

Reimagining software engineering with GenAI

A Primer

GenAI is transforming various domains including software engineering. This technology enables high productivity, rapid development, and abundant innovation promising overall productivity gains of 26-30%. Embrace the future and discover the extraordinary potential of GenAI.

WHAT'S INSIDE!

- 1 An overview of GenAI's impact on the software engineering industry
- 2 A detailed prognosis of GenAI's impact on the software development lifecycle
- 3 Tools and useful technologies for GenAI-assisted software engineering
- 4 Future trends in GenAI for Software engineering



Key insights: How GenAI can impact software engineering

1 Improves productivity

GenAI presently enables an estimated ~28% (26% - 30%) overall productivity gain in general. A further annual productivity improvement of 10% - 12% is expected in the next 2-3 years.

Currently, gains from the implementation and testing phases contribute 84% of total benefits. Regardless, GenAI does speed improve task completion in various phases of the software development lifecycle [1] [2]

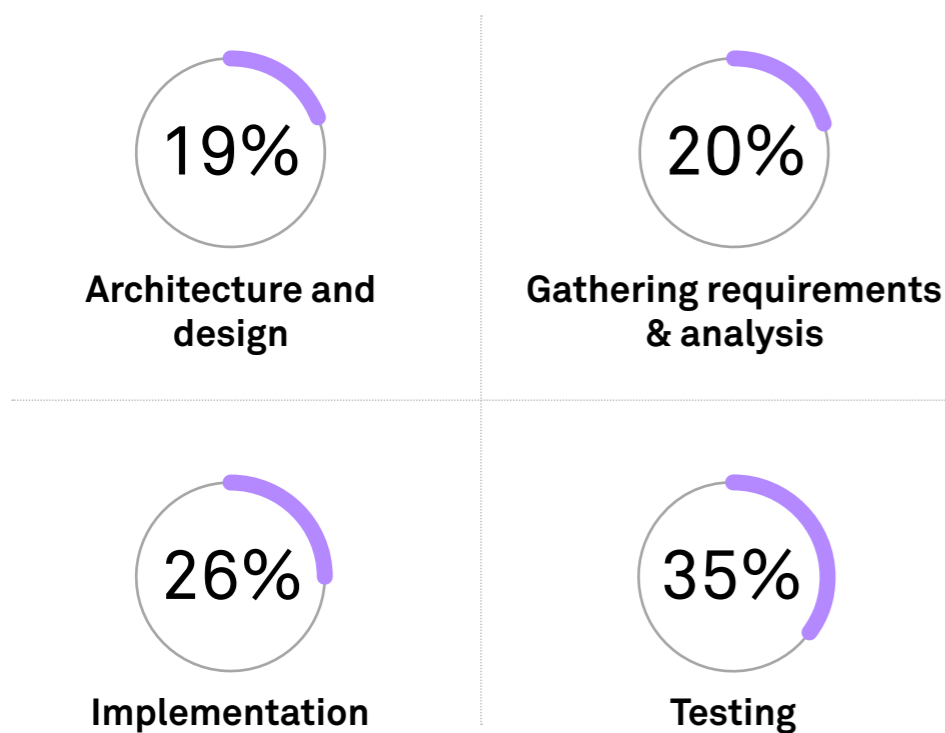
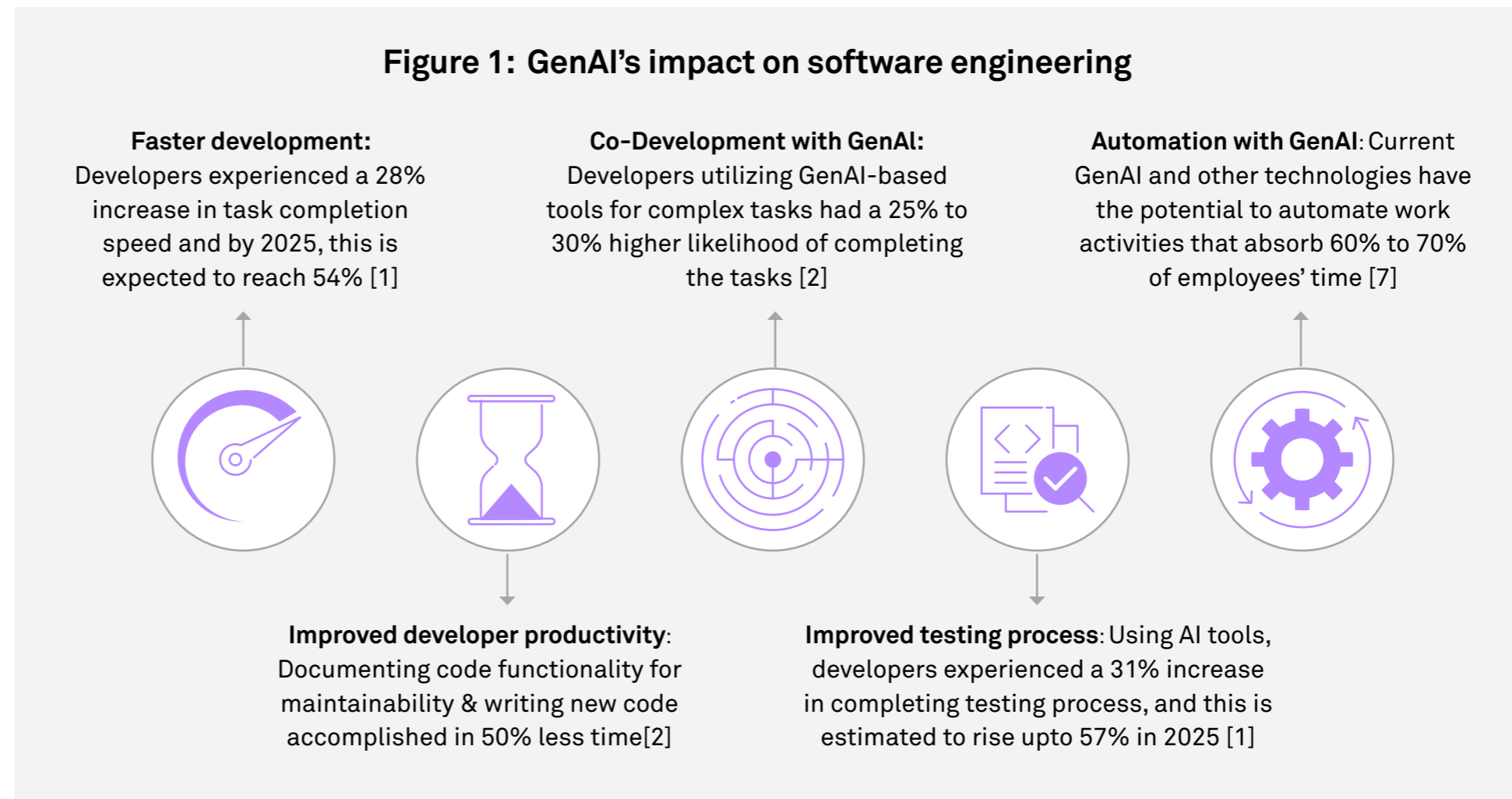


Figure 1: GenAI's impact on software engineering



2 Improves revenue and profitability

GenAI can benefit the software development industry with a nearly 25% - 30% increase in application development and maintenance revenue. This may benefit enterprises with a 5% - 6%

improvement in overall profitability. Further benefits can be accrued simply through staying up to date on the latest technology. If GenAI tools are not adopted, IT service providers may lose their competitive advantage.

3 Rising market size & share

The GenAI market is expected to grow at a 42% CAGR over the next decade, to an estimated \$1.3 Trillion USD. It's further expected to increase its share in overall IT spending from 1% - 10% by 2030 [3].

4 Industry-embraced

AI coding tools are already pervasive in the industry. Most developers believe they provide a competitive edge. Currently, 60% of software engineers believe that AI coding tools will provide them with a competitive edge [4]. GenAI tools help developers keep up-to-date on technology advances, effectively manage scope creep, and satisfy unclear requirements.

5 Labor shortage

There is expected to be a shortfall of 4 million developers by 2025 [5]. GenAI can assist in addressing this shortfall. It can automate repetitive coding tasks and generate code snippets. This enhances productivity and enables developers to focus on more complex and creative aspects of their work.

6 Strategy is necessary

A comprehensive enterprise-wide GenAI implementation strategy is critical to fully unlock potential productivity gains. This includes tool selection, conversations with customers (if necessary)

As GenAI tools automates repetitive tasks, developers can focus on strategic thinking and creative work; 60% of developers believe that GenAI coding tools give them a competitive edge.

and forming a vision, investment strategy, deployment strategy, and developer training roadmap.

7 Digital transformation, automated

Enterprises plan to adopt various emerging technologies such as AI, mobile, cloud, IoT, 5G and blockchain to gain a competitive edge and improve their efficiencies. GenAI holds the potential to improve and quicken digital transformation adoption through its ability to automate various tasks necessary to the process.

8 Boosts R&D

Incorporating GenAI into the R&D process may

improve R&D efforts by a significant margin.

Estimates typically fall between 10% - 15% of the overall costs [6]. Analysing vast amounts of data, AI-powered algorithms can identify patterns and generate unique insights that can drive breakthrough discoveries. The technology's iterative nature further promotes a culture of continuous learning, allowing teams to adapt quickly, refine their strategies, and accelerate innovation.

9 Supply-chain impact

Automating tasks, improving efficiency, and continuous innovation all impact the industry supply chain. GenAI-powered solutions can improve industry bottlenecks and help engineers' upskill their careers.

10 Challenges in implementation

Detailed study needs to be conducted on various factors such as initial installation effort, resource training, associated license cost and approvals, before enterprise wide implementation. Also, productivity benefits depends on various factors such as programming language, requirements, AI tools, technology integration, project scope and implementation phase. It is also important to consider the need for continuous fine-tuning models and to establish a process that involves both humans and AI co-pilot tools with checker and maker roles.

GenAI's impact on the software development lifecycle

2.1 GenAI's application to the various phases of software development

As a co-pilot development tool, GenAI can accomplish the following:

- Generate code, explain functionality and provide guidance on libraries & classes
- Improve code quality with automated refactoring and commenting
- Simplify code structures and suggest alternative solutions
- Translate code languages
- Auto-generate unit tests and accelerate debugging process
- Draft technical documentation
- Detect and repair bugs for software security
- Optimize UI design and performance

Leveraging GenAI enables developers to optimize their time and resources, code excellence, and the realization of project goals. It's estimated that AI's direct impact on software engineering productivity might account for a 20% - 45% reduction in annual expenditure [6].

Although software engineers may be the primary beneficiaries of GenAI within the broader software industry, other teams may also derive substantial advantages. GenAI tools can assist architects and consultants in the creation of new designs and prototypes for IT solutions. Sales teams can use the technology to generate novel customer insights and price predictions. Other important use cases remain, and many will be discovered over time.

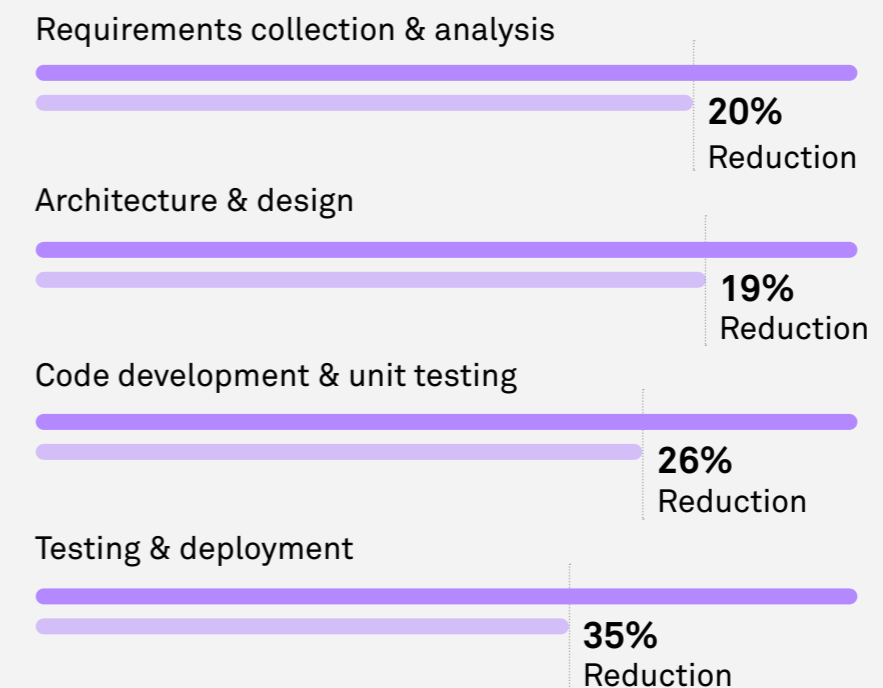
Employing GenAI has markedly reduced the duration of task execution across various software development stages, as noted in the previous section. The diagram on the right illustrates the efficiency gains attributed to GenAI throughout the software development lifecycle. Additional commentary details the ways that GenAI can impact every stage of software development.

Requirement collection and analysis

GenAI can help gather and analyse requirements from multiple sources, assess feasibility, and identify potential conflicts to minimize risks and ensure

smoother development. This enables greater clarity on project schedules, more accurate projections of deliverables, and better mitigation of scope creep. Improved requirement management can reduce costs and benefit project outcomes.

Impact of GenAI: Change in task completion time



Architecture and design

Developers can leverage GenAI to analyse codebases and generate new architectural designs, informed by learned patterns and best practices. The technology allows for an exploration of alternative configurations and optimal scalability, performance, and maintainability solutions. GenAI can also assist in visualizing and simulating decisions, enabling informed and validated design choices prior to any implementation.

Code development and unit testing

GenAI models can be used to generate new programming code, complete partially written code, or even translate code from one programming language to another. Automation of code snippets and components streamlines software development, reduces errors, and enhances efficiency. However, it does remain necessary to review the generated code before deployment.

Testing & deployment

GenAI models analyse large amounts of data, including existing test cases, code repositories, and user inputs, to best understand the behaviour and patterns of the software being tested. After learning from this data, GenAI models can generate new and unique test cases that cover a wide range of scenarios, including both expected and improbable

cases. GenAI can also leverage its analysis capabilities to detect and fix bugs efficiently.

Use of custom-built accelerator with GenAI

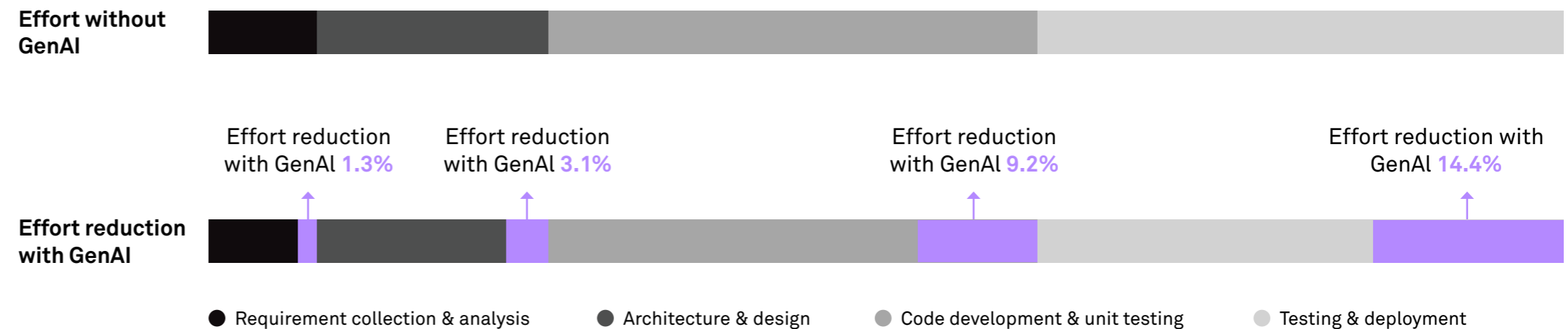
The introduction of code generation tools can have ill effects of non-adherence to standards, lack of validation like using outdated APIs, and the emergence of new patterns of errors. To mitigate these issues, the Maker-Checker custom framework is an innovative way of code development, where the power of AI is leveraged with process rigour to minimize the negative effects of prolific code generation. The Maker Pod uses GenAI tools for solution design, code generation, and automated unit testing. The Checker Pod performs Compliance, Malicious code, and functionality checks to ensure productivity and mitigate issues.

2.2 Is GenAI the ultimate effort-reduction tool?

Each phase in the software development lifecycle requires a significantly varied amount of effort or human intervention. For example, the architecture phase involves complex tasks that require human intervention, while the code development phase is less complex and thus requires less human intervention.

We have derived the GenAI effort reduction potential of each phase through a consideration of a weighted average of both current effort and possible effort-savings for each phase. The diagram below showcases life-cycle-wide efforts required across each phase, both with and without using GenAI.

Effort reduction with GenAI



While some phases may be more impacted than others, developers are still be able to save time and effort in every phase through the use of GenAI tools.

As mentioned in section 1, and showcased in the diagram on the right, implementation and testing phases account for a 23% effort reduction— and 84% of total effort savings across the lifecycle.

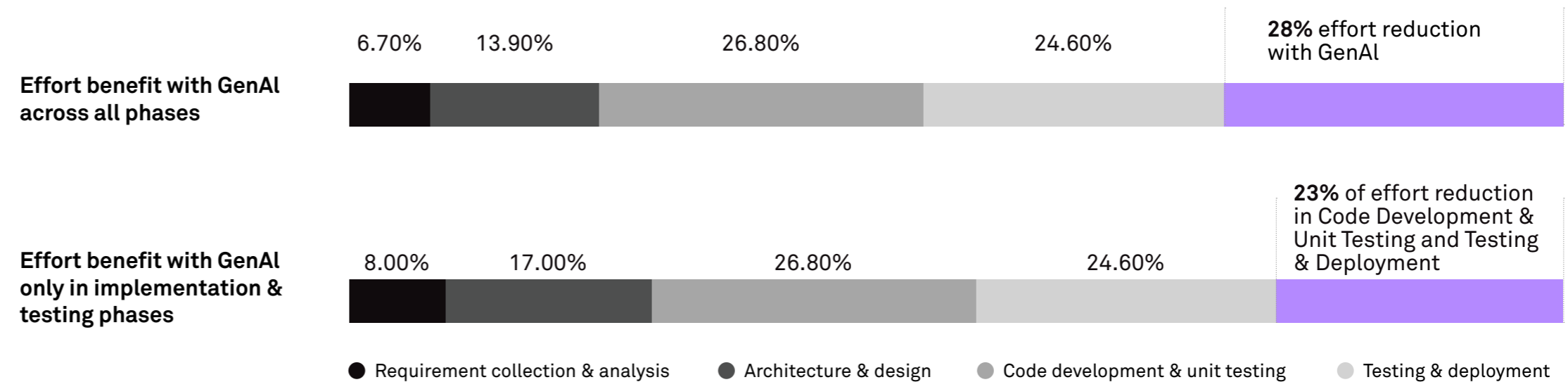
For example, in legacy migration projects, there has been credible results in technical debt reduction with GenAI tools– effort reduction by 50% in .NET migration from 2.0 to 6.0 and by 25% in cases of .NET to core 6.0.

In the following subsections, we will dive deeper into GenAI’s implementation and testing effort-saving capabilities.

2.3 Diving deeper: Code development and unit testing

- GenAI models enable developers to expedite programming tasks by generating code through natural language prompts, suggesting completions for partially written code, and even facilitating code translations between programming languages. However, it remains necessary to review this auto-generated code before integration into production to ensure its precision and efficiency.

Effort reduction with GenAI



- GenAI can facilitate faster migrations through IDE tools for various languages such as .net, VB and classic ASP 2.0 with 20% - 30% productivity improvement. In addition to this, custom-built accelerators with GenAI can provide additional benefit of 10% - 15%.
- GenAI improves code documentation speed by 45% - 50% and boosts code generation by 35% - 45% [2]. It’s equipped with features for advanced code completion, swift prototyping, multi-language code creation, and the ability to produce code from plain text directives.
- GenAI has capabilities for natural language code

summarization, automated code refactoring, and simultaneous code translation and documentation.

- Developers harnessing GenAI also stand to gain from its automated and fine-tuned software deployment processes, proactive error detection, predictive maintenance, intelligent troubleshooting, and recommendations for problem-solving.
- Developers must follow best practices and get trained on tools such as Co-pilot, IDE platform new features, enhancements to utilise the capabilities of GenAI. For example, Co-pilot adoption in projects, has seen effort reduction up to 30% for back-end Spring boot.

2.4 Diving deeper: Testing & deployment

- GenAI tools streamline the developer experience by automating testing processes, accelerating code generation, and completing existing code sections. Notably, GenAI's proficiency in rapidly and accurately analyzing vast code volumes surpasses the time-intensive manual bug identification methods.
- Platforms like GitHub Copilot leverage GenAI algorithms to offer context-aware code suggestions and solutions. This AI integration efficiently detects and rectifies bugs by combing through extensive data sources, including user inputs, code databases, and pre-existing test scenarios.
- AI-powered tools automatically generate, prioritize, execute, and review code tests. This not only expedites the testing phase but also enhances test coverage and efficacy. GenAI based solutions can also help in test suite optimization by identifying duplicate test cases and aid in effectively reducing the test cases suite size. With GenAI, software testing can be 15% - 30% faster and achieve 40% improved quality efficiency [7].
- GenAI's multifaceted offerings encompass code quality improvement, automated test suite and data generation, test automation, test case and

report generation and documentation, software output analysis, and iterative learning. For example, adoption of GenAI for testing phase has effectively shown 30% effort savings.

2.5 Comprehensive enterprise strategy: Adoption and implementation

Enterprises need to create and adopt a comprehensive GenAI strategy [8] to fully leverage the technology.

Steps for enterprise leaders entail the following:

- 1 Enterprise leaders must first formulate and guide development teams through a shared strategic vision. They must communicate outcome-based goals and design a comprehensive approach. They will form hypotheses towards achieving goals, while allocating investments based on a risk-reward framework.
- 2 Gather feedback and insights, and further clarify their vision, expected outcomes, budget capacity, and communications with key stakeholders.
- 3 Create an implementation strategy targeting the highest-leverage phases of software development. Most likely, these will be the implementation and testing phases.

- 4 Research popular and effective tools. Select the most useful for enterprise-particular need and budget. Leaders must consider cost, accuracy, privacy, and security factors to ensure the selected tools are appropriate and seamlessly integrate with existing development environments.
- 5 Develop a comprehensive deployment plan for the integration of GenAI tools throughout the software development process. Leaders must establish a policy that addresses concerns around privacy, security, and compliance with laws and regulations.
- 6 Invest in the resources and training necessary for developers. Leaders will ideally encourage curiosity and questioning, provide opportunities for experimentation, and reward creativity and innovation.
- 7 Obtain internal approval from all necessary stakeholders, particularly customers, before implementing desired tools.
- 8 Continuously monitor and evaluate the impact of new GenAI tools on both productivity and end-quality. Review customer satisfaction and developer feedback, and correct course accordingly.

Tools, and useful technologies for GenAI-assisted software engineering

3.1 Integration of GenAI with DevOps

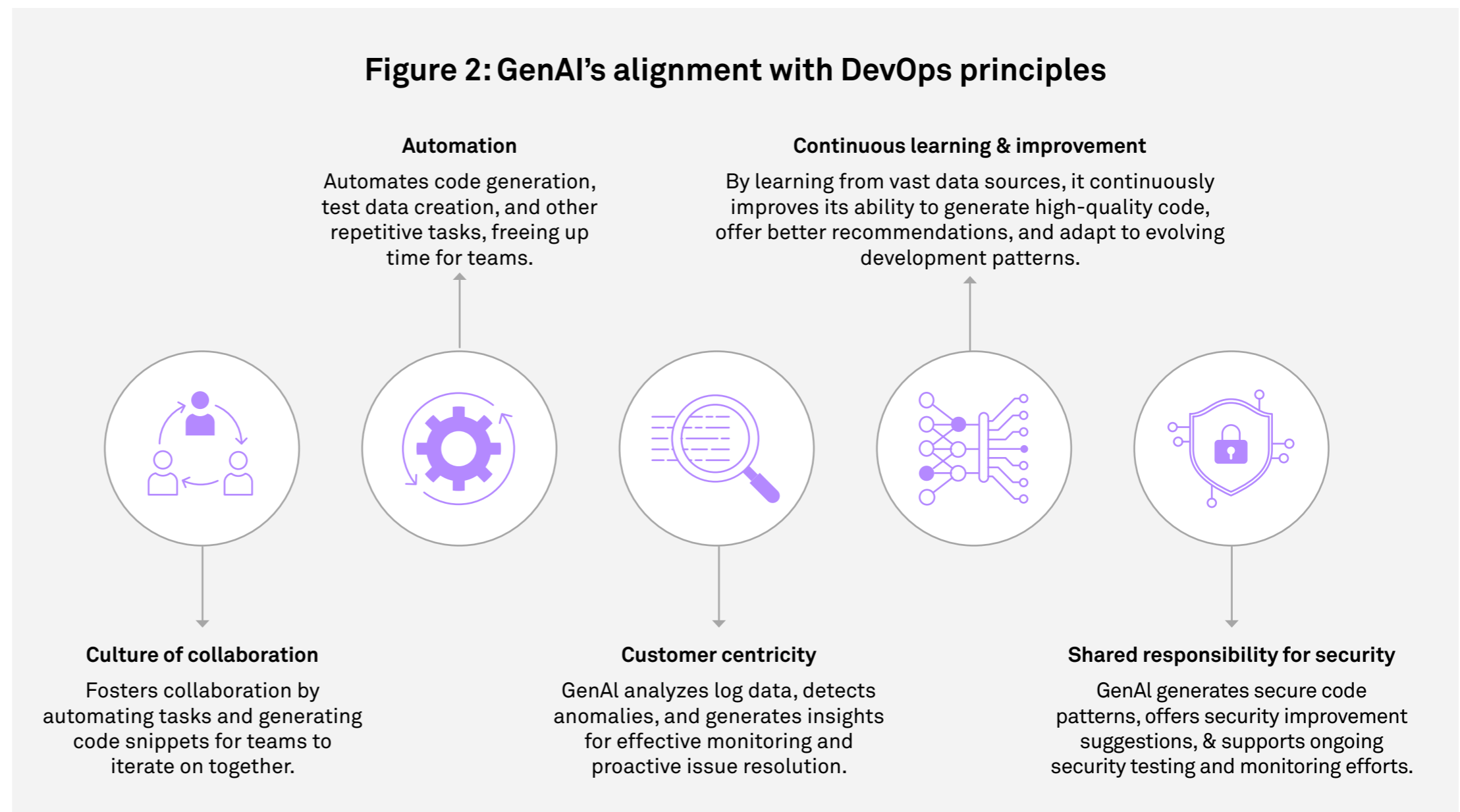
GenAI models resonate with most of the DevOps principles [9], due to their ability to generate content, automate tasks, and provide intelligent insights.

Adopting GenAI in the DevOps Software Development Environment can further increase productivity via script generation, config management automated monitoring and alert generation of prod, dev and testing environments, synthetic data for pipeline load testing to prevent downtime to accelerate time to release and improve customer satisfaction.

3.2 Impact of GenAI on Low Code No Code platforms

GenAI can complement and enhance Low Code No Code (LCNC) capabilities in general, but will not render them obsolete.

Figure 2: GenAI's alignment with DevOps principles



Using GenAI, LCNC platforms [10] can:

- **Integrate visual developer interfaces**

Developers can use GenAI to refine outputs through natural language. An example of this can be found in Microsoft’s Power Apps.. Power Apps now include ChatGPT-based capabilities, such as a chat interface that enables users to create a basic application through conversation.

- **Quicken development cycles**

Integrating GenAI into LCNC platforms enables more capabilities for non-technical users, allowing them to develop desired outputs faster. They can now converse with GenAI tools to quickly find solutions.

- **Create text and multimedia assets**

Developers can leverage GenAI to rapidly create text and multimedia assets to enhance their no-code and low-code projects and improve adoption.

3.3 Key platforms for code generation

Assessing the GenAI coding tools are essential, and a reliable dataset is crucial for benchmarking process. For example, OpenAI’s HumanEval dataset [11][13]. In addition, customer-specific standards should also be considered.

Popular platforms

#	Platform	Description
1	Copilot by GitHub (Collaboration with OpenAI)	An AI-enhanced collaborative coding editor, fueled by OpenAI Codex, that transforms everyday language into coding instructions. This tool offers code suggestions and adapts itself to the programmer’s unique style. It seamlessly works with various programming languages and taps into a rich database of public code repositories, excelling at generating foundational code.
2	CodeWhisperer by AWS	Machine learning-driven code generator that assist developers in identifying code defects, providing suggestions for improvements, and automating code reviews.
3	ChatGPT by OpenAI	Not specifically designed for code generation, it can be utilized as a creative tool for assisting with code-related queries, providing explanations, and aiding in problem-solving. It has a broader focus on natural language understanding and generation.
4	Vertex AI by Google Cloud	Google Cloud’s Vertex AI presents Codey APIs for code generation, chatbots, and code completion. It features Vertex Accelerate ML for unified data and AI, allowing developers to create GenAI apps with Model Garden and GenAI Studio. While specific code generation features may not be as advanced as dedicated tools like GitHub Copilot, it offers the flexibility to build tailored solutions.
5	TabNine By Codota Dot Com Ltd.	AI code completion tool that uses deep learning algorithms. It offers automated code completion, syntax highlighting, and integration with popular IDEs

Other popular tools include Replit GhostWriter, AI2SQL, Codeium, and AlphaCode - these are also widely used to generate code and improve productivity.

Future trends in GenAI for software engineering

4.1 Future trends

The field of code generation using AI is constantly evolving, and there are many exciting future possibilities. Here are some trends to expect in the future [12]:

- **Advanced NLP capabilities**

Developers can leverage NLP technologies to craft innovative applications with natural language interfaces. Integrating NLP with machine learning and computer vision, they can create advanced applications that interpret and react to human language. Further, ethical practices in NLP enable developers to create just and impartial applications in line with ethical standards, fostering the responsible use of AI.

- **Context-Aware code generation**

Leveraging AI tools, developers can gain deeper insights into the context and nuances of programming tasks, leading to more precise and context-sensitive code creation. This progress results in more intelligent and customized code

recommendations and solutions, significantly enhancing the development process's speed and precision.

- **Enhanced human collaboration**

AI-powered collaboration revolutionizes the landscape of software development, fostering effective teamwork and improving creativity amongst developers. With real-time code suggestions and conflict mediation, AI tools can simplify the integration process among multiple developers. Merging AI-driven code with human ingenuity allows developers to better intertwine their distinct problem-solving abilities and specialized knowledge. This fusion sets the stage for innovative solutions and an enhanced development process.

- **New careers**

As AI becomes more prominent in software development, new roles will emerge for experts specialized in training and fine-tuning AI models

to ensure optimal performance and reliability.

Additionally, roles centered on prompt engineering will focus on designing precise instructions or cues to obtain the preferred outputs from AI models. Professionals skilled in prompt engineering will be crucial to enhancing AI-generated code's output quality and accuracy.

4.2 The future of programming

GenAI is rapidly transforming both the software and broader technology industries.

As GenAI attains greater ubiquity within the software engineering industry, software developers will undergo a paradigm shift in their roles and opportunities. They must stay ahead of the curve.

It is necessary to train developers in the use of GenAI, as this will equip them with the skills needed to identify the most suitable tools for their objectives and to integrate them efficiently throughout their software

development process. Additionally, effective training helps developers gain buy-in from all stakeholders.

Of course, monitoring the impact of GenAI tools on productivity, quality, and customer satisfaction will be essential. It's not likely to disappoint, either.

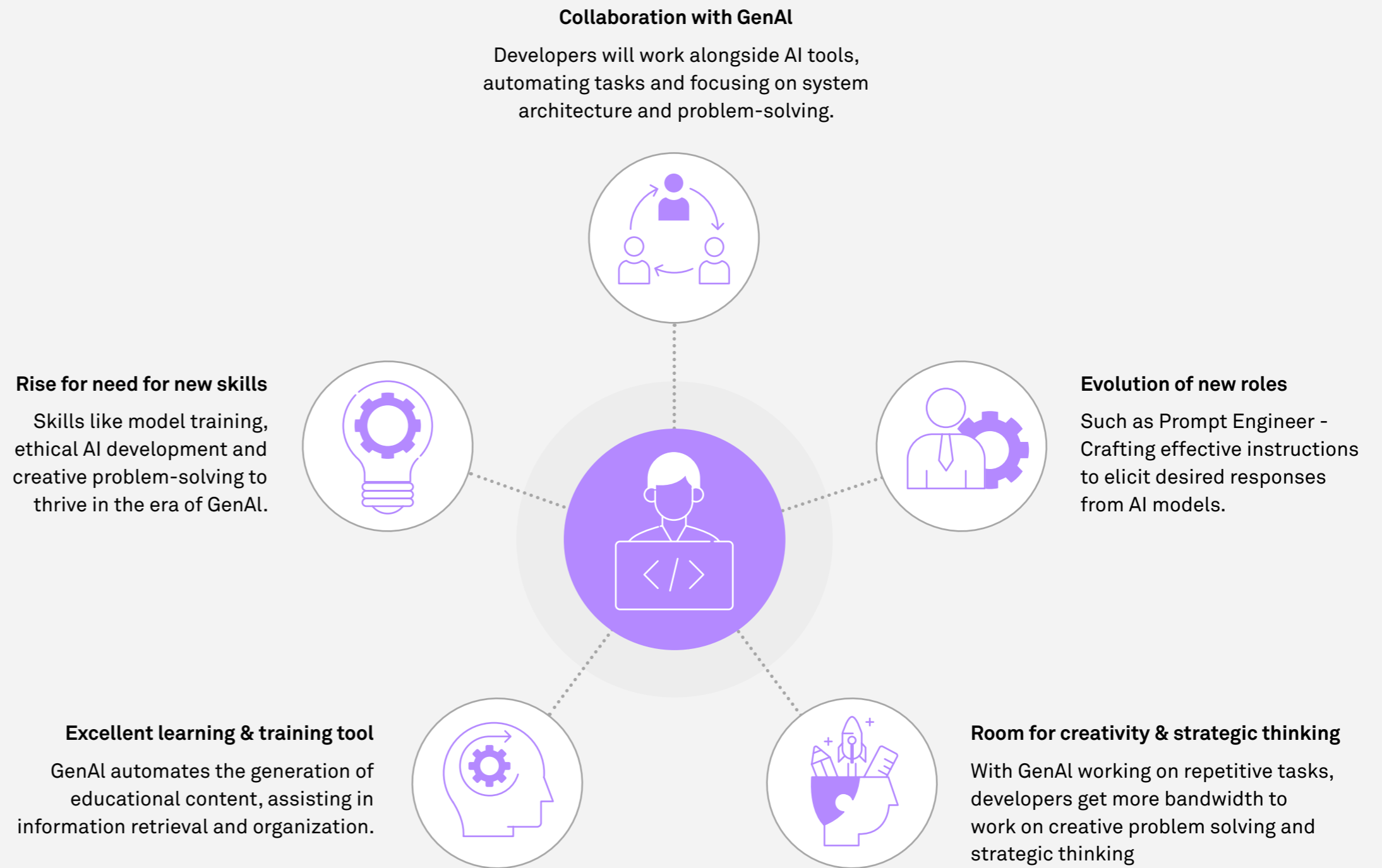
As AI advances, it will become increasingly essential to the development process, allowing developers to create more complex and sophisticated software than ever before. With GenAI comes both new challenges and opportunities for innovation and creativity.

As AI-assisted code generation continues to evolve, customized benchmarking that is contextualized to customer environment remains crucial in refining and optimizing the GenAI tools, fostering greater productivity and efficiency in software development.

Enterprises must formulate a comprehensive GenAI Strategy. We believe they will benefit most from an incorporation of GenAI tools in implementation and testing phases of software development lifecycle. This will maximize development cost and effort savings, along with quality improvement.

Note: The data points and insights mentioned in this document are based on Wipro's experience in multiple projects and also derived from secondary research data.

Figure 3: Future of programmers with GenAI



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