there are recurring patterns in data about customer pain points and competitor weaknesses, market segmentation and industry trends, product- or sales and marketing-specific characteristics, or external factors such as the regulatory environment, generative AI can help startups to process large amounts of such unstructured data for growth hacking insights and decision support. Interviewees cited specific startup examples of building new or enhancing existing products, including company-specific long-form content that can be turned into gamified microlearning quizzes to upskill employees (iBrainy), personalized outreach and customer acquisition (Creatext and Lyne AI), AI meeting assistants (Inkdrop), and growth experiment ideas derived from existing growth data (GrowthHackers). For example, Interviewee 6 pointed to the use of generative AI for employee training and assessment: "You can take a piece of text, like internal onboarding documentation, put it into the platform (powered by generative AI), and then with just one click you get a lot of quiz suggestions as microlearning content to be delivered to your employees' phones".

With respect to *operational efficiency*, our analysis suggests that

category-defining startups in particular, which aim to deliver unparalleled customer experiences through innovative business models, are increasingly integrating generative AI to optimize operational efficiency. Particularly for those seeking growth through geographic expansion, generative AI appears to be an indispensable asset in characterizing market-based indicators such as market size potential, consumer demographics, attitudes, and behavior, demand assessment, market entry barriers and competitors, the legal and regulatory environment (e.g., import/export regulations and taxes), economic stability and cultural aspects, local logistics, and technology adoption levels. For instance, one of the startups in our sample has integrated generative AI as a market research resource, providing information for market entry analysis to drive growth through geographic expansion.

Generative AI can also drive operational efficiency by processing large volumes of text, such as podcasts, specifically. It can create the transcript from a podcast episode, extract highlights, summarize them, create show notes, and then use this content to create a blog post: "You can infuse a lot of these tools into anything that you do, but because it is so new, people really haven't written the type of playbooks you need" (Interviewee 9). This efficiency allows for much faster execution than performing these tasks manually.

Generative AI-enabled knowledge management is one of the top business growth hacking opportunities identified in the interviews. Examples of leveraging fine-tuned models on specific knowledge management use cases include banking, fintech, and legal tech. This leverage can result in an accounting or legal AI assistant writing legal memos and querying case-specific legal documents such as shareholder agreements. These documents are often hundreds of pages long and require knowledge and time to comprehend. Generative AI facilitates interaction and communication with these documents. Even though these use cases do not directly affect growth, they drive operational efficiency for specific industries and show potential market opportunities for startups. As Interviewee 8 pointed out: "We have constant conversations with companies on how they can utilize LLMs for their benefit. Mostly it's about knowledge management, operational efficiency, acceleration of innovations, customer experience, employee experience, and personal experience". An example of a legal AI tool pointed out by Interviewee 13 is "Harvey.ai", a platform for the legal industry that leverages generative AI technologies to streamline legal processes and improve the accuracy of its advice to clients: "It is a GPT-based tool pre-trained on large amounts of data, including their legal memos, communication records, and internal documents, used to fine-tune this language model, so it's now like a sort of digital associate for law firms as a huge source of revenue". The effectiveness of these tools points to the opportunities that can be derived from any use case-specific data monopoly combined with generative AI.

Our data analysis also suggests that startups face multiple challenges in adopting generative AI technologies that need to be managed for effective implementation of the solutions. Table 3 details these challenges. In particular, fundraising will remain a key challenge for startups at all funding stages, as noted by Interviewee 9: "[Growth challenges] are speed and permissions, and once you get past that, it comes down to money". As illustrated, challenges such as operating and scaling in niche markets, grappling with unit economics, and navigating long sales cycles when selling to large enterprises can only be indirectly mitigated using generative AI.

Table 3
Top 5 growth challenges & LLM use cases as solutions.

Growth Challenges	LLM Use Cases
Over-reliance on paid marketing channels	SEO & Social-Media LLM content production & rewriting
Identification of customer and market needs and ICP (ideal customer profile)	LLM idea generation for hypothesis about ICP and pain points, market-entry analysis, and competition
Product differentiation	Development of LLM-based product features
Churn (when customers stop buying from the company over a given period of time)	Hyper-personalized outreach and offers to customers with a high chance of churn, chatbots 2.0 for customer service
Fundraising	Investor research assistant, the first line of the email for investor outreach

Our findings indicate that, for all of the LLM use case examples identified in Table 3, to achieve an accurate result, it is necessary for organizations to build capabilities around the AI implemented by guiding the AI in the right direction and providing context through tailored and precise prompts. For example, multiple prompts (prompt chaining) may be required to give the AI enough context to produce the desired result.

4.2. Mapping generative AI for startup growth: A use case framework

After examining the broader growth drivers and challenges, we developed a framework to identify specific applications and use cases where startups harness generative AI. The framework, called the AI Wheel (Fig. 2), summarizes how startups can apply generative AI to various activities during the growth phase at different stages of funding. Accordingly, creating product-related content and gaining go-to-market knowledge helps startups with product-led growth, while automating customer-facing activities and personalizing new services drives sales-led growth. For operational efficiency, given the scarcity of resources for startups, generative AI is being used to increase the productivity of human resources and lighten their operational customer relationship management tasks and workload.

4.3. Implementing generative AI in startups: Essential capabilities and strategies

Based on the results, we find that startups rarely follow structured processes compared to scaleups in terms of company-wide implementation processes. Specifically, of all the generative AI use cases, content creation and knowledge management present the most far-reaching opportunities for startups to accelerate existing processes or build new, improved products with which to grow the business. In addition, LLMs combined with AI image and video generation are seen as significant opportunities. Therefore, they are often planned to be implemented in business operations within the next five to ten years.

From a broader perspective, generative AI has the potential to dramatically change the way business and technology work, including significantly higher levels of automation. As an example, autonomous agents like AutoGPT are expected to become more mature and integrated into business operations. This integration will enable even more significant productivity gains through automation. Currently, software tools can be paired with AI through tools such as Zapier. Taking this one step further, by writing custom code with frameworks such as LangChain in Python, generative AI can be tailored toward company use cases with specific prompts and executed in prompt chains and bots. This pairing of the mentioned use cases in the AI Wheel allows a tremendous increase in the automation of business processes and thus a higher degree of integration of autonomous AI agents (self-operating AI-enabled software systems that perform intricate tasks without human intervention).

Interviewees 9 and 12 emphasized the combined power of AI and other technologies, such as AI and quantum computing. Based on their interpretations, in 15–20 years it may be possible to combine quantum computing power with advanced AI models to decode cryptography. LLMs have the potential to revolutionize business and technology by enabling more intelligent automation. Furthermore, all of the use cases demonstrate the increasing importance of prompt engineering, the process of crafting instructions that help AI models perform well on specific tasks. Other opportunities for combinatory AI include apps to design presentations (Tome App), graphs (ChartGPT), AI-generated music (Strofe AI), 3D modeling (3DFY AI), App, web & UI design

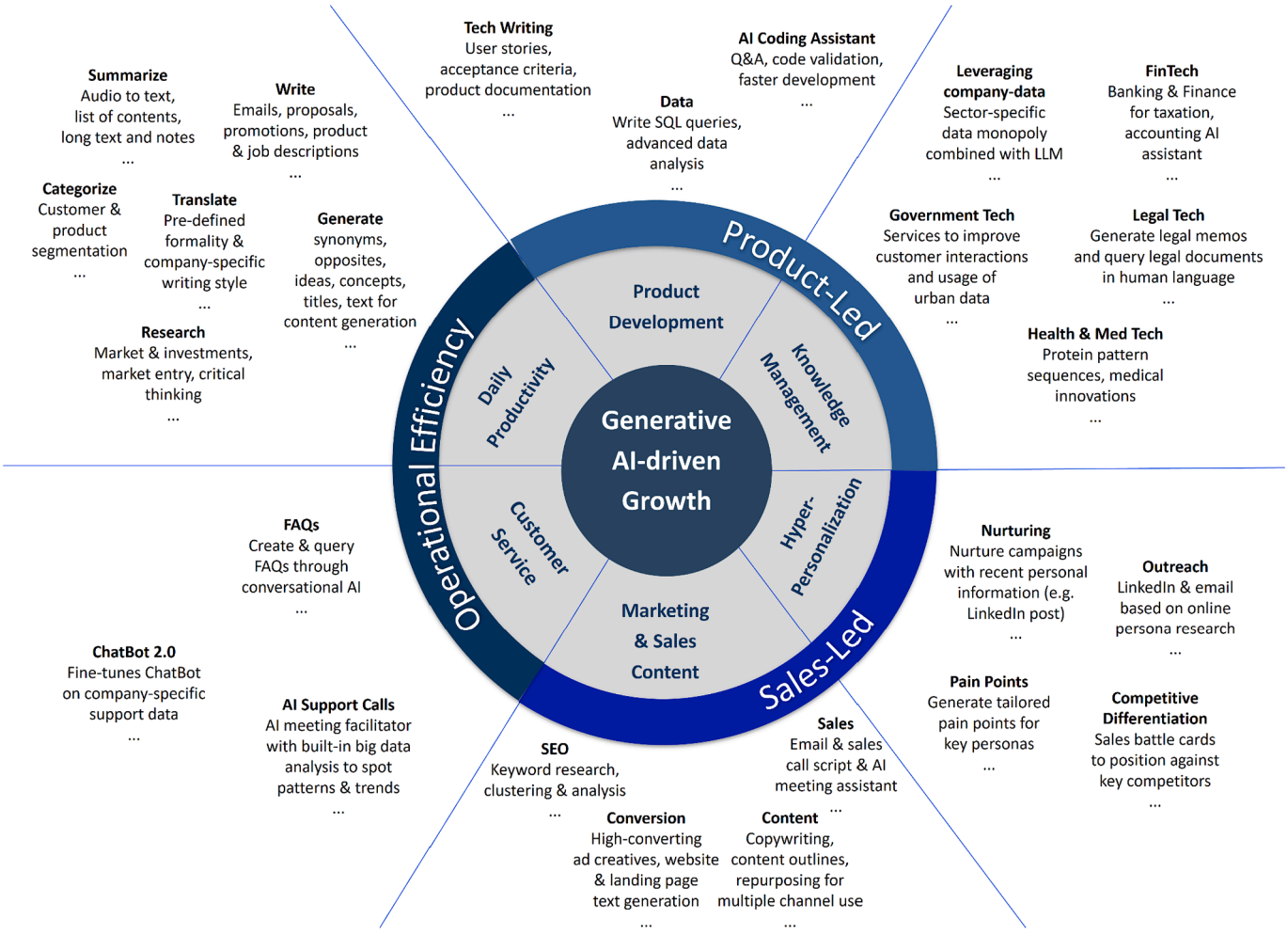

Fig. 2. AI Wheel: A framework to map generative AI for startup growth.

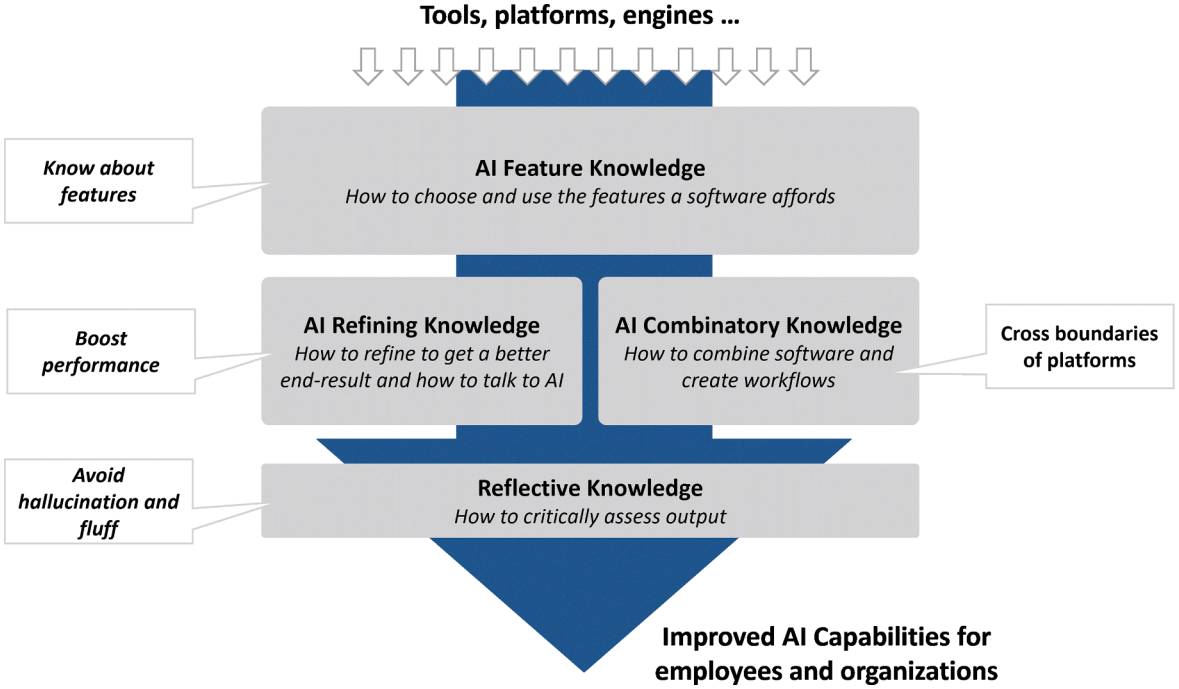

Fig. 3. AI capabilities framework.

(Uizard), and ad designs (AdCreative). Ample opportunities to drive innovation through generative AI are seen in climate tech, biotech, and chemistry, such as better CO2 emissions forecasts. In retrospect, it would have been difficult to predict the state of AI today. It is expected that startups will widely use generative AI in their business operations, thereby increasing their impact on society.

On the side of caution, in order to evaluate an unverified output in terms of factual accuracy, potential copyright infringement, and hallucinations, reflective knowledge is crucial to critically assess the AI output. According to Interviewee 18, "LLMs only boost productivity if the user can ask the right questions". For unique and novel problem scenarios, LLMs may run into problems due to a lack of context on the specific problem if it is a unique problem that has never been solved.

Based on a cross-case analysis of our sample, we developed an AI capabilities framework that clarifies the implementation structure of generative AI solutions in startups (Fig. 3). This is driven by interviewees' emphasis on the need for upgrading generative AI skills. For example, Interviewee 13 addressed the challenge of some employees lacking technological proficiency and emphasized the need for a structured approach to integrating generative AI technologies into business operations, ensuring that both managers and employees can adapt smoothly.

The framework shows that startups typically adhere to the implementation structure for company-wide processes built on *AI capabilities*. That is, startups must first build knowledge of generative AI-enabled features on their platforms, then refine that knowledge and learn how to combine different tools. In the third step, reflective knowledge is needed to combine AI with human intelligence to avoid AI hallucination (AI system misinformation due to potential flaws in the AI's training or missing data) and AI-generated filler content (content that is repetitive or formulaic in nature and lacks substance or relevance). In addition, managers adopt an iterative development of product features driven by customer feedback and continuous growth loops by building AI-driven growth hacking techniques into their products where possible. They then systematically adopt generative AI into the startup operation early in its lifecycle to gain a competitive advantage. The most promising implementation success factor identified is C-level buy-in and a structured bottom-up approach to idea generation. Management must demonstrate to employees that generative AI is accelerating rather than replacing their jobs to avoid fear of change among employees. Managers also need to be agile and quick to adapt to the faster pace of AI-driven market dynamics. Our results suggest that as AI-assisted business processes accelerate rapidly, markets will increasingly move faster. This means that strategic miscalculations and poor risk management can lead to severe consequences, including the potential for businesses to fail entirely. Overall, the AI capabilities framework follows a strategic and systematic approach to guiding startups in the integration of generative AI technologies.

4.4. Risks and unintended consequences of generative AI in startups

Despite the potential for startups, our findings also point to the risks and unintended consequences of generative AI solutions in terms of organizational, competitive, and societal risks (Fig. 4). First, with respect to organizational risks and ethical issues in AI, including data privacy and security, bias and discrimination, accountability, and

Fig. 4. Three-fold risks and unintended consequences of generative AI in startups.

intellectual property protection, our analysis emphasizes the importance of incorporating such ethical considerations into the implementation and use of generative AI in startups. For example, one of our sample startups highlighted the creation of an ethics committee within the startup to deploy safe AI that aligns with human values: "It's not about being legal anymore; it's about being ethical" (Interviewee 12). In terms of privacy and security, one interviewee compared generative AI tools to black-box systems, highlighting the uncertainty of how input data is accessed, processed, and stored. "It's a black box where you have no idea what's going on and who has access to your input data. So I will never share important data like my code base with any of these open-source tools and language models that sit somewhere in the cloud. The same goes for customer data, there is no way we integrate them into those tools and models" (Interviewee 17). Therefore it is recommended that only anonymized, encrypted, or aggregated data (free of sensitive information such as names, addresses, ID numbers) be fed into these systems to minimize privacy risks. Regarding AI bias, for example, one interviewee highlighted the issue of the representativeness of AI-generated content, which can lead to decision-making errors: "Biases in LLMs towards certain training data is very challenging […] the data models that are mainly trained for a Western or North American content, often lack relevance for other geographic contexts, so the knowledge base is limited" (Interviewee 5). Similarly, the quality of content or suggestions from generative AI-powered tools is not guaranteed, therefore the suggested strategies could lead to poor decisions and inefficient growth if not handled carefully. For example, one interviewee highlighted the uncertainty of quality monitoring in generative AI chatbots: "It's not very well monitored and checked for quality of what's written in a response. So the quality of the output can just be very bad" (Interviewee 13). To mitigate this effect, our analysis suggests fine-tuning AI models and solutions with human intervention to check and validate AI results: "Fine-tuning AI models is becoming very important because the models sometimes do not give you accurate answers. […] I believe that human intervention is necessary. With humans in the loop, the AI output can be validated to see if it's a valid answer or if there's bias, hallucination, or other problems" (Interviewee 5). In addition, the loss of personal touch when using generative AI is a concern: "If you rely too much on AI without enough human input, the content you produce will no longer be interesting" (Interviewee 7). Finally, the data analysis points to concerns about over-reliance on LLM providers: "I think we don't want to come off as overly reliant on generative AI, we still want to have people behind the systems that really know the products and services. And I think right now having a product that is dependent on someone else's language model is problematic" (Interviewee 9).

Another aspect is competitive risk, as competition pressures companies to develop and integrate generative AI. Technology is evolving faster than organizations and individuals are building use cases for it. Our analysis highlights the growing importance of *explainability* in LLMs, particularly in promoting transparent decision-making processes. For some startups, the ability to reproduce and understand generative AI-driven results takes precedence over first-mover advantages, as it builds trust and ensures compliance with ethical standards. Our results also suggest that competitive pressures will necessitate AI upskilling and reskilling of employees, which is a major concern for startups given their limited training resources and potential operational disruptions. Interviewee 2, for example, pointed to regular strategy meetings held at their company to review employees' skills in using generative AI tools: "We have regular strategy-focused key stakeholder meetings where we invite people from our various locations to come together and discuss our growth strategies, and last time we had a discussion around ChatGPT to understand who is using it and for what purposes". This is also a societal risk, as some skills will quickly become obsolete and new job functions will emerge across the organization, such as AI ethics departments, which are essential skills for an AI-driven future. This is underlined by one of the interviewees, who emphasized employees' concerns about job displacement: "People were standing up and shouting this is not going to take my job. I am much better than your tools" (Interviewee 9). This implies the need to train employees not only on different generative AI use cases and specific application areas related to their tasks, but also on the aforementioned limitations of the technology, such as inaccuracies caused by AI hallucinations, copyright protection, and so forth. Another interviewee pointed out the unintended consequences of AI automation on fraud: "Now marketers can combine automation tools with LLMs for faster results, but this could lead to a significant increase in spam emails that look very human, or can be used by bad actors for fraud. These can mimic human terminology and use information from the Internet, making them more realistic and harder to distinguish from real communications" (Interviewee 20). There are also references to the legal ramifications caused by generative AI-based automation: "It will be hard to really differentiate between AI automated mass emails and real human messages: Did someone actually sit down and think about how they could help me and then reach out to me? Or was it just some AI bots and automation?" (Interviewee 20). Finally, our analysis highlights the unintended environmental consequences of using generative AI, such as increased energy consumption: "If you do a Google search that's already like a couple of sets of energy costs. If you do a ChatGPT search, that's like 10 times more energy. And Yahoo or Bing are also implementing GPT, and Google too with Bart, then the future steps will use significantly more energy." (Interviewee 13).

Our data analysis furthermore sheds light on the growth trajectories of startups in the US and EU regarding their use of generative AI. In the US, the interviewees highlight the role of incubators and accelerators in mentoring and supporting managers and employees in the use of AI tools and techniques. Risks and challenges for US startups, which tend to target end-users, are more focused on market competitiveness, access to talent, technological disruption and environmental volatility. The interviewees in the EU emphasize ethical and regulatory considerations, such as compliance with legislation frameworks, including GDPR and the EU AI Act, among others. The interviewees from startups in Germany focus more on a B2B context, trying to improve knowledge management processes with a long-term view toward AGI (Artificial General Intelligence). They pointed out concerns about biases, inaccuracies, and high energy consumption, among others. The interviewees from Portuguese startups underline a more generic use of generative AI, such as for the creation of promotional content by sales teams, and predict a deeper integration of the technology into core business activities in the future. In addition, they highlight the creation of high-quality content rather than scaling up content production using generative AI. In terms of industry differences, the analysis suggests that tech startups are more focused on product development and innovation enabled by generative AI, including coding, testing, and user experience design. For marketing and sales startups, the use of generative AI is highlighted for creating highly personalized and tailored marketing content. Finally, in the healthcare and biotechnology sectors, startups use generative AI for research and data analysis of large data sets to identify patterns in medical data and generate insights for more accurate diagnoses and personalized treatment plans.

5. Discussion

In response to calls for research on the business implications of generative AI (Bandi et al., 2023; Dencik et al., 2023; Lucchi, 2024; Mariani and Dwivedi, 2024), this study sheds light on generative AI-powered growth hacking methods for startups and scaleups. Contributing to the findings of previous research that highlighted different approaches to startup growth, such as category creation (Yoon et al., 2011), digitally enabled business model innovation (Kulkov, 2023), and customer engagement and loyalty (Liu et al., 2022), our results suggest that to better understand the impact of emerging technologies on startups, it is important to focus on the specific growth approaches that startups choose to follow. Drawing on a literature review and our empirical results, this research focused on product-driven growth, sales-

driven growth, and operational efficiency.

For product-driven growth, in line with previous literature that stresses the importance of achieving PMF (Andreessen, 2007; Ries, 2011), our study finds that LLMs can support this by creating technical (e.g., coding, databases, and programming) and non-technical marketing content (e.g., acceptance criteria and product documentation). In terms of sales-led growth, and corroborating previous research on the importance of empowering sales teams to better understand customer needs and wants (Ainamo, 2007; Blythe, 2009), which leads to additional product sales (Papasolomou-Doukakis, 2002), our research explored how startups use generative AI to create and repurpose promotional content for multiple marketing channels and hyper-personalized outreach. Finally, regarding operational efficiency, our research adds to the findings of previous studies that highlight the importance of streamlining business processes (Dholakia and Kshetri, 2004) and reducing costs (Choudhary et al., 2019) for resource-constrained startups looking to move into the scaleup and established business phases. Overall, and consistent with recent research on the benefits of generative AI for the efficiency and effectiveness of marketing processes (e.g., Arora et al., 2025), we find that startups use the technology to improve their ideation, market research, and customer event management capabilities in a resource-saving and cost-effective manner.

In alignment with previous studies on AI for business growth, which also highlight the barriers, risks, and challenges (Mariani and Dwivedi, 2024; Stahl and Eke, 2024), we find that this is one of the main reasons why some startups are reluctant to use LLMs. In this sense, our research identifies the key organizational, societal, and competitive risks that startups face when using the technology, and the need to manage the unintended consequences of using generative AI for growth hacking. For instance, our findings on the need for startups to form AI ethics committees within their internal corporate governance structures corresponds closely with prior research on the risks of biased AI algorithms and systems (Buolamwini, 2018; Doshi et al., 2025) and Artificial General Intelligence (AGI) development risks (Ord, 2020), referring to "a machine with human-level intelligence […] that has learnt by itself to conduct a number of different tasks and has capacity to learn more" (Hogarty et al., 2020, p. 42).

6. Theoretical and practical contributions

Contributing to the extant literature, the identification of business-related drivers and barriers to growth hacking and generative AI use cases adds to the debate on the challenges and opportunities of using the technology for AI-generated content such as text (Moravec et al., 2024); AI's role in early-stage growth dynamics (Kulkov, 2023); and the double-edged sword effects of growth hacking on innovation failure within firms (Bargoni et al., 2024b). Additionally, the application of growth trajectories is novel in AI and machine learning literature, paving the way for future research efforts to understand the business aspects of generative AI implementation in different sectors. The AI Wheel framework adds to the relatively limited understanding of the role of digital transformation technologies, such as generative AI across multiple stages of the customer lifecycle (Conway and Hemphill, 2019). The identification of generative AI-driven risks contributes to the existing AI risk literature, which often addresses the risks of specific tools such as ChatGPT (Stahl and Eke, 2024) and focuses on isolated features or specific concerns, such as the protection of intellectual property (Lucchi, 2024). Finally, by providing insight into how LLMs can be leveraged to drive growth, a clearer and more specific understanding of AI's role in startup success is possible.

In terms of the implications for management, we first highlight the importance of managing the unintended consequences of new technologies (Nohria and Taneja, 2021) — in this case those caused by generative AI. Given that this work focused primarily on actionable use cases for startup growth hacking, it only partially touched on the unintended adverse effects of generative AI. Our results imply that the pressure for modern generative AI-powered solutions may justify the use of means and methods that could compensate for social and environmental costs. It is therefore critical that managers gain a clear understanding of how generative AI can trigger unintended consequences and identify and manage the potential risks associated with AI applications. Identifying the triple AI risks in this study (Fig. 4) as a first step helps explore areas where generative AI can make a difference in social and environmental value creation.

7. Conclusion

In this study, we set out to understand how startups can capitalize on generative AI applications as effective growth hacking strategies. We found that while the technology is still in its early days, generative AI is expected to deliver significant productivity gains and help drive growth. The study identified the top use cases for adopting growth hacking strategies across three approaches: product-led growth, sales-led growth, and operational efficiency-driven growth. Based on our data analysis, we discussed the growth hacking challenges faced by startups and proposed generative AI- and specifically LLM-enabled use cases to address them. To advance the understanding of the successful implementation of generative AI-powered growth hacking solutions in startups, we developed the AI Wheel framework to show how startups can use the technology over the different stages of funding. This was complemented by the AI Capabilities Framework to provide a better understanding of the implementation structure for startups adopting the technology as a growth hacking technique. These results suggest that generative AI, while still in its infancy, offers potential improvements in product development, revenue growth, and operational efficiency, and contributes to startups' growth hacking performance. Based on the findings, however, the unintended consequences of startups' use of generative AI should also be considered in order to effectively manage and mitigate organizational, competitive, and societal risks.

In light of this study, we propose several avenues for future research. First, the barriers and internal and external challenges to integrating generative AI into business operations, and thus promising use cases for startup growth, need to be further explored. Future research could explore how these challenges vary by industry, corporate characteristics such as size, ownership structure and maturity level, and funding stage. Solutions to such challenges need to be quantitatively validated through industry-focused research, such as fintech, banking, or legal scaleups. This may include large-scale surveys, experiments, and archival patent data to assess the effectiveness of generative AI-driven growth strategies for startups. Future research should also focus on the seed funding stage, allowing researchers to draw more specific conclusions about startups' seed fundraising, venture capital, incubators and accelerators, pre-money and post-money valuation, cash runaway, bootstrapping, and crowdfunding. While the AI Capabilities Framework developed in this study (Fig. 3) provides a structured approach for implementing generative AI technologies, future research can draw on the resource-based view and the dynamic capabilities perspective to clarify the multifaceted relationship between generative AI capabilities and growth hacking performance, as well as the moderating and mediating factors that influence it. Empirical studies could examine how startups develop and mobilize generative AI-related resources and capabilities to achieve sustained competitive advantages at different stages of growth. Finally, given the importance of the safe and responsible use of AI, it is essential to understand how problem-solving optimization methods, such as genetic algorithms, can help prevent discrimination through filters aligned with human values, to achieve fairness in relation to homosexuality, religion, and racism, among others.

CRediT authorship contribution statement

Arash Rezazadeh: Writing – review & editing, Visualization,

Methodology, Investigation, Formal analysis, Conceptualization. **Marco Kohns:** Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **René Bohnsack:** Validation, Supervision, Resources, Investigation, Conceptualization. **Nuno António:** Validation, Supervision, Resources. **Paulo Rita:** Validation, Supervision, Resources.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This research was supported by the European Union's Horizon projects: OMEGA-X (GA ID: 101069287) and exPEDite (GA ID: 101139527). Funding was provided to René Bohnsack and Arash Rezazadeh in support of their contributions to this work.

Nuno António and Paulo Rita were supported by national funds through FCT (Fundação para a Ciência e a Tecnologia), under the project - UIDB/04152/2020 - Centro de Investigação em Gestão de Informação (MagIC)/NOVA IMS) (https://doi.org/10.54499/UIDB/04152/2020).

Appendix 1. Interview guide

Interview guide with six key questions (Q1, Q2, Q3, Q4, Q5, Q6) + optional probing questions.

General approach to growth *(5 min)*

- **Q1**: **What is your approach to growth?**
  - Q1.1: Where does most growth for your start-up/scale-up come from?
  - Q1.2: What are the primary **growth challenges** you are currently facing?
  - Q1.3: Are you using any strategy or framework to drive growth?

LLMs as an approach to growth *(5 min)*

- **Q2: Do you use LLMs (such as GPT-3/ ChatGPT) for business operations?**

Implementation/adoption process *(5 min)*

- **Q3: Do you have a process for implementing LLMs in your business operation?**
  - Q3.1: *(If LLMs are not implemented):* Are you planning to implement LLMs as an approach to growth within the next 12-24 months?
  - Q3.2: *(If LLMs are implemented):* When did you start implementing LLMs?
  - Q3.3*:* Will this approach differ from your current growth strategy?

Impact *(5 min)*

- **Q4: What is the impact of LLMs on your growth?**
- Q4.1: Can you share any quantitative measures that show the impact of LLMs compared to not using LLMs?

Risks and Chances *(5 min)*

- **Q5: Do you see any risks or chances in using LLMs?**

Future outlook (5 min)

- **Q6: Where do you see generative AI in 5-10 years?**

Snowballing

- **Who else could I talk to?**

Appendix 2. Initial exploration of data through text mining analysis

Through text mining analysis, we developed preliminary codes or categories for thematic analysis. This guided code refinement and the identification of areas in the data (interview transcripts) that were considered important for further investigation. For example, as shown in the word cloud in Fig. A1 below, interviewees repeatedly emphasized the importance of "people". This includes all stakeholders, but especially employees, and the role they play in the smooth and effective adoption of generative AI technologies by startups. Other examples include the words "growth," "product,"

and "AI," among other commonly used keywords that align with the research objective and solidify the topic under investigation. It also reinforces the findings from our literature review that most startups focus on products for their growth rather than marketing and sales.

Fig. A1. Word cloud resulting from word frequency analysis of interview transcripts

In addition, a bigram and trigram text mining analysis (the association of 2 or 3 characters that appear consecutively in the data) led us to a better contextual understanding of the messages of the interviews and to realize the relationships and interconnections between concepts. For example, based on a trigram analysis shown in Fig. A2 below, LLM-based use cases are highlighted as driving startups' product-led growth and helping them better recognize and achieve product-market fit.

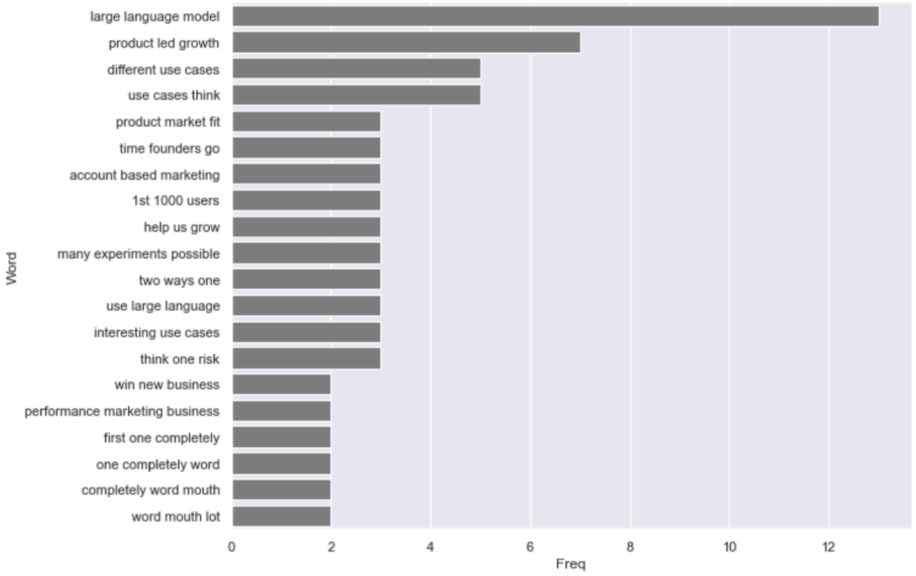

Fig. A2. Text mining frequency analysis – Trigrams

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