

The art of software

THE NEW ROUTE TO VALUE
CREATION ACROSS INDUSTRIES



#GetTheFutureYouWant

Executive Summary

Software is a strategic capability, transforming the way businesses design their products and services, function, compete, and provide value to their customers.

In today's rapidly evolving business landscape, every company must become a software company, regardless of its industry or sector. A significant 62 percent of organizations concur that software offers them a competitive advantage. Nearly 60 percent of organizations agree that software-driven transformation is now a board-level topic.

To stay competitive, organizations are accelerating their investments in software transformation:

Our research shows that, on average, nearly 18 percent of R&D budgets are spent on software-driven transformation. Moreover, 60 percent say their investment level is likely

to increase by 2025 (by 9 percent from current levels, on average).

Generative AI will accelerate software transformation:

Our research shows that 72 percent of organizations will use Generative AI to augment software engineering in the next 12 months. Moreover, Generative AI will assist in writing 1 among every 5 lines of code in the coming 12 months.

Successful transformation has immense revenue potential – quadrupling by 2030:

Organizations expect software-based revenue as a share of total revenue to grow to nearly 30 percent (in FY 2030) from 7 percent (in FY 2022). Leading organizations are already enjoying benefits from software-driven transformation, from faster R&D to cost reduction and improved customer experience.

Executive Summary

To realize a successful transformation, organizations should follow a comprehensive approach based on six pillars:

- 1. Strategize:** Organizations need to align their software investment with their overall strategy to assess how the former can enhance their products and services; deliver value to their customers; and bolster their competitive positioning. Additionally, demonstrating a tangible ROI is crucial to securing management buy-in.
- 2. Design:** Today, only one in three (34 percent) organizations uses customer insights to adapt their software product and services design. A focus on adaptive, human-centric design, which can be adjusted in response to customer feedback, ensures relevance and competitiveness and promotes ongoing improvement. An architectural framework that focuses on standardization, modularity, and scalability is also essential. Organizations should integrate sustainability into software-design decisions to optimize data structures.
- 3. Collaborate:** To transform into a true software organization, they must identify key software frontiers where partner support is required; assess existing suppliers and partners; and nurture long-term strategic partnerships with a range of ecosystem players. Collaborating with strategic partners can introduce the expertise and agility required to capitalize on the benefits of software-driven transformation. Internally, fostering a software-centric and collaborative culture is key.
- 4. Strengthen:** Organizations also need to establish a comprehensive strategy to acquire critical skills related to software engineering, cloud and data, cybersecurity, and artificial intelligence (AI). Organizations expect 39 percent of their workforce to be in software-based domains within the next three years. To merge the industry skills with the new software skills, they need to develop centers of excellence capable of supporting intensive training programs.
- 5. Organize:** Organizations should focus on building a model around software products and services. This will involve a combination of strong autonomous teams;

Executive Summary

the model should be split by production or service perimeter; driven by client satisfaction; and apply agile and lean management principles, such as transparency, empowerment, collaboration, iterative delivery, and experimentation.

- 6. Streamline:** Integrating agility with standardized software factories, which endorse continuous integration and the utilization of standardized application programming interfaces (APIs) and micro-services enhances efficiency and value realization. As organizations integrate Generative AI into their software journeys, it is imperative to develop a clear vision, strategy, and roadmap for prioritizing use cases. Additionally, there is a requirement to bolster testing capabilities and establish guardrails to ensure responsible and effective usage of Generative AI in software engineering.

60%

of organizations agree that software-driven transformation is now a board-level topic.



Who should read this report and why?

This report offers recommendations that organizations across industries may act upon to help them achieve success in a software-driven future. It primarily caters to business and technology executives across strategy, innovation, product, engineering, R&D, digital, data, software, and customer experience functions.

Drawing on insights from a comprehensive multi-sector survey of 1,500 senior executives (director level and above) from

large organizations with annual revenue above \$1 billion, this report establishes the logic (“the why”) behind software-driven transformation and additionally focuses on the “how” of the transformation ahead. The recommendations span software-driven vision, design, talent, organizational structure, partnerships, methodologies, technologies, and architecture, and are corroborated by in-depth qualitative insights provided by more than 20 industry leaders.

Introduction

The global economy is entering a new software-led era. In this new environment, executives no longer consider software to be simply a tool or add-on but, rather, a strategic asset that is the key to staying competitive and unlocking new value. Across industries, software and software-enabled technologies such as cloud, Internet of Things (IoT), high-performance networks (including 5G), and AI/ML are accelerating innovation, crafting personalized customer experiences, managing product/architecture complexity, and introducing new revenue and business models. For instance:

- Multinational automaker Stellantis is launching a new business unit, Mobilisights, which intends to monetize all vehicle data as a core element of Stellantis's bid to generate €20 billion (\$21.4 billion) in annual revenue from software-related services by the end of the decade.¹
- Pharmaceutical firm Novartis has recently partnered with a Danish digital health startup, Dawn Health, to create Ekiva-MS, a patient companion app to support people living with multiple sclerosis.²

- GE Appliances is personalizing the consumer experience: its SmartHQ consumer app generates custom recipes instantaneously based on food available in the user's kitchen, while the Generative AI-based conversational interface answers users' questions about the operation and care of connected home appliances.³
- Retail giant Walmart is bringing its aisles to life within a virtual format, in which consumers can access fashion, style, beauty, and entertainment products and services through Roblox Metaverse.⁴

Software-driven transformation is at the core of the development of products, services, and new business models built in a software-focused framework (see *"What do we mean by software-driven transformation?"* for the full definition). It includes redesigning products and services architecture, operating models and engineering processes, and the creation of "software-product organizations."

Introduction

Increasingly, organizations are defining, designing, and operating products, services, and business models around their software. However, they face numerous challenges across talent, technology, organization, and ecosystem orchestration. As organizations seek to establish a baseline for the transformative journey ahead, the “how” will be just as important as the “why.”

To address these questions, we surveyed organizations from both transitional products and service organizations in the automotive, aerospace, life sciences, consumer products, industrial and capital goods, high-tech manufacturing, energy and utilities, telecom, retail, and banking industries and sectors. All these organizations possess either an established or work-in-progress vision and strategy for software-defined products and services. To complement the quantitative insights, we also conducted in-depth interviews with representatives of these sectors.

In this report, we focus on three key areas:

01

Why is software-driven transformation crucial?

02

What is the size of this opportunity and what benefits will it provide to organizations?

03

How can organizations overcome critical hurdles to harness the full potential of software-driven transformation?



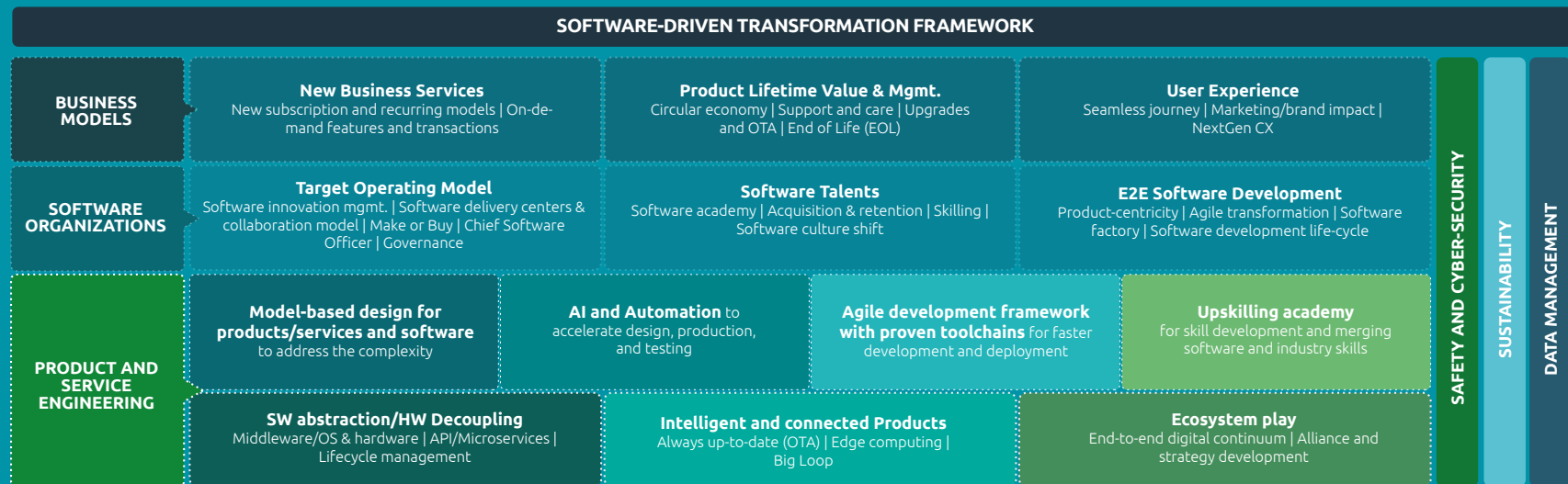
What do we mean by Software-driven transformation?

Software is transforming customer expectations of products/services and the organizations from which they buy them. To deliver on these, organizations need to develop new, software-defined, intelligent and connected products and services, and new business and operating models. They also need to build supportive alliances within their ecosystems. Our previous research covers this topic extensively.⁵

However, transitioning and structuring an organization to create, build, and support these software-based connected products and services requires an extensive revision of value streams, organizational structures, skills and talent, ways of working, and culture. This research aims to understand these facets of software-driven transformation (see Figure 1).

FIGURE. 1

Key elements of a software-driven transformation framework



Source: Capgemini Research Institute analysis.



01

**SOFTWARE IS REDEFINING THE
FUTURE OF ORGANIZATIONS –
THEIR COMPETITIVE
ADVANTAGE AND THE MARKETS
THEY OPERATE IN**

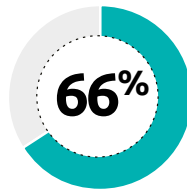
Software is bringing a new age of disruptions and opportunities

Organizations are recognizing the fundamental role that software plays in digital transformation. Software is dramatically changing how businesses operate, compete, and deliver value to their customers (see Figure 2). Imran Ansani, ex-head of product for retail industry vertical, edge computing at Dell, adds: *“Once a hardware-centric enterprise, we’ve transformed into a holistic solutions innovator. In an era of ubiquitous hardware, our cutting-edge software and unparalleled managed services distinguish us from the rest.”*

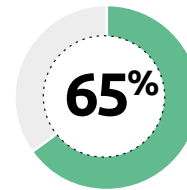
FIGURE. 2

Software is fundamentally changing the way in which businesses operate

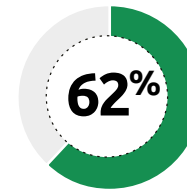
% OF ORGANIZATIONS AGREEING TO THE STATEMENTS BELOW...



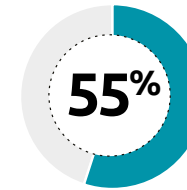
Software is critical to our future product/service strategy and roadmap



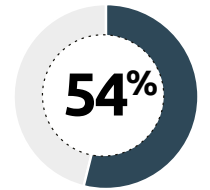
Software will enable a new phase of disruption and innovation larger than the digital/internet era of the 2000s



Software capabilities offer a greater competitive advantage in our industry than those offered by hardware



Our organization will lose market share in the next five years if we don't invest now in software skills and technology



More than anything else, strong software capabilities will determine whether our company thrives in the coming years

Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,500 organizations.



“Once a hardware-centric enterprise, we’ve transformed into a holistic solutions innovator. In an era of ubiquitous hardware, our cutting-edge software and unparalleled managed services distinguish us from the rest.”

IMRAN ANSANI

ex-head of product, for retail industry vertical, edge computing at Dell

The imperative of software adoption has driven organizations to transform themselves into software companies

Organizations initially saw digital mediums as a way to personalize offerings and connect with end users. This was the heart of the digital transformation of the late 2010s. Today, organizations are driven to transform themselves into software companies:

- To transition from a traditional telco into a genuine software company, Vodafone intends to add 7,000 software engineers to its European workforce by 2025.⁶ Agricultural equipment manufacturer, John Deere, now employs more software development engineers than mechanical design engineers.⁷ More than 12,000 individuals, constituting one-quarter of the workforce at Goldman Sachs, are software engineers.⁸

- In 2020, AB InBev launched BEES, a business-to-business e-commerce platform to empower small and medium-sized retail partners and help grow their businesses. The platform captured \$32 billion in gross merchandise value in 2022, a 60 percent year-on-year increase.⁹
- Mercedes-Benz CEO Ola Källenius adds: *“We are also on a journey to become a software company. We will put supercomputer-like performance into every single Mercedes.”*¹⁰

Clearly, software-driven transformation will define the future of organizations across sectors. Our research confirms this: one-quarter of the organizations we surveyed already consider themselves software companies. An additional 32 percent say they expect to be within the next 3-5 years (see Figure 3). Currently, one in three (33 percent) of organizations in high-tech manufacturing already considers themselves to be a software company.

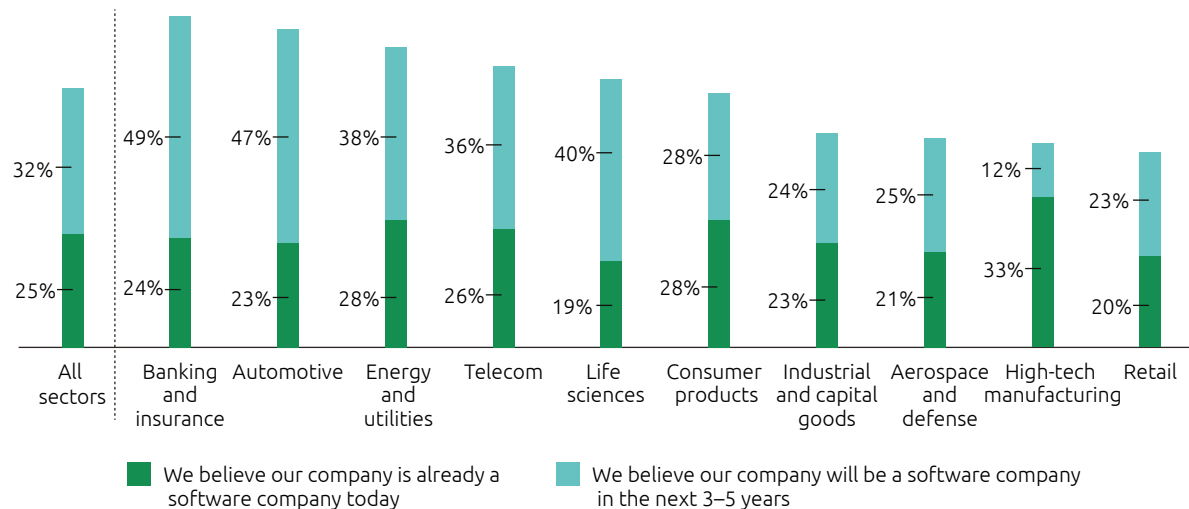
25%

of the organizations surveyed already consider themselves to be software companies

FIGURE 3

One in four organizations from traditional sectors already considers itself to be a ‘software’ company*

% OF ORGANIZATIONS AGREEING TO THE STATEMENTS BELOW...



*By “being a software company,” we mean that organizations are reconstructing their business models around software and, in doing so, transforming their business processes, organizational structures, and revenue models.

Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,500 organizations.

However, organizations have taken only the first steps to develop their software capabilities. Only 2 percent of organizations have scaled up the monetization of their software programs, with 12 percent piloting various monetization models.

Organizations are accelerating their investments in software transformation

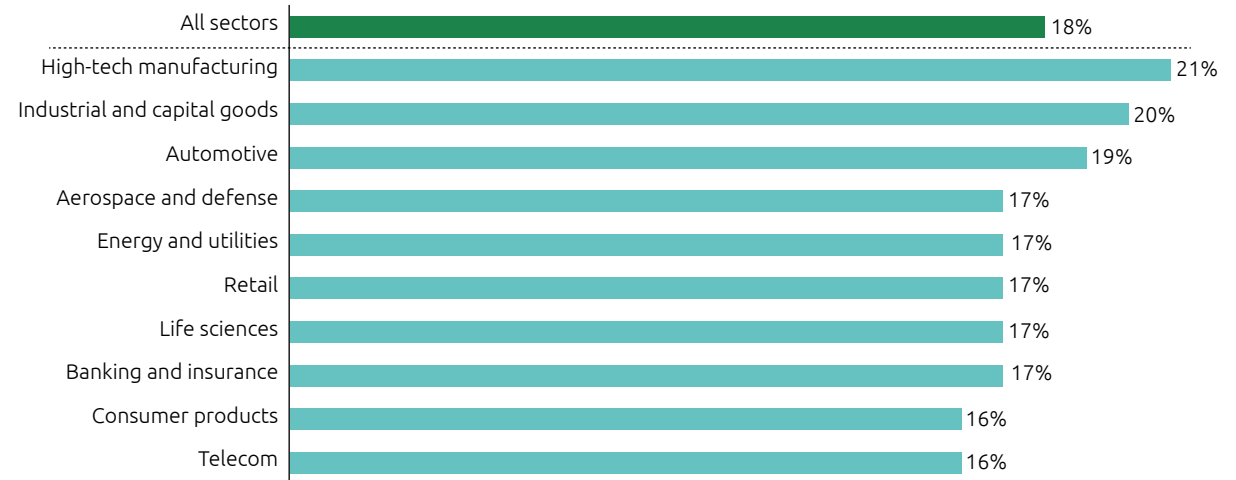
On average, organizations invest 18 percent of their R&D budget on software initiatives. High-tech manufacturing leads in this respect, with 21 percent of R&D investment in the industry going to software-driven transformation (see Figure 4). We also found that:

- 66 percent of organizations say their investments in software-driven transformation have increased from last year (by 5 percent, on average)
- Moreover, 60 percent of organizations say their investment is likely to increase by 9 percent from current levels cumulatively by 2025

FIGURE. 4

Organizations invest one-fifth of their R&D budgets in software

AVERAGE % OF R&D ORGANIZATIONS SPEND ON SOFTWARE INITIATIVES



Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,500 organizations.

60%

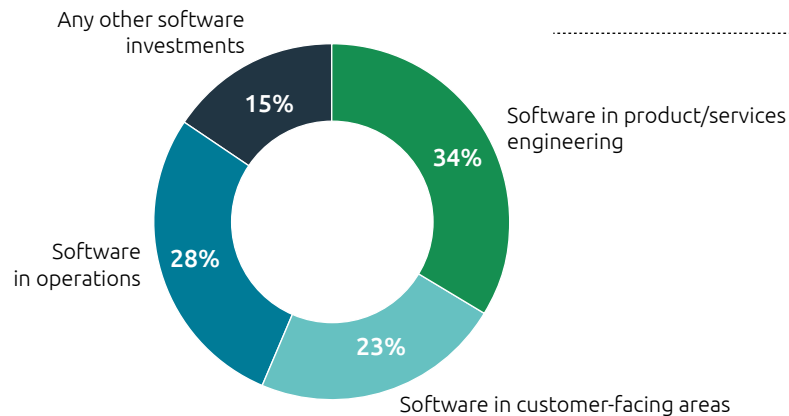
of organizations say their investment is likely to increase by 9 percent from current levels cumulatively by 2025

Following a deep dive into software investment patterns, we found that nearly one-third of strategies focus on engineering/R&D. This includes the build budgets (from design and production through to end-product maintenance), as well as tools supporting product/service development, such as product lifecycle management (PLM), digital twins, etc. (see Figure 5).

FIGURE. 5

More than one-third of software investments focus on product or services engineering

SOFTWARE INVESTMENTS, SPLIT BY FUNCTIONAL AREA



Areas of software-defined transformation covered in this research

Source: Capgemini Research Institute, Software-driven transformation survey, June - July 2023, N = 1,500 organizations.

In this research, we focus on two components of software-driven transformation: software utilized in products and services; and the software for customer management (such as in marketing, sales, aftersales, etc.). In our survey 1,350 organizations say they have/are building a strategy to become a software-driven organization, with a focus on software-defined products services. The remaining 150 organizations focus on using software in operations only. The next chapter mainly focuses on insights from the majority of organizations that focus on software-defined products/services.



GENERATIVE AI WILL ACCELERATE SOFTWARE TRANSFORMATION

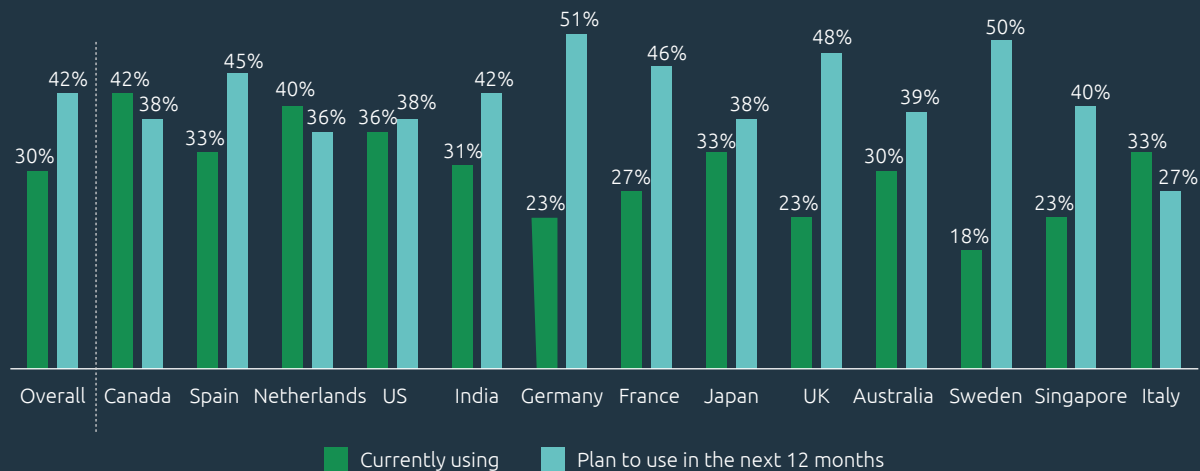
Seven in 10 organizations will be using Generative AI for software engineering in the next 12 months

Increasingly, software engineers are using Generative AI throughout the software development lifecycle, from business-needs analysis and writing agile user stories to assistance in writing software code, optimization, completion, testing and debugging, and monitoring. Our research shows that, today, 30 percent of organizations are experimenting with Generative AI for software engineering. An additional 42 percent plan to use it in the next 12 months – which showcases that only 28 percent of organizations will not be using Generative AI for software engineering in the next 12 months (see Figure 6).

FIGURE 6

A majority of organizations either experiment with or plan to use Generative AI to assist software engineering in the next 12 months

% OF ORGANIZATIONS USING AND PLANNING TO USE GENERATIVE AI TO ASSIST SOFTWARE ENGINEERING



Note: "Currently" is representative as at survey date; "next 12 months" represents the period from the survey date.
Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,500 organizations.

Generative AI will assist in writing 1 among every 5 lines of code in the coming 12 months

Generative AI already assists in writing nearly 1 in 8 lines of code, and this will increase to 1 in 5 lines of code in the next 12 months (see Figure 7).

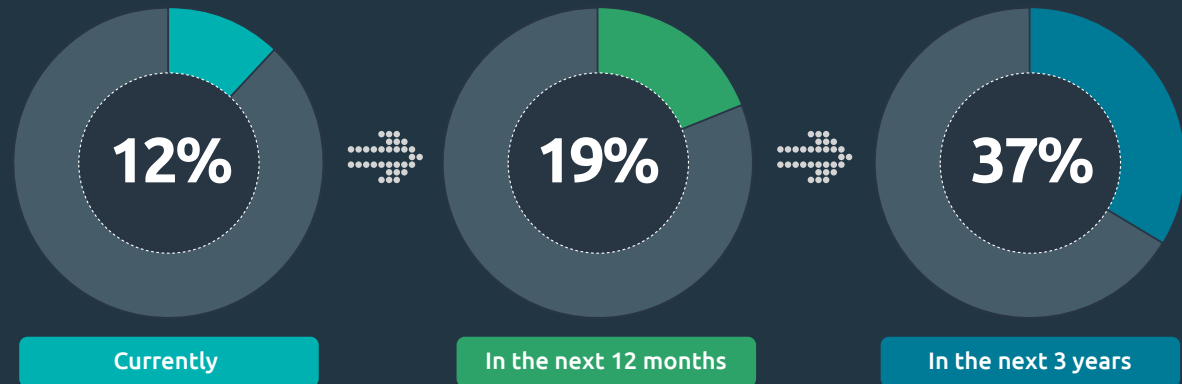
67%

of executives see Generative AI bringing the most value to IT as an enabler for driving innovation across functions.

FIGURE 7

In the next 12 months, organizations expect 1 in 5 lines of code to be generated with assistance from Generative AI

% OF CODE GENERATED THROUGH ASSISTANCE FROM GENERATIVE AI



Note: "Currently" is representative as at survey date; "next 12 months" or "next 3 years" represents the period from the survey date.

Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,500 organizations.

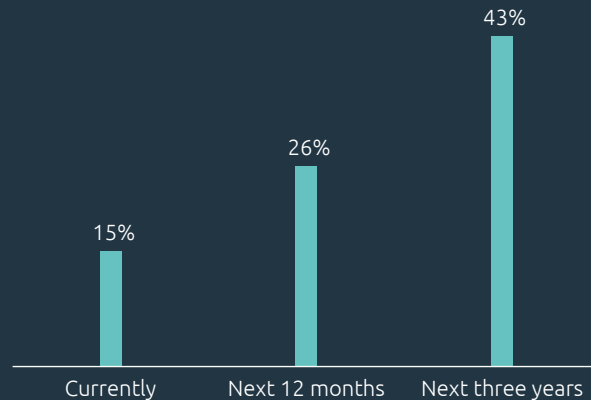
Generative AI has the potential to greatly enhance the productivity of software engineers

Large language models (LLMs) are uniquely placed to complement software engineering. Our recent research highlights that 67 percent of executives see Generative AI bringing the most value to IT as an enabler for driving innovation across functions.¹¹ We also see strong productivity gains due to Generative AI (see Figure 8). Girish Mathrubootham, CEO of Freshworks, adds: *“We use ChatGPT to write code. Software development used to take anywhere from eight to 10 weeks; now, it can be done in less than a week.”*¹² This will enable development teams to focus on more complex business problems.

FIGURE. 8

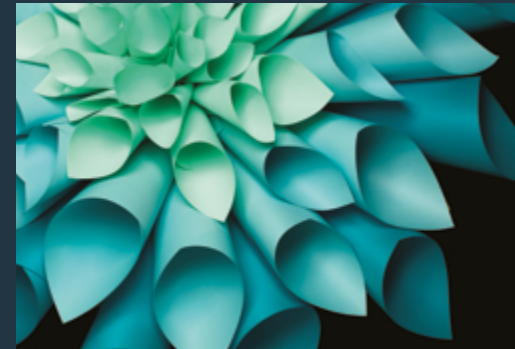
Improved productivity gains from Generative AI for code generation

PERCENTAGE OF TIME SAVED BY USING GENERATIVE AI TO ASSIST IN CODE GENERATION



Note: "Currently" is representative as at survey date; "next 12 months" or "next 3 years" represents the period from the survey date.

Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,500 organizations.



Generative AI, however, cannot replace software developers – it can only complement their task and functions. It still needs to be supervised and tested. *“[Generative] AI should not be considered a replacement for software developers, but more of a companion to help them be more productive,”* says Marco Argenti, CIO, Goldman Sachs.¹³ Various protected, regulated, and critical systems like those in medical devices, aerospace and defense, and automotive would require strong oversight and policy on the use of Generative AI in their code.



02

**SUCCESSFUL
TRANSFORMATION HAS
IMMENSE REVENUE
POTENTIAL – QUADRUPLING
BY 2030**

Software and digital services revenue will make an outsized contribution through the 2020s.

As Figure 9 highlights, software-based revenue was 7 percent of total organizational revenue in 2022; organizations expect this to double, to 14 percent, by 2025 and more than quadruple, to 29 percent, by 2030.

- Avid Swartsenburg, Head of Digital Strategy and Transformation at Singapore-based United Overseas Bank, shares: *"Through digitalization and automation, most conventional banks can conservatively expect cost reductions up to 20% in the near term. As the business and operating models of banks pivot towards digital, cost structures will evolve, with some savings being replaced by investments in technology capabilities, infrastructure, personnel, testing, and other digital-related expenses."*¹⁴
- Ford is aiming to create a continuing revenue stream from software services, which will help even out the boom-and-bust cycles in the automotive industry. The company already has over 500,000 software subscribers, mostly in



its commercial fleet business. CEO of Ford Motor Company, Jim Farley, states: *"We are in the hundreds of millions of dollars now in [software] revenue, with very healthy margins. We expect to increase that tenfold in the coming years."*¹⁵

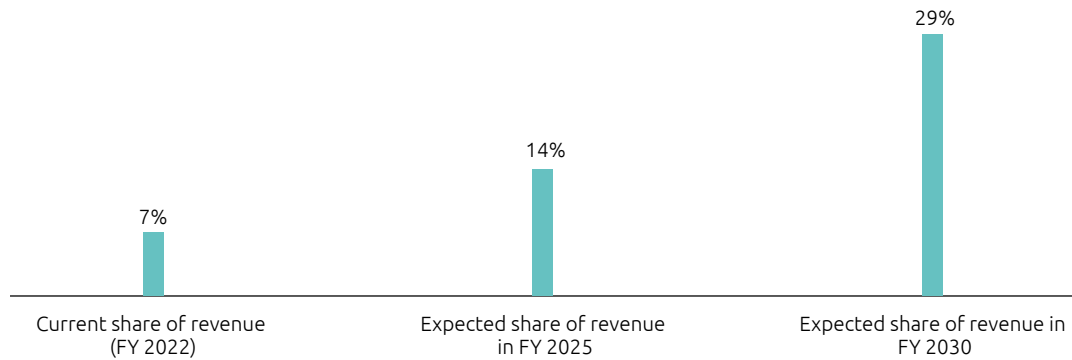
- Ericsson partnered with Deutsche Telekom to offer Mobile Network API software using the Vonage platform, which

Ericsson acquired in 2022 for \$6.2 billion. Ericsson CEO, Börje Ekholm, says: *"We view the API as an attractive standalone business."* It is predicted that revenue from mobile network APIs will grow to over \$20 billion by 2028.¹⁶

- In 2022, the global Software-as-a-Medical-Device (SaMD) market was already valued at just over \$19 billion and is expected to grow at a CAGR of 23.6 percent in 2023–32.¹⁷

FIGURE. 9

Organizations' software-based revenue as a share of total revenue is expected to grow to around 30 percent by 2030

SOFTWARE AND DIGITAL SOLUTIONS REVENUE AS A % OF TOTAL ORGANIZATIONAL REVENUE

Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,350 organizations that have/are building a strategy to become a software-defined organization, with a focus on software-defined products/services.



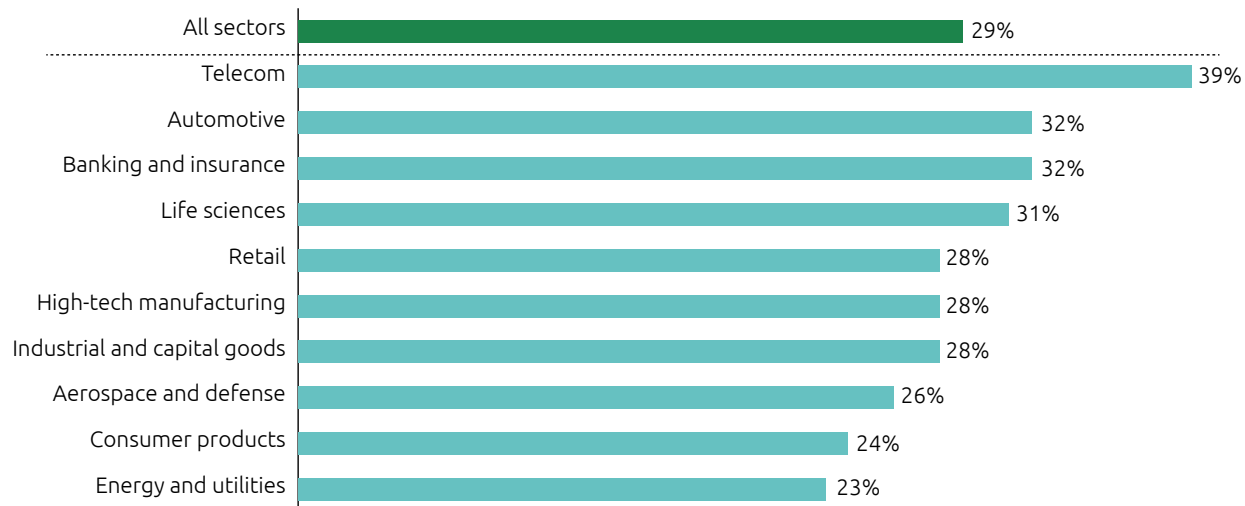
Growing software revenue requires a transformation of business models and operating structures. This includes new methods of customer contracts and payments; organizations need to incorporate and scale leasing, micro-payments, on-demand, and subscription models to take advantage of software-based features and capabilities.

29%

of an organization's revenue contribution is expected from software and digital solutions by 2030

FIGURE. 10

Software-based revenue as a share of overall revenue is expected to increase to 29% by 2030



Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,350 organizations that have/are building a strategy to become a software-driven organization, focusing on software-defined products/services.

Organizations are already reaping significant benefits

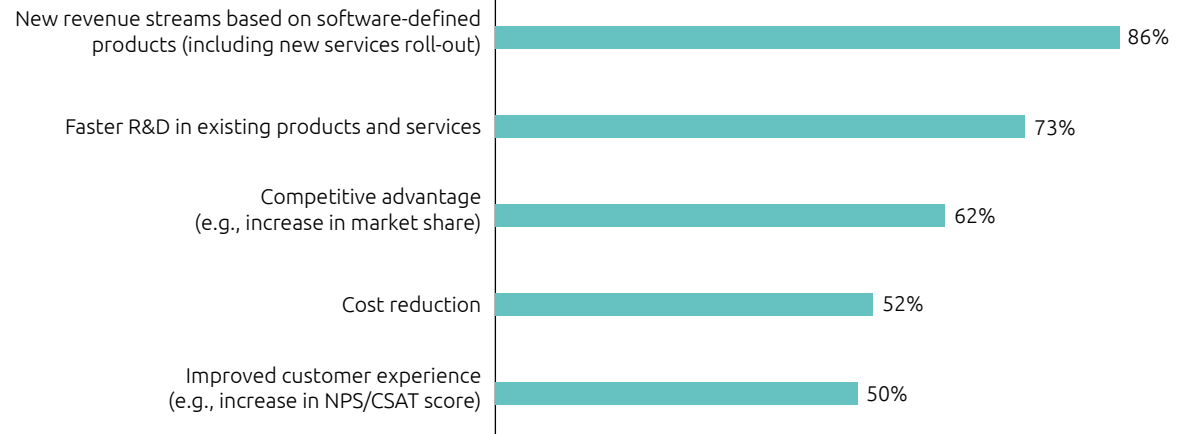
A majority of organizations are witnessing benefits from software-driven transformation including new revenue streams, an improved customer experience, and faster R&D, enabling continuous innovation.



FIGURE. 11

Several organizations have already realized significant software-driven benefits

% OF ORGANIZATIONS THAT HAVE ALREADY REALIZED SOFTWARE-DRIVEN BENEFITS



Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,350 organizations that have/are building a strategy to become a software-driven organization, focusing on software-defined products/services.

Moreover, software constructs can help in better managing complexity. For instance, in the telecom sector, software-defined networking (SDN) enables management of entire networks of devices, regardless of the complexity of the underlying systems. Moreover, a service-oriented architecture will reduce this complexity significantly. In our previous research for the automotive sector, Christoph Hartung, President Cross-Domain Computing Solutions at Bosch comments: *"With increasing reliance on software and electronics, managing the complexity of vehicle architecture is going to be extremely difficult - and mastering it is going to be even more challenging. It is a good sign that the OEMs are investing in the development of service-oriented architecture."*¹⁸

86%

of organizations have seen the benefit of new revenue streams based on software-defined products and services



FIGURE. 12

The infographic below gives some more examples of realized benefits

**NEW REVENUE STREAMS**

90% of automotive companies say they generate new revenue streams by deploying software-defined products and services

In 2022, automaker Mercedes-Benz made around \$1.6 billion in revenue from software-enabled services. Britta Seeger, Member of the Board of Management of Mercedes-Benz Group AG, says: ***"By 2025, we are targeting more than €2 billion (\$2.12 billion) from our connected car park (subscription services). Our connected car park is forecast to grow by 60 percent in the next three years. This will have a huge impact on our software-enabled revenue."***¹⁹

**FASTER R&D CYCLE**

77% of banking and insurance and 75% of high-tech organizations saw a reduction in R&D and time required to market their existing products and services

HSBC built its Risk Advisory Tool on the Google Cloud platform to process multiple what-if scenarios real-time data requests for intraday risk and capital management. Previously, HSBC ran limited scenarios manually. With the new tool, employees run multiple scenarios simultaneously to build portfolios that are resilient to many different outcomes. Owing to the use of this tool, the calculation speeds have become 16 times faster than previously.²⁰



COMPETITIVE ADVANTAGE

67% of industrial and capital goods, 66% of life sciences, and 64% of high-tech manufacturing organizations cite competitive advantage as a benefit of software-driven transformation

Nvidia has pivoted from hardware to software, hiring several software engineers and researchers to put the organization at the cutting edge of AI. Manuvir Das, VP of enterprise computing, says, ***“We know we have the best combined hardware and software platform for Generative AI.”*** It is predicted that the rapid growth in Generative AI usage could result in \$3 billion to \$11 billion in sales for Nvidia over the coming 12 months.²¹



COST REDUCTION

59% of industrial and capital goods organizations, 59% of retail, and 55% of banks and insurers have reduced costs as a result of software-driven transformation efforts

Low-cost airline easyJet will invest in the latest aircraft software from Airbus, designed to cut costs on jet fuel as a part of a flight-management system upgrade to be undertaken by end-2023. Airbus estimates that this upgrade will help easyJet save more than 98,000 kg of fuel per year per aircraft across its European network.²²



CUSTOMER EXPERIENCE

61% of automotive and 59% of consumer products organizations claim that software has enabled them to offer personalized, enhanced customer experiences

To establish itself as a digital retail company, French supermarket Carrefour developed the Sherpa Project to revamp its digital in-store back office and enhance customer service. Through the AI-powered u.care app, designed for store managers and associates, Carrefour has reduced the time required to send information between sales and the store's office. This enables employees to manage their time better and spend more time attending to customers.²³



03

HOW TO REALIZE A SUCCESSFUL SOFTWARE-DRIVEN TRANSFORMATION

Most organizations are in the early stages of their software-driven transformations

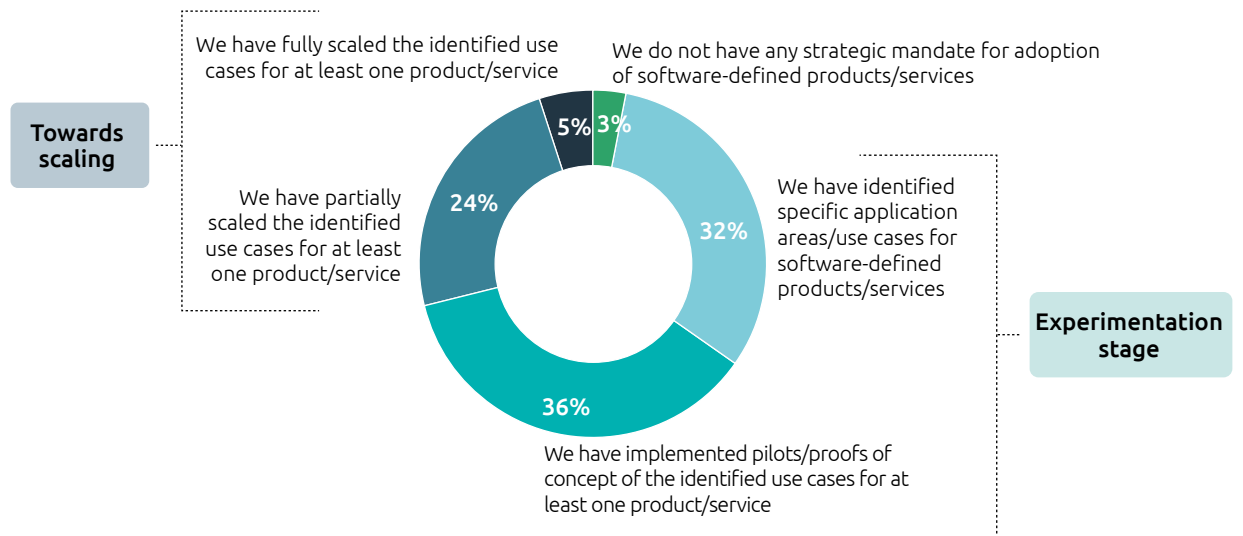
A majority of organizations are focusing on software development. However, only a few are using software to drive transformation, as Figure 13 shows:

- A large majority (68 percent) are at the experimentation stage, either identifying application areas/use cases or implementing pilots/proofs of concept (PoCs)
- Only 29 percent of organizations have started to scale and utilize software to drive transformation – with only 5 percent fully scaling identified use cases

FIGURE. 13

Most organizations are in the early stages of their software-driven transformations

MATURITY OF SOFTWARE-DRIVEN TRANSFORMATION IN PRODUCTS/SERVICES



Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,350 organizations that have/are building strategies to focus on software-defined products/services.

68%

of organizations are at the experimentation stage, either identifying application areas/use cases or implementing pilots/proofs of concept (PoCs)

Mauli Tikkiwal, IT Director at Johnson Controls, adds: *"My experience with software has been to start small, fine-tune it, make it work, monitor it, showcase it, then scale up in phases."*



"My experience with software has been to start small, fine-tune it, make it work, monitor it, showcase it, then scale up in phases."

MAULI TIKKIWAL

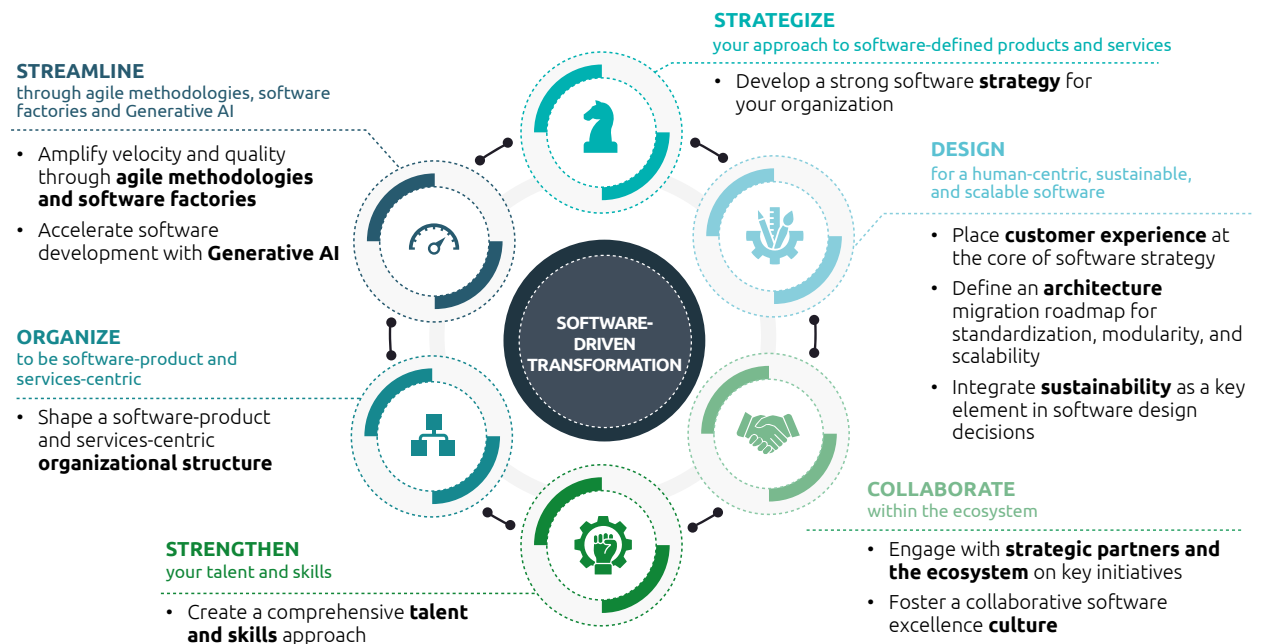
IT Director
at Johnson Controls

Building a software-driven organization: A six-pillar approach

Drawing on our experience in working with leading global organizations and insights gleaned from this research, Figure 14 identifies several critical success factors for scaling transformation.

FIGURE. 14

A framework identifying critical success factors for software-driven transformation:



Source: Capgemini Research Institute analysis.

3.1

STRATEGIZE

your approach to software-defined products and services

Develop a strong software strategy for your organization

In our research, nearly 60 percent of organizations agree that software-driven transformation is now a board-level topic. However, as Figure 13 (above) shows, only a few organizations can harness the full potential of software to drive transformation. Organizations must have a strategy to decide which products and services should incorporate smart, connected, software-driven capabilities. Organizations need to map the software to the overall strategy to assess how it can improve products and services, provide value to the customer, as well as reinforce their competitive edge in the market. This requires new go-to-market approaches. In our research, only 40 percent of organizations say they have a comprehensive software-driven transformation strategy that incorporates timelines, roadmaps, dedicated resources, and funding.

There is also a need to showcase ROI to ensure management buy-in. More than half (56 percent) of respondents rank leadership-related challenges among the top three barriers impeding software-driven transformation. When US-based manufacturer Stanley Black & Decker began its software-driven transformation journey, it used an AI algorithm to design its new products. The pilot used a simple crimper, with the idea that, should it fail, the effort and resources involved would not be significant. Although skeptics within the organization believed that computer-generated designs would fail the physical stress tests, the pilot was successful and today AI is integral to product design.²⁴ Ángel Beltrán, Director Program Management at BMO (Bank of Montreal), adds: *“To shift the mindset of the organization, it is important to have a solid internal communication strategy. At BMO, we conducted roadshows across many lines of business and technology, communicating the importance of software initiatives, the business value, and laying out the plan with a timeline. Through this, we were able to bring the organization on board.”* A pivot to software-based

business models requires a holistic vision, a well-articulated strategy, innovative product and services development, and new organizational structures, operating models, and technology architecture.

40%

of organizations say they have a comprehensive software-driven transformation strategy that incorporates timelines, roadmaps, dedicated resources, and funding

3.2

DESIGN

for a human-centric, sustainable, and scalable software

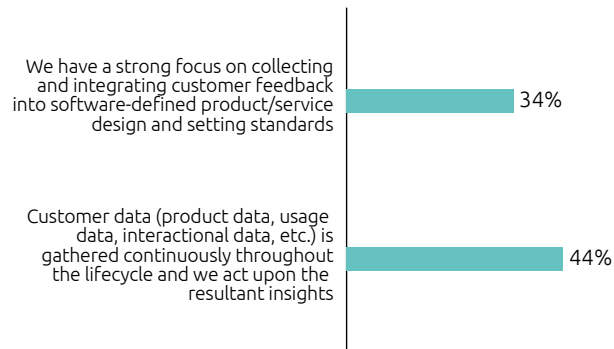
Place customer experience at the core of software strategy

Software offers the opportunity to engage more deeply with customers through continuous contact and lifetime digital product management. Creating a more personalized and engaging customer experience should be at the heart of the software strategy and roadmap. Figure 15 shows that only one in three (34 percent) organizations uses customer insights to adapt their software product and services design.

FIGURE. 15

Organizations struggle to achieve a human-centric design for software-defined products and services

% OF ORGANIZATIONS AGREEING TO THE STATEMENTS BELOW



Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,500 organizations.

For a successful, human-focused software strategy, organizations must:

- Focus on an adaptive, human-centric design:** Understanding customer or user personas and their journeys will help organizations better empathize with customer needs and the context in which they operate. US-based multinational conglomerate 3M is an example of an organization that places a high value on human-centric design methodology, whether the focus is on physicians, nurses, technicians, or patients.²⁵ Judy Ma, until recently a design director with 3M, shares an example: *“Many patients often worry about whether their doctor is familiar with their complete medical history and understands their unique needs. Healthcare workers and doctors need to take the time to enter patient data into electronic medical record (EMR) systems while also trying to interact and engage with their patients. To simplify and humanize this process, our team at 3M developed an intelligent voice assistant powered by AI technology. This tool allows for the automatic capture of a fully structured*

clinical note in the electronic health record (EHR) directly from the patient-physician interaction. This happens in the background, freeing up the clinician's focus on the patient, resulting in more personalized care."

- Encompass user experience throughout the product/service lifecycle:** Products and services design should be built around a complete user journey. Most organizations tend to build products and use cases in isolation. Human-centric design requires undertaking real-world usage - which consist of different platforms, scenarios, and interfaces. This should also consider the 'usage' part of the product or service design – a transition for traditional product-selling organizations. For example, vehicular infotainment systems should be able to integrate user personal devices and/or interface with them, since most consumers tend to be primarily tethered to their personal devices. Such integration improves consumer engagement and allows unfettered access to personalized information and applications.
- Adapt software requirements based on customer feedback:** The initial alignment of software requirements with business strategy is crucial, but adapting based on customer feedback is equally important. There is also a need to prioritize requirements aligned with strategy, business impact, and technical feasibility. One of the many frameworks organizations use for backlog prioritization

is Reach, Impact, Confidence, and Effort (RICE).²⁶ "Reach" refers to the number of users affected by the change; "Impact" refers to the business value of the change; "Confidence" refers to the team's belief in their ability to implement the change; and "Effort" refers to the time and resources required. Kathryn Koehler, Engineering Director, Developer Productivity at Netflix, says: *"We prioritize customer issues based on the RICE framework. We budget 50 percent of our teams' capacity for new initiatives*

*and 50 percent for KTLO ['keeps the light on' activities] and other team-based initiatives. We also work with developers to understand the key results that will indicate success or failure: the impact our work has on customers, not just 'we shipped the thing'."*²⁷

Updating documentation, end-to-end tracking, and bi-directional traceability also ensure a clear understanding of safety, security, and compliance.





“Many patients often worry about whether their doctor is familiar with their complete medical history and understands their unique needs. Healthcare workers and doctors need to take the time to enter patient data into electronic medical record (EMR) systems while also trying to interact and engage with their patients. To simplify and humanize this process, our team at 3M developed an intelligent voice assistant powered by AI technology. This tool allows for the automatic capture of a fully structured clinical note in the electronic health record (EHR) directly from the patient-physician interaction. This happens in the background, freeing up the clinician's focus on the patient, resulting in more personalized care.”

JUDY MA

until recently a
design director with 3M

FORMULATE A COMPREHENSIVE APPROACH TO MANAGE OTA UPDATES EFFECTIVELY

Over-the-air (OTA) updates refers to the system for updating software or firmware remotely. NASA's interstellar Voyager 1 and 2 received a software update beamed from 12 billion miles away!²⁸

Recent research highlights that consumers expect 2-6 OTA updates per vehicle, per year by 2025.²⁹ Tesla has released 90 software updates to date.³⁰ Effective software updates are critical to any strategic plan that requires fast deployment of innovations and new features, enabling new data-driven services and revenue. OTA eliminates the need to recall products with defects that can be fixed by software. For instance, recently, Samsung realized that a particular washing machine model posed a fire hazard. Conventionally, the organization would be required to recall these units to ensure customer safety,

but this issue was resolved with an OTA update.³¹ Moreover, updates are key to securing future revenue streams from digital business models. OTA updates can also help with compliance by ensuring the product satisfies all regulatory requirements.

And finally, OTA extends the life of the product, thereby increasing circularity and sustainability.

In the automotive industry, regulations such as UNECE regulation R156 require vehicle manufacturers to have a documented process for



OTA updates and make this process available to approval authorities on request. This means that every aspect of the OTA software update process must be recorded and executed in a way that satisfies the regulation; otherwise, it will fail to receive certification.³² Manufacturers should prioritize standardization of the ability to receive software updates in all their smart, connected products. To achieve this change successfully, they must:

- **Prioritize a 'security-first' approach.** Manufacturers must incorporate security measures such as robust encryption and authentication systems. LG Electronics is working to develop post-quantum cryptography (PQC) technology for its in-vehicle infotainment (IVI) systems. The organization aims to create a more secure connected-vehicle environment, encompassing key areas (including OTA updates).³³ Organizations should deploy patches for existing applications, new features, and defect resolution. Micro-segmented, private connectivity ensures the authenticity of software and applications.
- **Ensure safety via thorough test updates.** OTA updates, when not executed correctly, have the potential to disrupt other components within a product, resulting in operational malfunctions. Such occurrences pose safety hazards, including critical system failures. To mitigate these risks, organizations must conduct comprehensive testing of updates prior to their deployment, ensuring compatibility with existing systems and safeguarding the product's overall performance and safety. Moreover, organizations can design products in a way that allows roll-back to a version of the embedded code that has been proven to work. For this, consider full virtualization or designing the architecture to store two versions of code, with an ability to flip from one to the other.
- **Design operational processes by following CI/CD principles, supported by virtual and hardware in the loop (HiL) testing.** Include processes for identifying when an update is required, for designing and building software in short release cycles, for rapidly (but thoroughly) testing new software, for implementing updates in a timely fashion, and so on.
- **Define an end-of-life (EOL) plan for their connected product.** EOL OTA strategy needs to have a roadmap and timelines for new-feature updates, technical support, security patches, and depreciation. Communicate to customers when the product will no longer receive updates and support. Also, in cases where full software updates are unfeasible owing to hardware obsolescence, consider updating just the electronics hardware, or delivering targeted, critical security updates.

Define an architecture migration roadmap for standardization, modularity, and scalability

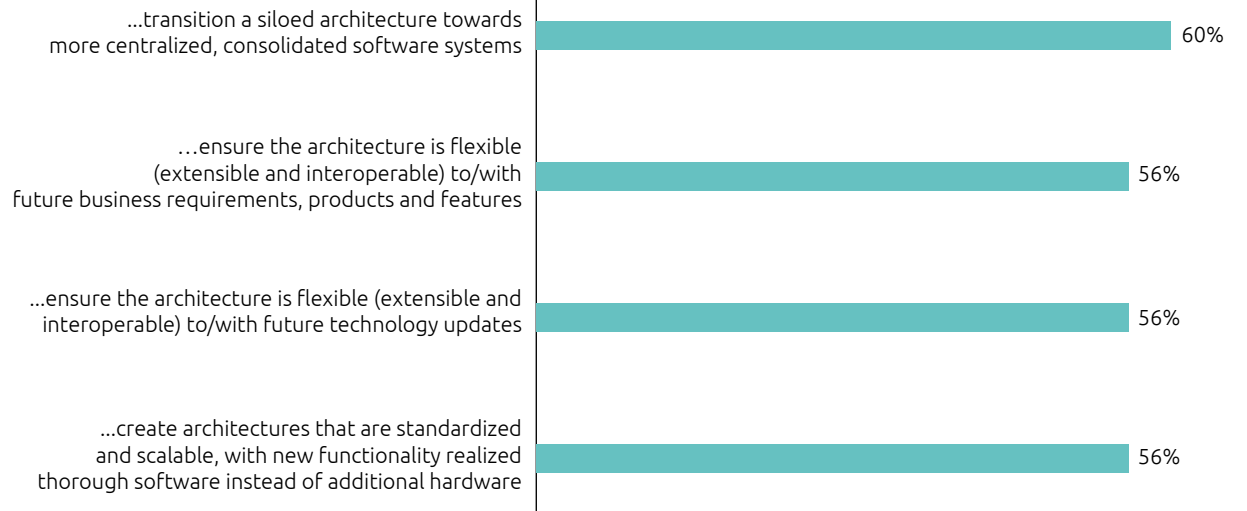
The various components of software initiatives must be scalable and capable of interaction with various other systems, including software stacks, communication channels, operating computing infrastructure, hardware platforms, and data management, storage, and analytics.

Owing to the complexity of these systems, managing long-term operating costs and performance levels becomes a critical challenge. Every such platform should, therefore, follow principles of standardization, modularity, and scalability (see Figure 16). An executive at a Canada-based bank adds: *“An organization can never get 100 percent common components and architecture that align with every business team’s needs. An organization has to build a centralized architecture that requires small degrees of specialization.”* Efforts should be made to use open-source and industry standard solutions, while ensuring compatibility across these solutions. Our research shows that only 43 percent of organizations have a formal program that governs the adoption and use of open source.

FIGURE. 16

A majority of organizations state that standardized, flexible, and scalable architecture is important

IT IS IMPORTANT FOR US TO...



Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,500 organizations.

When deciding on an architecture, a few key areas need to be considered:

- **Design using common standards and solutions:**

Organizations should base system design and engineering on open and widely followed standards and solutions, whenever such solutions exist. Organizations should also invest in industry-wide standardization efforts. Custom and bespoke solutions increase complexity and, as a consequence, uncertainty. Organizations should only use such solutions when required to tackle a unique challenge or build a solution that offers a competitive advantage. They should aim to standardize base components that do not create differentiation. A majority (62 percent) of organizations say they have a strong focus on architecture standardization for scalability.

62%

of organizations say they have a strong focus on architecture standardization for scalability.

- **Flexibility and scalability:** Software solutions should be interoperable and offer flexibility across various platforms (e.g., cloud, on-premise, edge computing). Factors such as lock-in and technical debt (the prioritization of speed of delivery of code over technical quality) should be given considered. Engineers should design systems to ensure future-proofing and the development of plug-in architectures to accommodate new features, solutions, and integration. Standard interfaces and APIs that can access the underlying data, algorithms, and processes offer a stable and standard interface. Less than half (48 percent) of organizations in our survey claim to have a highly scalable architecture that is experience, infrastructure, and sustainability aware.

48%

of organizations claim to have a highly scalable architecture that is experience, infrastructure, and sustainability aware.





“To shift the mindset of the organization, it is important to have a solid internal communication strategy. At BMO, we conducted roadshows across many lines of business and technology, communicating the importance of software initiatives, the business value, and laying out the plan with a timeline. Through this, we were able to bring the organization on board.”

ÁNGEL BELTRÁN

Director Program Management at
BMO (Bank of Montreal)

- **Modularity and abstraction:** Modularity facilitates upgrades and troubleshooting. It also supports multiple design roadmaps, each with its own architecture. This approach empowers organizations to utilize existing solutions, while retaining the option to sprint new features and solutions. However, it is necessary to strike a balance, as overly modular designs can introduce additional communication overheads. Such systems also add complexity and necessitate clearly defined boundaries and operations.
- **Availability and reliability:** Uptime and reliability are essential criteria for any architecture decision. System decisions should be backed up by redundancy, allowing normal operations to continue, if required. All single points of failure (SPOFs) must be identified and backed up and load testing is essential.

Architecture selection often involves both strategic and operational decisions and a trade-off between various factors. The outcome of the selection will have long-term consequences and, therefore, requires a farsighted vision and a clear roadmap.

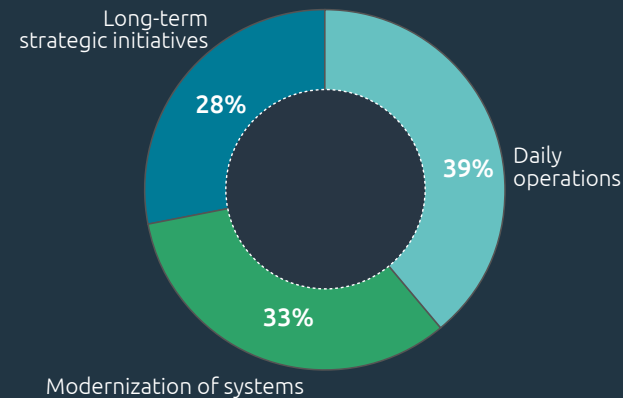
ADDRESS LEGACY AND PRODUCT SUPPORT LIFECYCLE THROUGH RATIONALIZATION AND REDUCING TECHNICAL DEBT

Many organizations focus on the short-term business impact of their software product, rather than longer-term value. This leads to unnecessary spending on the maintenance or continuity of legacy software products (see Figure 17). This limits the availability for innovation and modernizing legacy software –skewing towards end-of-life products and support over the long term.

FIGURE. 17

Nearly 40 percent of organizational software investments today focus on maintaining legacy products

SPLIT OF CURRENT SOFTWARE INVESTMENTS



Source: Capgemini Research Institute, Software-driven transformation survey, June - July 2023, N = 1,500 organizations.

39%

of organizational software investments today focus on maintaining legacy products

Forty-four percent of organizations also rank technical debt among their top three technology-related challenges to software-driven transformation. One key factor is quantifying how much technical debt an organization carries. Progrexion, a US-based credit report repair company, measures its technical debt against the key technology metrics of supportability, expected remaining life span, stability, and the additional attributes of business criticality and strategic alignment.³⁴

In our research, organizations share the following best practices to manage technical debt (top five ranked):

01

Ringfence a portion of investment to modernize legacy code and systems

02

Focus on high modularity, microservices architecture, and/or low-code platform

03

Change ways of working and development culture

04

Include a governance structure to tackle technical debt in Agile-DevOps workflow

05

Developer education and awareness

Cloud-based capabilities can also reduce existing technical debt. The concept of a “coreless enterprise” is also gaining ground to scale transformation. The coreless approach is based on modular, microservice-based architecture, allowing businesses to tailor different areas of the digital lifecycle, integrate best-of-breed solutions, and upgrade redundant functions. This flexible, composable blueprint also eliminates disruption and downtime caused by service and infrastructure updates. In our research, 24 percent of organizations are already using microservices, and an additional 31 percent plan to use them for their software delivery in the next 12 months. Moreover, Generative AI has the potential to transform legacy code refactoring by analyzing thousands of lines of code and decoupling dependencies. Converging microservices and Generative AI can improve the efficiency, agility, and quality of software development.

Integrate sustainability as a key element in software design decisions

Sustainable software engineering prioritizes long-term energy efficiency and environmental considerations. It encompasses streamlined architectural design and development, and ongoing maintenance of both software and hardware, while continuing to meet expected quality standards and business needs.

In our survey, 83 percent of organizations agree that software-driven transformation will reduce carbon footprint. Yet, most organizations still fail to measure the environmental impact of their software initiatives. Our survey indicates that:

- Only 28 percent of organizations measure the environmental impact of their software development
- Only 27 percent have an internal cost of carbon for their software projects

Along with reducing carbon footprint, sustainable or green software development also offers benefits

including reduced energy bills and improved performance (applications developed with reduced computational power are faster, more responsive, and more reliable).

It is crucial, therefore, to ensure sustainability as a pillar of the software architecture, as well as the design of specific software modules. Paul McEwen, Global Head of Technology Services for UBS, comments: *“The way we design and build our applications has a direct relationship with how much carbon they emit. With a better understanding of the impact our application designs have on the environment, we can make choices that have a more positive impact on the planet.”*³⁵

83%

of organizations agree that software-driven transformation will reduce carbon footprint.



Below, we highlight a few best practices for a **sustainable software design**, based on learnings from our previous report on sustainable IT, as well as insights shared by industry leaders:

- Data storage consumes large amounts of energy and must be factored into an organization's sustainability strategies. Organizations need to optimize algorithms and data structures to reduce computational complexity and energy consumption.
- In our previous research on sustainable IT, we found that only 19 percent of organizations measure the energy impact of pre-production development and testing of applications, and only 21 percent measure the sustainability impact of the production environment (live applications). Conducting a sustainability impact assessment of the entire lifecycle helps identify areas of improvement.³⁶
- The choice of application architecture is a determining factor in software power consumption and resource utilization. Microservices architectures, for example, can be used to apply innovations such as containerization (bundling code with all the files and libraries that an application requires to run on any given infrastructure) and serverless computing. Containerization enables teams to move workloads to more energy-efficient locations, and

28%

of organizations measure the environmental impact of their software development

27%

of organizations have an internal cost of carbon for their software projects

19%

of organizations measure the energy impact of pre-production development and testing of applications

serverless architectures offer even greater efficiencies by allocating cloud resources to applications only when those applications are required, saving both capacity and energy usage.³⁷

- Efficient code saves processing power as well as energy. Organizations can achieve coding efficiency through methods such as optimizing algorithms, reducing

redundancy, and offloading tasks to less energy-intensive systems. Moreover, regular code reviews – both automated and manual – help maintain efficiency. Generative AI code assistants also enable developers to write better code more efficiently, supporting sustainability.

- Organizations should also focus on developing long-term reusable code that is modular, reliable, and well-organized,

and that enables developers to build upon existing systems with fewer new lines of code.

- Defining key performance indicators (KPIs), setting up a carbon cost for software development, fostering sustainable employee behaviors and attitudes and making environmental impact is a key consideration in the selection of IT vendors are equally crucial activities.



3.3

COLLABORATE

within the ecosystem

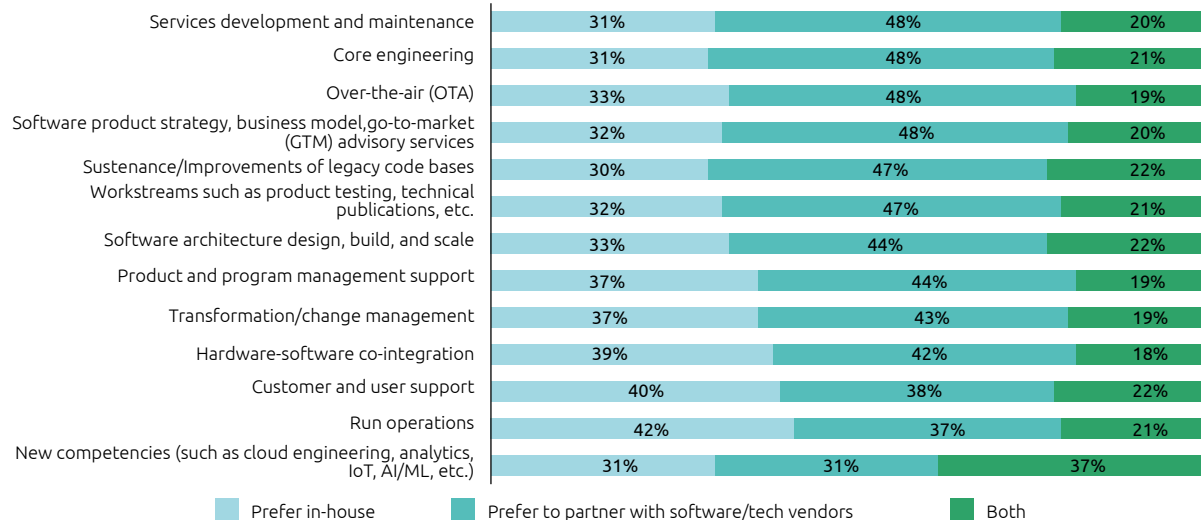
Engage with strategic partners and the ecosystem on key initiatives

Ecosystems comprise multiple stakeholder groups – chipset providers, hardware and sensor vendors, cloud and platform providers, connectivity providers, testing and certification agencies, cybersecurity services providers etc. Collaborating with strategic partners can introduce the expertise and agility required to take full advantage of the benefits of software-driven transformation. To become software-driven, organizations must identify key software domains where partner support is essential; evaluate current suppliers and partners; and establish long-term strategic partnerships with ecosystem players. Our research indicates that fewer than half of organizations intend to execute core functions and competencies in-house, preferring instead to partner with software or technology vendors, or to carry them out in parallel with in-house development (see Figure 18).

FIGURE. 18

Nearly half of organizations prefer to engage strategic partners for software advisory, core engineering, Over-the-Air (OTA) and services development

DISTRIBUTION OF ORGANIZATIONS' DEVELOPMENT CHOICES FOR SOFTWARE INITIATIVES



Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,500 organizations.

BUILD VERSUS BUY


One of the key junctures in any software-development initiative is the decision on the build versus buy strategy (whenever buying is applicable), which involves a trade-off between various operational and strategic options. It





should be noted that not all needs are covered by already developed solutions (for instance, in the automotive industry, there is no there is no 'off-the-shelf' CarOS). Organizations should invest in building the software that gives them a competitive advantage.

Software development is an expensive proposition; related decisions need to have clear strategic goals and outcomes (see Figure 19):

FIGURE. 19

Decision factors for build vs. buy decisions for software development

DECISION FACTOR	BUILD ADVANTAGES	BUY ADVANTAGES	FACTOR DECISIONS
 Technology and platforms	<ul style="list-style-type: none"> • Compatibility, adaptability, and integration • Full access to code 	<ul style="list-style-type: none"> • Market-tested, with known features and capabilities • Rapid testing and prototyping • Faster adoption 	<ul style="list-style-type: none"> • Data privacy and security • Level of integration • Current open-market solutions • Technology advantage vs. parity
 Features and capabilities	<ul style="list-style-type: none"> • Prioritization of feature and capability development • Focus on solutions without bloatware • Future-proofing 	<ul style="list-style-type: none"> • Packaged solutions with easy adoption and implementation • Easy testing and PoC 	<ul style="list-style-type: none"> • Prioritization and importance of feature development • Scalability and adoption

DECISION FACTOR	BUILD ADVANTAGES	BUY ADVANTAGES	FACTOR DECISIONS
 Performance	<ul style="list-style-type: none"> • Development control • Upgradability and optimization 	<ul style="list-style-type: none"> • Tested configuration and market benchmarks • Established service level agreement (SLA) 	<ul style="list-style-type: none"> • Downtime consequences • Scale and demand change over time • Performance testing, target, and standards
 Documentation, training, and support	<ul style="list-style-type: none"> • Target documentation based on user profile • Control over support and its prioritization 	<ul style="list-style-type: none"> • Documentation, training, and support readily available • Vendor expertise and support • Periodic updates with competitive parity on features and performance 	<ul style="list-style-type: none"> • Simplicity or complexity of interface and solution • Ongoing support and training • Cost of support and initial cost of training
 Speed to market or adoption	<ul style="list-style-type: none"> • Incremental release cycles give more control • Integration with existing platforms, data and processes 	<ul style="list-style-type: none"> • Faster development, quality control, documentation, and support enable quicker adoption • Most common and critical features come out of the box 	<ul style="list-style-type: none"> • Criticality of timelines • Opportunity cost
 Long-term support requirements	<ul style="list-style-type: none"> • More control • Can ensure software support in the long run 	<ul style="list-style-type: none"> • Up-to-date software with security patches, bug fixes, and new features 	<ul style="list-style-type: none"> • Longevity of support required

Source: Capgemini Research Institute analysis.

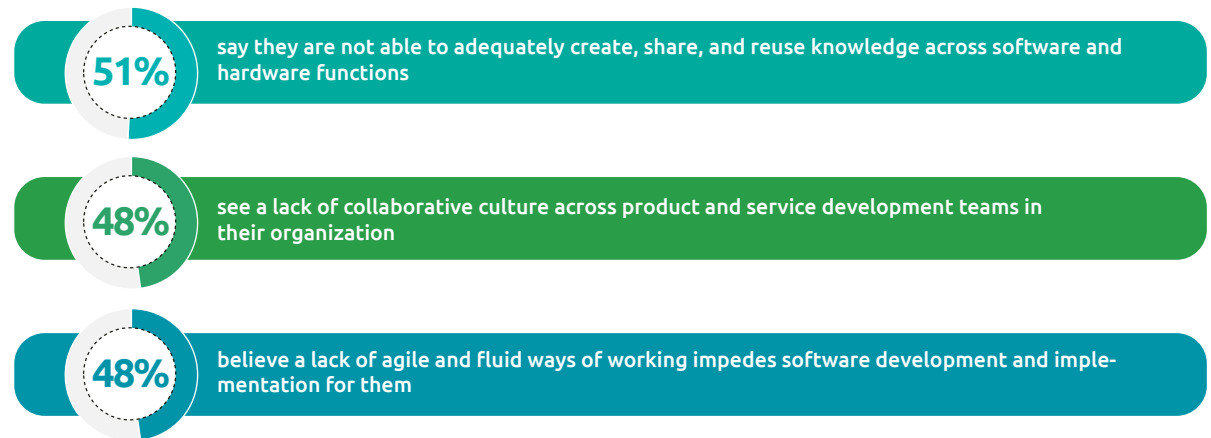
Foster a collaborative software excellence culture

A software-centric and collaborative culture is key to the success of software-driven transformation – to accelerate time to market and enable scalability, upgradability, and safety. Our research shows that nearly half of organizations rank knowledge sharing and collaboration among the top culture-related challenges for their organizations (see Figure 20).

FIGURE. 20

Lack of collaborative culture is a challenge for nearly half of organizations

% OF ORGANIZATIONS RANKING THE BELOW CHALLENGES AMONG THEIR TOP 3 CULTURE-RELATED CHALLENGES



Source: Capgemini Research Institute, Software-driven transformation survey, June–July 2023, N = 1,500 organizations.

Organizations should:

- **Encourage cross-function collaboration:** Open communication and collaboration between engineering and business functions such as marketing, sales, and customer experience helps to integrate customer-use data and feedback into the design process. Our research suggests that only 36 percent of organizations involve customer experience (CX) professionals early on in the software product/service design process.
- **Embrace the cultural aspect of software toolchains:** Agile and DevOps is more than a technology movement; it is a holistic culture and practice that demands a governance model, skills, and new ways of working. It also inherently requires the creation of cross-functional teams of software architects, developers, testers, business users, and, in some cases, clients/customers. As per a recent survey, 69% of organizations ranked increased collaboration as a top benefit of scaling agile.³⁸
- **Promote autonomy, trust, and psychologically safe experimentation:** For success in software-driven transformation, organizations need to embrace failure and foster a blame-free environment for rapid testing, failing, experimentation, and innovation through activities such as “failure nights” (where employees talk openly about their experiences of failure in their professional lives) and “innovation slams.”

Organizations also need to reshape the operating model, including organizational structures to transform the culture sustainably. The following sections discuss operating models and software toolchains in detail.

36%

of organizations involve customer experience (CX) professionals early on in the software product/service design process.



3.4

STRENGTHEN

your talent and skills approach

Create a comprehensive talent and skills approach

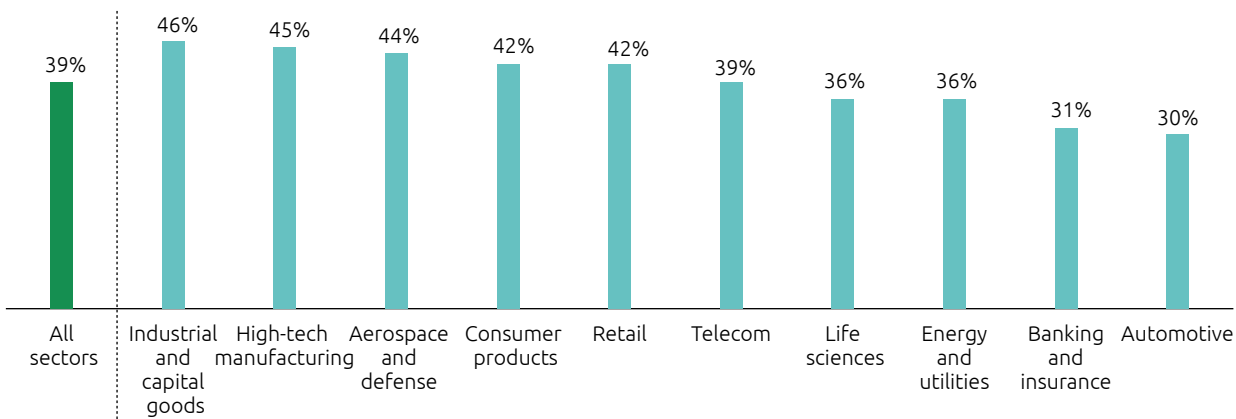
There is a growing need for software engineering expertise within organizations. In our research, organizations expect 39 percent of the workforce to work on software solutions in the next three years (see Figure 21).

39%

of an average organization's workforce is expected to work on software solutions over the next three years

FIGURE. 21

The share of software skills in the workforce will rise to more than one-third in the next three years

EXPECTED PROPORTION OF EMPLOYEES WORKING ON SOFTWARE SOLUTIONS IN THE NEXT THREE YEARS

Source: Capgemini Research Institute, Software-driven transformation survey, June–July 2023, N = 1,500 organizations.

Consequently, demand is growing for the key technology capabilities necessary to propel software-driven transformation. In 2022 American Express announced that it intended to add 5,000 tech roles across domains such as product and engineering, software engineering, data science, product management, and information security.³⁹

More than half (55 percent) of organizations in our research cite traditional development teams' lacking the skills to co-develop software as a challenge for their organization. As companies such as Ford move towards complete in-sourcing of the development of second-generation electric vehicle (EV) architecture, and writing all the software in-house⁴⁰ there be huge growth in demand for key software skills. However, at present, significant talent gaps exist in several critical technology areas:

- Cybersecurity and compliance, including in homologation (granting of approval by an authority), certification, and other areas (61 percent of organizations cite it as a gap)
- AI, ML, and deep learning (DL) talent (60 percent of organizations)
- Data- and cloud-related skills (57 percent of organizations)
- Moreover, over 40 percent cite software engineering, application development and programming, testing, verification, and validation as a gap in itself



Along with closing these gaps, there is also a need for a good mix of both industry and technology expertise. However, for nearly half (49 percent) of organizations, recruiting talent with domain as well as technical skills is a big challenge. Bhavesh Gupta, Global Director of Engineering at Honeywell, comments: *“Integrating technical, domain-specific, and business knowledge is rare but essential. Engineers will understand how to do software development, but they may not understand the other two [areas]. People who understand the nuance of domains may not necessarily*

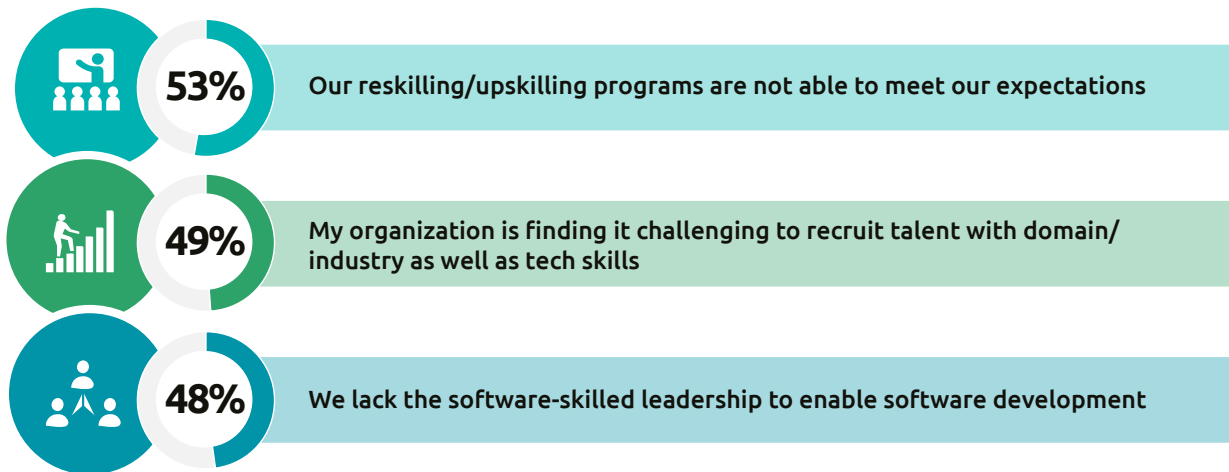
understand how to develop software or how to make a viable business out of it. And people who are business gurus don't always understand the domain or software-development aspects. You need at least one person that understands all three aspects, to tie them all together.”

To reduce the pressure of hiring new talent, organizations must also strive to upskill their existing engineers with software knowledge and proficiency. However, upskilling programs are falling short of anticipated outcomes for a majority of organizations (see Figure 22).

FIGURE. 22

Upskilling ranks as the top talent-related challenge that organizations face.

TOP TALENT-RELATED CHALLENGES FACED BY ORGANIZATIONS



Source: Capgemini Research Institute, Software-driven transformation survey, June–July 2023, N = 1,500 organizations.

The competition for top technology talent is fierce. More than half (53 percent) of traditional product- and services-centric organizations agree that they compete on recruitment not only with their industry peers, but also with big tech and digital-native organizations. Frequently, this top technology talent encounter "cultural fit" challenges while working in traditional organizations. To solve business problems, they require autonomy, ample opportunities to grow, insights into business metrics, and support in enhancing their skills. To attract, engage, retain, and upskill talent, organizations should:

- **Establish a comprehensive strategy to acquire critical skills:** Today, top software and technology talent isn't confined to job sites. Organizations should explore open-source communities, meet-ups, and hackathons to hire for these specialized skills. As per our survey, only 46 percent of organizations say they hire from open-source communities connected to projects they use, and 49 percent connect with developer communities through meet-ups and sponsored hackathons. Strategic partners can also add significant value to software teams by providing access to skilled talent at scale and contributing chip-to-cloud expertise.

53%

of traditional product- and services-centric organizations agree that they compete with big tech and digital-native organizations on recruitment.

- **Focus on continuous learning and upskilling:** In 2021 Stellantis announced the launch of a “Software Academy” for the upskilling and reskilling of new and existing employees. The company also plans to launch a global learning curriculum, called the Agile-Auto Software and Data Academy, which will cover software, data, and cloud technology. The aim is to train more than 5,000 developers and engineers by 2024.⁴¹ Our research shows that 48 percent of organizations have already developed

centers of excellence to concentrate knowledge in the software space. Along with technical skills, these upskilling programs should encourage new ways of thinking about software development.

- **Track and improve “developer experience”:** A recent survey by Forrester shows that, by improving developer experience (DevEx), 77 percent of organizations can shorten time to market, while 85 percent can positively impact revenue growth. Moreover, 82 percent reported increased customer satisfaction, and 81 percent saw a positive change in developer recruitment and retention.⁴² However, only 47 percent of organizations in our research track their DevEx scores.
- **Enable the “citizen developer” with low-code/ no-code platforms:** Low-code development enables business users with virtually no programming experience to create applications using a graphical interface. This can be undertaken for simple workflows, optimization of established processes, and low-security apps – but not for the solutions that create market differentiation. In our survey, 47 percent of organizations say they directly encourage and support non-traditional developers in creating software using a low-code development strategy. The Dutch national railway company, NS, launched a new customer application, Treinwijzer, that uses a low-code platform, allowing passengers to check how busy trains

are in real time, enabling them to switch to a less crowded service.⁴³ It is important that low-code platform and security teams work together to define governance policy and implement guardrails.

Generative AI tools can also support traditional organizations by shortening the timeline for building software development skills. Paulo Rosado, Founder and CEO of low-code development platform OutSystems, adds: *“I expect many more people to start using these tools to speed up projects, from LLMs that generate code snippets, to highly complex low-code solutions that abstract the entire software-development lifecycle. However, this does not mean AI will obliterate the software development job market. ... Instead, it will help them accomplish much more in less time.”*⁴⁴

“Integrating technical, domain-specific, and business knowledge is rare but essential. Engineers will understand how to do software development, but they may not understand the other two [areas]. People who understand the nuance of domains may not necessarily understand how to develop software or how to make a viable business out of it. And people who are business gurus don't always understand the domain or software-development aspects. You need at least one person that understands all three aspects, to tie them all together.”

BHAVESH GUPTA

Global Director of
Engineering at Honeywell

3.5

ORGANIZE

to be software-product and services-centric

Shape a software-product and services-centric organizational structure

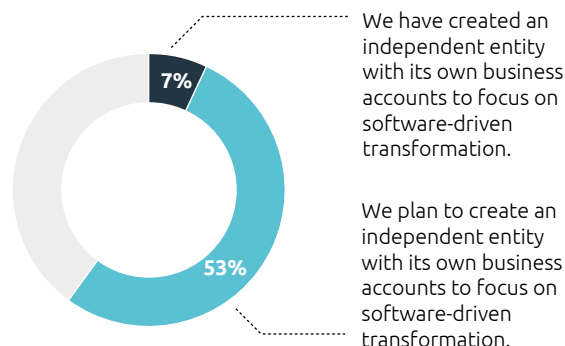
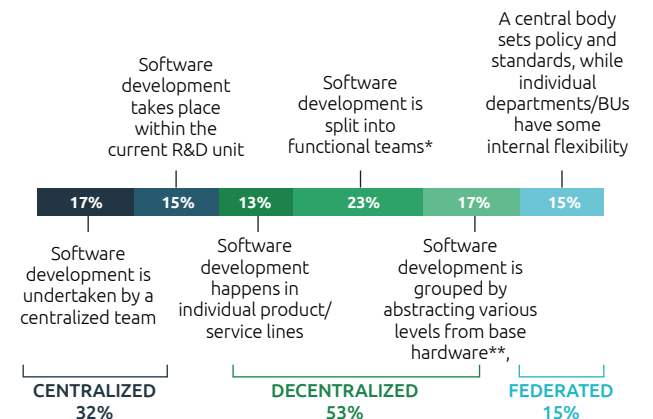
Large automakers have built new software organizations (MBition GmbH, in the case of Mercedes-Benz cars) with the sole purpose of developing software for their vehicles.⁴⁵ Within Robert Bosch GmbH, a new business unit, Bosch Mobility, which focuses on software-based engineering, will be managed as a business sector with responsibility for its own business and its own leadership team.

Figure 23, below, lays out the current state of organizational structures as per our research. Organizations need to evaluate each and choose which will work best for them:

- A majority (60 percent) of organizations are planning to create an independent entity to focus on software-driven transformation
- More than half (53 percent) of organizations currently focus on a decentralized approach to software development

FIGURE. 23

A majority of organizations are aiming to create an independent entity to focus on software-driven transformation

CURRENT AND PLANNED ORGANIZATIONAL STRUCTURE FOR TRANSFORMING INTO A SOFTWARE-DRIVEN ORGANIZATION**CURRENT STATE OF SOFTWARE DEVELOPMENT TEAMS**

Note: * i.e., separate development teams for HMI, autonomous, powertrain, etc., in a car); **e.g., microcontroller/assembly programming, low-level/closer to metal development, virtual environments, cloud computing, etc.

Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,500 organizations.

It should be noted that every model has benefits and challenges. For instance, of organizations with a centralized software development model, 42 percent rank “backlog prioritization” as a key challenge, owing to the necessity of shared resources. A digital and innovation lead at a global biotechnology company comments: *“In a centralized model, one of the biggest challenges you face is finding enough people to manage the ongoing projects. Additionally, a centralized model could be a barrier to innovation as the workload can overwhelm people.”* Similarly, of the organizations with a decentralized software team, half (53 percent) rank duplications and redundancies among their top three organizational challenges.

A software-product and services-centric organization

is a combination of strong autonomous teams; split by production or service perimeter; driven by client satisfaction; and applying agile and lean management principles, such as transparency, empowerment, collaboration, iterative delivery, and experimentation.⁴⁶ Software-product and services-centric organizations address all business aspects, including customer relations, operations, product management, and change management and innovation, as well as all IT aspects of their products and services, including legacy systems and digital delivery. A recent survey highlights that 85 percent of organizations have adopted, or plan to adopt, a product-centric application-delivery model.⁴⁷



42%

of organizations rank “backlog prioritization” as a key challenge, owing to the necessity of shared resources.

JP Morgan Chase is overhauling its IT organization of around 12,000 people with teams encompassing product owners along with technology, data, and design leaders. Instead of separate teams for each account type, there is a unified, multifunctional team dedicated to account opening. This team oversees the entire account-opening process, from design to upgrades, leading to a consistent experience across channels. Gill Haus, CIO for Consumer and Community Banking at JP Morgan Chase, adds: *"No matter how agile you are, you are solving different problems for customers in different ways unless you are organized by product and are customer-backed."*⁴⁸

85%

of organizations have adopted, or plan to adopt, a product-centric application-delivery model.



3.6

STREAMLINE

through agile methodologies, software factories and Generative AI

Amplify velocity and quality through agile methodologies and software factories

To create a holistic agile organization, agile principles and practices, as well as the underlying mindsets, must be scaled beyond individual teams. Frameworks such as scaled agile framework (SAFe), Large-Scale Scrum (LeSS), Nexus, and Disciplined Agile (DA) can help to kick-start an agile transformation, but it is important to customize the approach based on organizational culture. A data platform head at a French insurer says: *“We use agile frameworks only as a toolbox. If we want agile to work, we need to have a degree of adaptation and be tailored and relevant to our context.”*⁴⁹ In our research, only 34 percent of organizations agree that they select an agile-at-scale framework as a base for their own custom framework.

Building a modern software factory gives organizations the tools to innovate rapidly, streamlining all software-engineering processes to compete in the digital age. Combining agile with DevOps, supporting continuous integration and use of standard APIs multiplies efficiency and helps achieve value faster. Organizations also need to implement intelligent testing to build durability and detect weaknesses, saving on costs, staying compliant, and allowing for continuous innovation. This requires teams to develop comprehensive testing capabilities using AI and ML to predict and rectify issues before the software is deployed. Cloud-based, virtualized software development toolchains improve scalability, reduce development time, and improve collaboration. To apply DevOps in product-based industries, organizations should focus on strengthening virtual testing. To do this, they should:

- **Align engineering teams with value streams, with a focus on product delivery:** The example below describes the situation for a credit card company where business and IT have been vertically integrated through specific business products and customer journeys. Supporting these

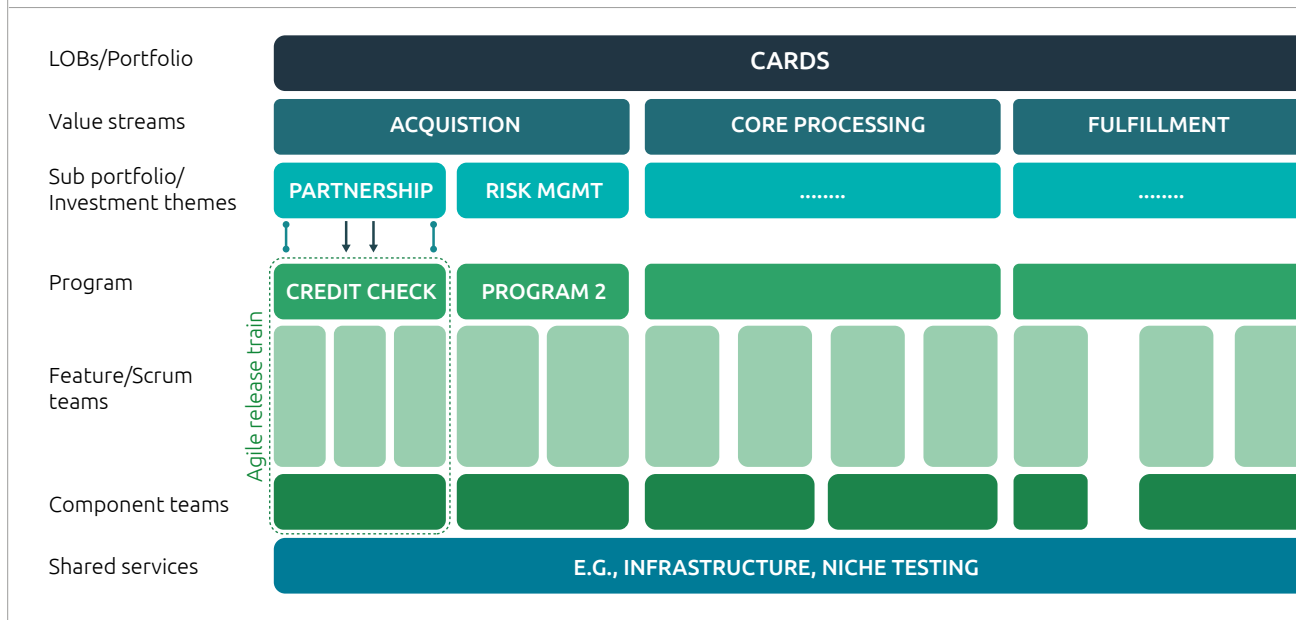
teams are component teams responsible for common technology architectural components such as cross-line of business (LoB) platforms. Over time, architectural changes can reduce the need for heavy component teams by abstracting business functionality into a more dynamic microservices layer.

34%

of organizations agree that they select an agile-at-scale framework as a base for their own custom framework.

FIGURE. 24

An example of a product-centric, vertically integrated organization



Source: Capgemini, "The state of art in agile software development," July 2021.

Moreover, our previous research highlights that agile frontrunners start by defining the customer journey and establishing guardrails for spending policies, guidelines, and practices for a specific portfolio of value streams.⁵⁰ A VC-type approach to funding fosters innovation and allows organizations to test more ideas, progressing the best. Antonietta Mastroianni, Chief Digital and IT Officer at Proximus, adds: *"Financial models need to evolve and become agile. The old approach, where organizations realize benefit after two years, is a no-go. So, the new focus should be rationalized [into] investing and creating value in small steps, with clear goals and plans."*

- **Use DevOps, DevSecOps, and continuous integration/continuous deployment (CI/CD) approaches to accelerate value:** While not a new concept, DevOps principles have gained tremendous support based on their ability to consistently reduce the time from development to operations. Automating end-to-end workflows through CI/CD pipelines enables shorter intervals between iterations and reduces the number of errors. Our research shows that 36 percent of organizations today are already using cloud-resident continuous integration tools and an additional 36 percent plan to use them in the next 12 months. One in three (33 percent) organizations currently uses a cloud-resident continuous development environment, and 39 percent plan to use it in the next

36%

of organizations today are already using cloud-resident continuous integration tools

12 months. With the rise of the use of Generative AI in software development, these toolchains become even more important, as they make it easier to both measure and manage process change.

Leading organizations are also extending DevOps to other key capabilities, such as security. DevSecOps – *incorporating practices and automation tools to validate the necessary security requirements for the full software development cycle* – can help organizations to reduce effort and costs, accelerate release, and improve security and compliance. Leading organizations shared the following best practices:



- In building software architecture, organizations must employ a security-aware mindset throughout. To “shift the security to the very left” of the development cycle requires revamping the security operating model.
- Organizations should create an automated build and test pipeline based on risk, including dynamic and static application security testing, functional testing, and unit testing. Alan Hohn, Chief Engineer at Lockheed Martin’s Software Factory, comments: *“Our customers are seeking frequent delivery of high-quality, secure software and we are rising to the challenge. We are using infrastructure automation to build systems in minutes, not days. We are using containerization to update systems continuously, not waiting for full system integration and delivery events.”*⁵¹
- Moving from the traditional way of working to the DevSecOps mindset requires a cultural shift. Organizations should focus on providing specific training for individual roles, embedding security champions into delivery teams and making security a shared responsibility.
- Organizations should use metrics to track improvements and lessons learned from security incidents and to incorporate them into the design process.



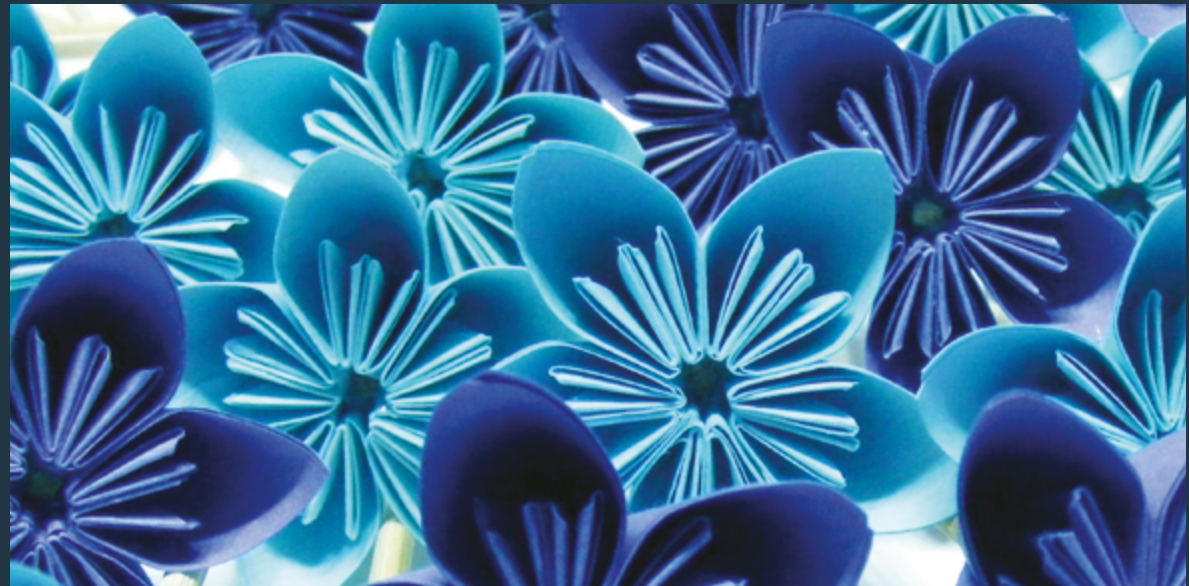
“Financial models need to evolve and become agile. The old approach, where organizations realize benefit after two years, is a no-go. So, the new focus should be rationalized [into] investing and creating value in small steps, with clear goals and plans.”

ANTONIETTA MASTROIANNI

Chief Digital and IT Officer
at Proximus

DEVELOP A STRATEGY AND CULTURE TO INTEGRATE THE HARDWARE-SOFTWARE DEVELOPMENT CYCLES FOR INTELLIGENT AND CONNECTED PRODUCTS

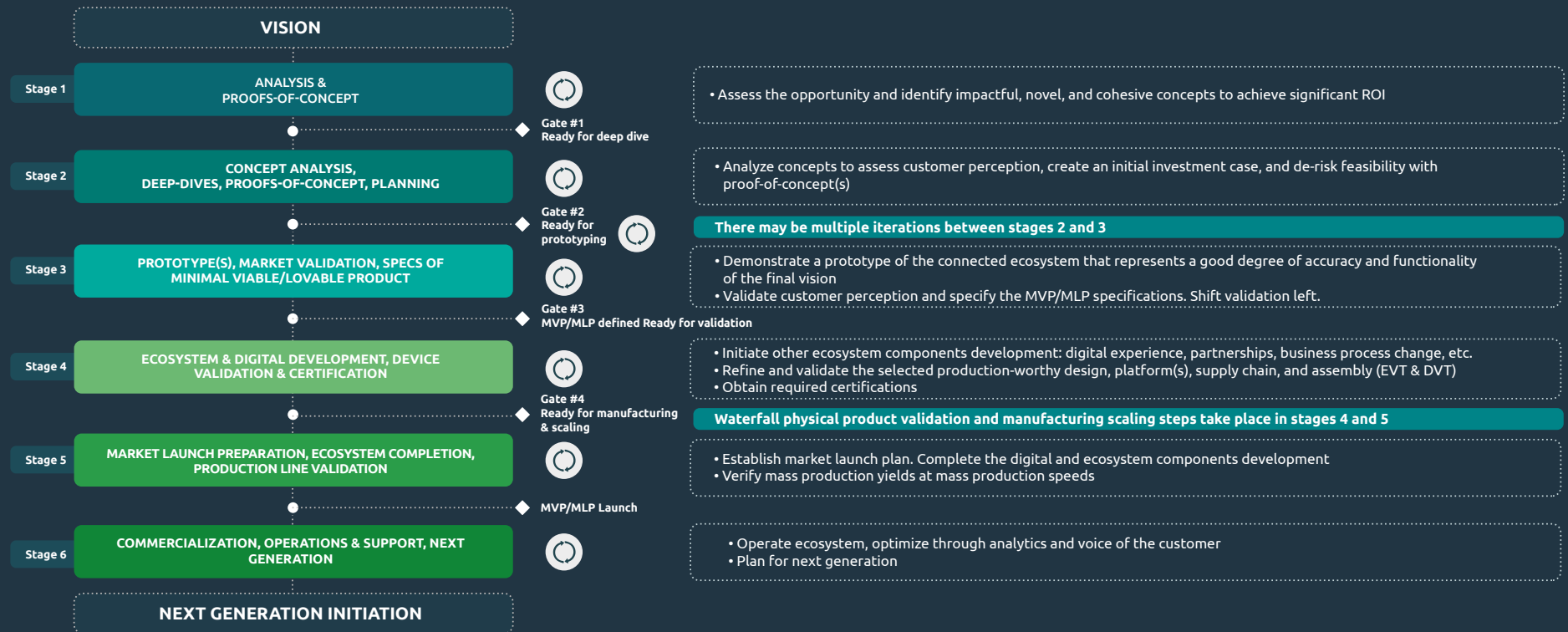
The integration of hardware development of traditional industries with software capabilities is an essential factor. Hence, a bimodal development approach works best to find the optimal balance between desirability, viability, feasibility, and sustainability perspectives. In the initial stages, all the ecosystem components should be developed in an agile manner, but some physical scaling steps – and some embedded software – may require a more sequential approach in the later stages. Proper integration of these two types of development cycles and its associated culture



can make a significant difference in performance optimization, deployment cost and, ultimately, user experience. Bimodal strategies also demand a culture of collaboration and communication.

Regular meetings and discussion are required to align expectations and synchronize hardware and software development.

For orchestrated hardware-software development, there are a few key requirements:⁵²



Accelerate software development with Generative AI

Software teams are under pressure to deliver software faster and to higher standards. However, they struggle to implement testing for quality, functional and technical

32%

of organizations are already piloting generative design for generating recommendations of new design concepts/configurations

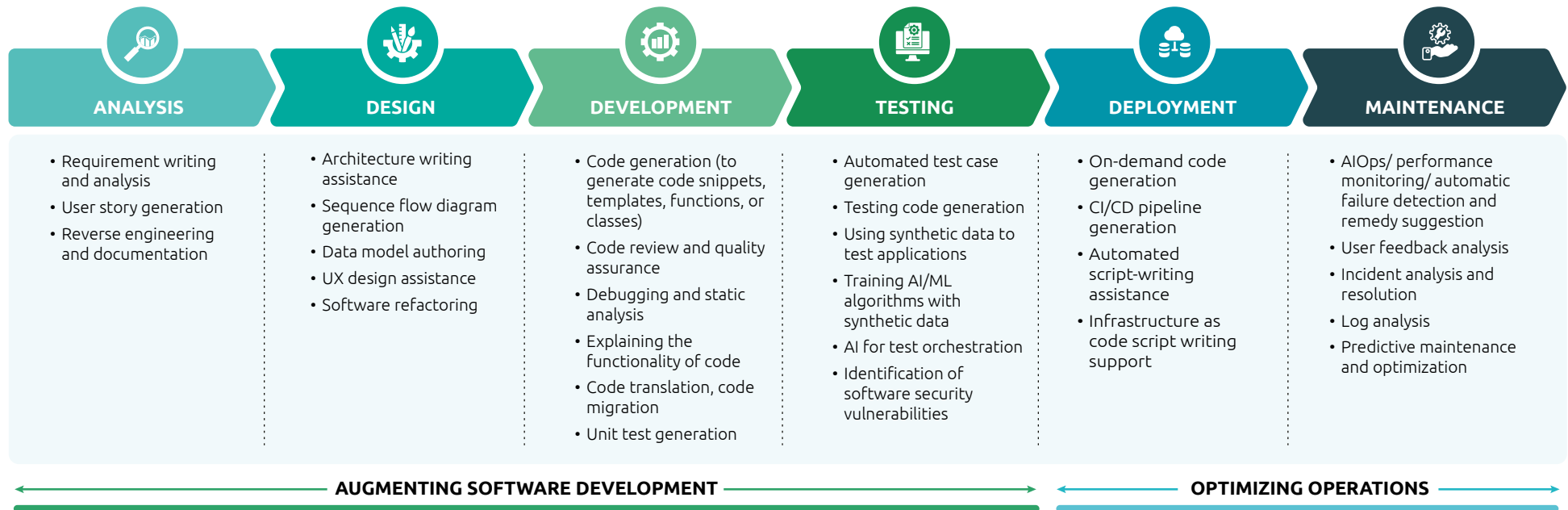
defects, cybersecurity vulnerabilities, and technical debt. Generative AI has the potential to transform software development and innovation.

Generative AI can streamline code creation, optimization, completion, testing, and debugging. Figure 24 (below) highlights the use cases of Generative AI in the software engineering lifecycle. Our previous research highlights that 32 percent of organizations are already piloting generative design for generating recommendations of new design concepts/configurations; 32 percent are doing pilots/PoCs on synthetic data generation; and 24 percent are experimenting with Generative AI for product testing.⁵³ Deutsche Bank is investigating the potential of Generative AI for three key areas: developing software code that aids developers in boosting productivity; implementing AI chatbots to assist employees and clients with queries using unstructured data and voice; and accelerating risk calculations.⁵⁴ As organizations delve deeper into Generative AI, and start experimenting and using it in their software journeys, they also need to develop a clear vision, strategy, and roadmap for prioritizing use cases.



FIGURE. 25

The use cases of Generative AI span the software lifecycle



Source: Capgemini Research Institute analysis.

Generative AI can also help employees who lack a coding background become productive developers within a managed lifecycle – essentially citizen developers. Amsterdam-based ING Bank began to explore citizen data-science capabilities amid a shortage of professional data-science talent in many countries in which it operates. ING uses these citizen developers to identify the use cases possible with automated ML, freeing up the data-science team.⁵⁵ However, there is also a need to enhance testing capabilities, such as regression testing, as well as to ensure proper guardrails to prevent the explosion of “gray IT” in organizations.

A product group manager at a global consumer product company says: *“Generative AI is arguably the most significant revolution we’ve witnessed in the last 5-10 years, with a high impact across all technical fields. In the past couple of years, Generative AI has demonstrated remarkable results. For example, GitHub Co-pilot offers extensive assistance in generating code. However, one needs to exercise caution regarding issues related to privacy and copyright infringement.”*

To harness Generative AI in software development, organizations should:

- Assess their current software lifecycle

- Conduct value, accessibility, and risk analysis to identify and prioritize the most prominent use cases
- Identify where they expect Generative AI to augment, automate, or optimize their software development
- Design and secure the required technology, people, and process foundations to deploy Generative AI at scale, safely, and at a controlled cost
- Upskill and engage teams on Generative AI
- Build best-in-class Generative AI-powered joint product teams or a “software house”

- Measure the impact of Generative AI across the software lifecycle on parameters such as productivity, quality, security, and developer experience
- Identify specific challenges and adapt the pace and scope of deployment accordingly

Our previous research revealed that nearly three-quarters of organizations identified a lack of data privacy and protection as a major concern in realizing the full potential of Generative AI.⁵⁶ For software engineering, as well, there are concerns regarding security and ownership of the IP and code. Organizations must recognize these challenges, establish guidelines, and adapt accordingly.



Conclusion

In today's rapidly evolving business landscape, software is a key strategic asset, crucial to unlocking new value streams, creating personalized customer experiences, and establishing competitive differentiation. Yet, as organizations embark on their software-driven transformation journeys, they encounter an array of challenges impeding scale, in areas including defining a strategy, designing for the user, collaborating, acquiring and retaining talent, building an enabling structure, and streamlining technologies.

To turn the tide and achieve software excellence, organizations must navigate the "why" and "how" of software transformation and

consider software as a key strategic business asset. This will require organizations to define a strategic vision, design a human-centric, sustainable, and flexible software and architecture roadmap, and engage with key ecosystem partners to realize the value potential that software-based business models offer. Transitioning and creating software excellence also demands a considerable shift in culture, talent, structures, and ways of working – including streamlining via agile methodologies and technologies such as Generative AI.

Software is no longer an optional area for the curious to explore; it is the new frontier through which businesses must decisively chart their courses to secure sustainable success.

Research methodology

To understand the various routes of value creation that software can unravel in organizations across industries, we conducted extensive research, with qualitative and quantitative components.

In-depth interviews

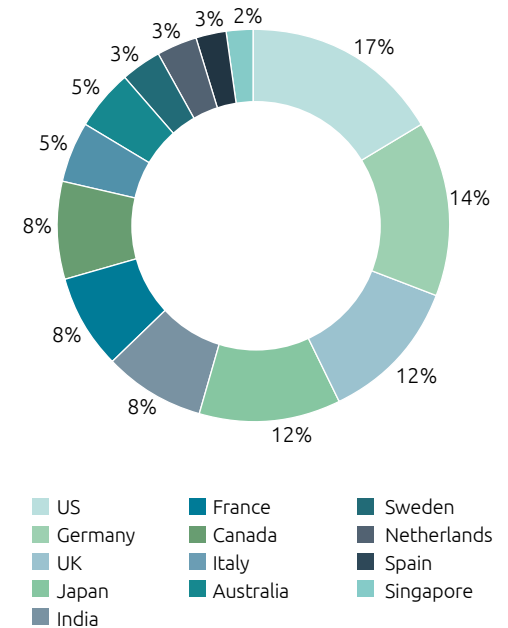
We conducted more than 20 in-depth interviews with industry executives from various organizations, which includes traditional manufacturers and digital natives. Interviewees comprised those involved in the development of software-driven transformation initiatives working across all functional areas, such as general management/strategy, innovation, software engineering, research and development, IT and data management, marketing and sales, product/service development, and customer management.

Executive survey

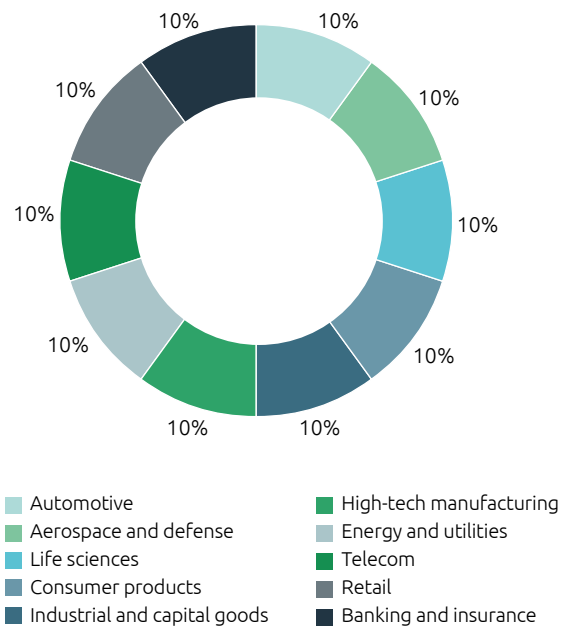
We surveyed 1,500 respondents from unique organizations with over \$1 billion in annual revenue, across 10+ countries. Out of these, 1,350 organizations have/are building a strategy to become a software-driven organization, focusing on software-defined products/services. The respondents were at director level or above, responsible for software initiatives in their organizations. The distribution of respondents and their organizations is provided in the following figures.

The study findings reflect the views of the people who responded to our online questionnaire for this research and are aimed at providing directional guidance. Please contact one of the Capgemini experts listed at the end of the report to understand specific implications.

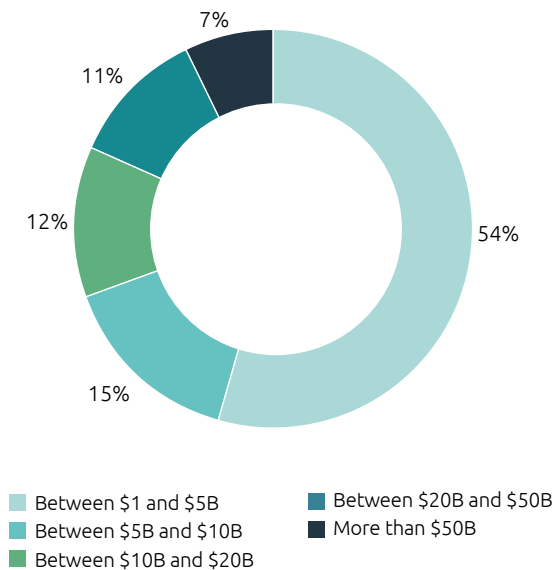
% OF ORGANIZATIONS BY HEADQUARTERS LOCATION



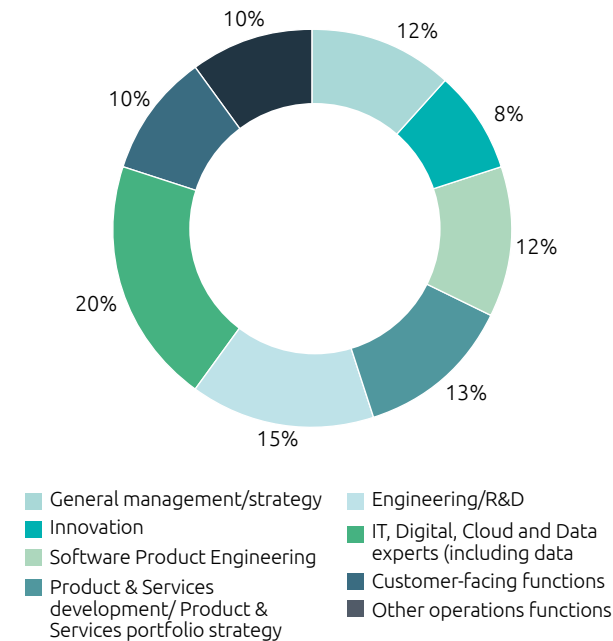
% OF ORGANIZATIONS BY SECTOR



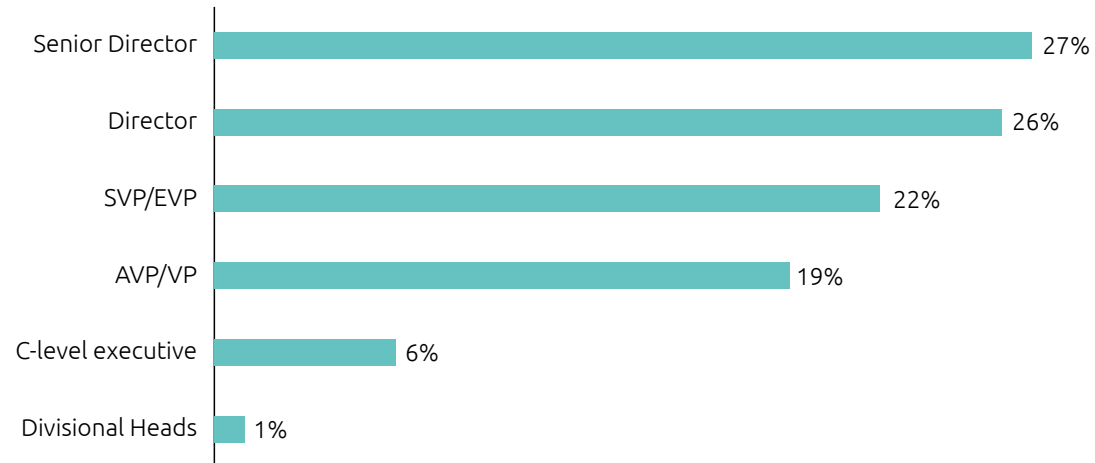
% OF ORGANIZATIONS BY REVENUE



% OF RESPONDENTS BY FUNCTION



% OF RESPONDENTS BY DESIGNATION



Source: Capgemini Research Institute, Software-driven transformation survey, June-July 2023, N = 1,500 unique organizations that have created new routes of value creation through software-driven initiatives.

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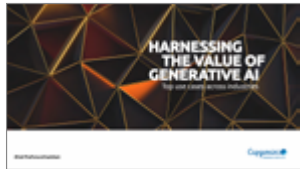
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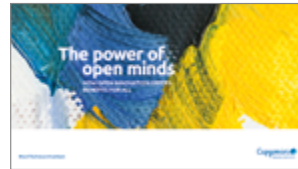
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