



# The Role of Digital Enablers in Creating Viable Supply Chains

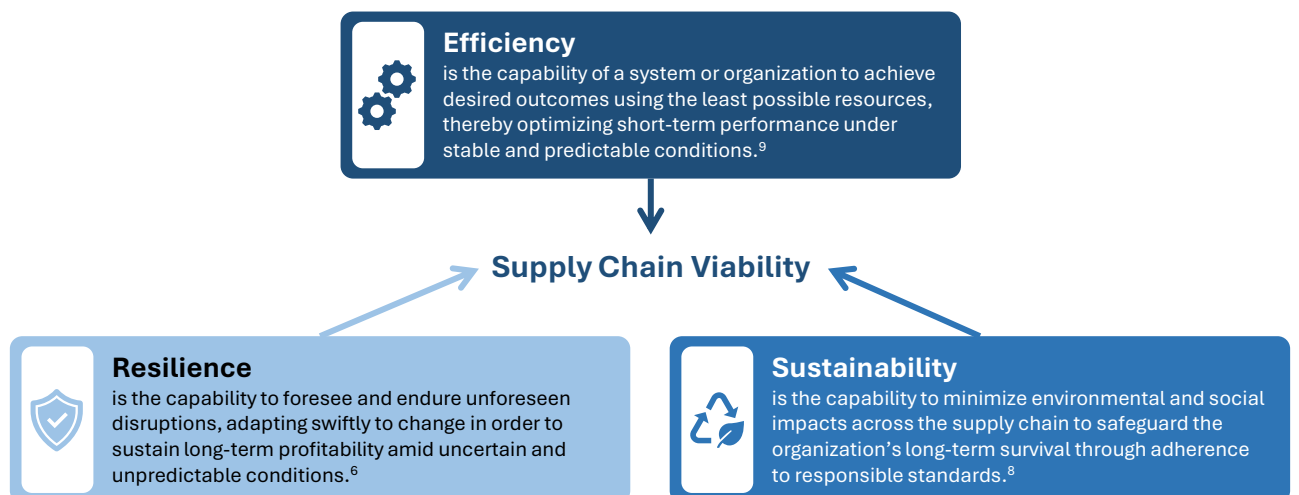
# From the Efficiency Paradigm to the Need for Viable Supply Chains

The twenty-first century is defined by a degree of complexity and uncertainty unprecedented in modern history<sup>7</sup>. Societies and economies are undergoing rapid transformation, driven by technological innovation, shifting demographics, geopolitical tensions and accelerating globalization. This creates a VUCA environment characterized by volatility, uncertainty, complexity and ambiguity, in which paradigms of efficiency-driven growth are no longer sufficient.<sup>7</sup>

COVID-19 has made this uncertainty clear to all stakeholders. The pandemic severely disrupted global supply chains (SCs), affecting all stages from sourcing to delivery. Lockdowns, border closures and transport restrictions caused shortages of labor and materials, halting production across multiple industries. International logistics were constrained, while sudden shifts in demand created further instability. The crisis exposed the fragility of efficiency focused SCs and underscored the need for greater resilience and adaptability.<sup>12</sup>

For SCs, this means that traditional optimization for cost and speed must be complemented by strategies that foster resilience and sustainability. Only by balancing efficiency with the capacity to absorb shocks and adapt to change can SCs remain viable and competitive in a world where disruption is no longer the exception but the norm. As a response to these emerging requirements, the concept of Supply Chain Viability (SCV) has been established.

Figure 1  
Elements of SCV



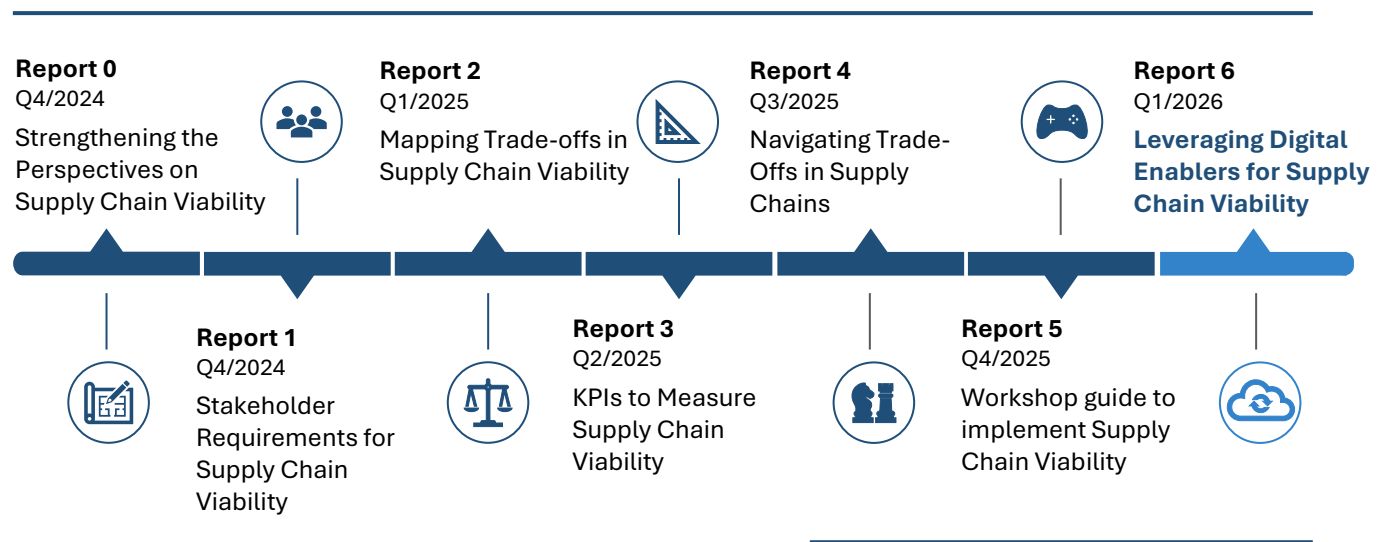
# Digital Enablers build a Foundation for Implementing SCV

SCV extends beyond short-term resilience by explicitly integrating sustainability, adaptability, and long-term survivability into SC design and decision-making. Within this context, digital enablers are not viewed as isolated technologies, but as foundational capabilities that support transparency, coordination, and informed decision-making across SCs.<sup>3</sup>

Digital solutions enable end-to-end visibility, real-time information sharing, decentralized decision-making, and the orchestration of increasingly complex SC networks. Rather than replacing managerial judgment, digital enablers enhance the ability of decision-makers to assess trade-offs between efficiency, resilience, and sustainability in a structured and timely manner. Digital technologies such as data analytics, digital platforms, and integrated information systems contribute to the development of adaptive SC structures, which are essential for maintaining viability over time.<sup>13</sup>

Building on the preceding reports, this contribution situates digital enablers within the overall SCV report series. While earlier reports established the conceptual foundations of SCV, identified stakeholder requirements, mapped key trade-offs, defined measurement approaches, and explored strategic and practical implementation pathways, this report focuses on the role of digital enablers in supporting viable SCs. You may find all the previous and published reports on our project website ([www.sc-evolution.ch](http://www.sc-evolution.ch)).

Figure 2  
**Roadmap of the report series**



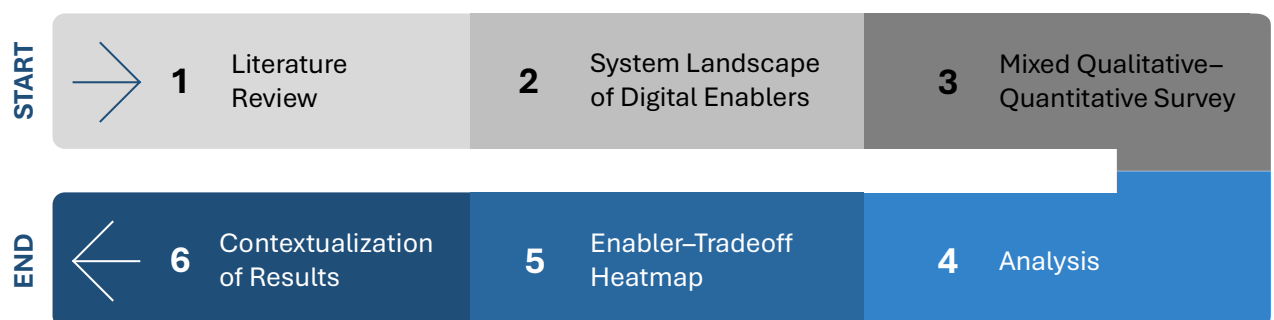
# Research Methodology

This report follows a structured, multi-stage research approach to identify and assess digital enablers for SCV. The analysis combines conceptual grounding with empirical validation and qualitative contextualization to ensure both analytical rigor and practical relevance.

The research starts with a comprehensive literature review to identify digital enablers relevant to SCV. Rather than focusing on individual technologies, the review consolidates digital capabilities into functional enabler categories that support transparency, coordination, and decision-making across efficiency, resilience, and sustainability dimensions. This results in a structured system landscape of digital enablers that forms the basis for the empirical analysis.

Building on this landscape, a mixed qualitative-quantitative survey assesses the relevance of digital enablers in practice. The results are analyzed using a heatmap-based approach, enabling a comparative view of enabler relevance across SCV dimensions. To enrich these findings, a workshop-based qualitative analysis is conducted to contextualize the results, explore interaction effects, and account for factors such as firm size and digital maturity.

Figure 3  
**Stepwise research process**



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# Digital Infrastructure Supporting the Implementation of SCV

Digitally enabled SCs rely on a layered ecosystem of operational, planning, sustainability, risk, and analytics systems, each supporting different viability goals.

At the core of operations, firms deploy transactional and execution systems such as ERP for integrated order, inventory and financial flows, WMS/TMS for warehouse and transport execution, and MES/automation platforms on the shop floor to coordinate production and logistics in real time, often extended with IoT, AI and cloud platforms for visibility and coordination. On the planning side, APS and advanced analytics/big-data platforms support demand forecasting, network planning and inventory optimization, frequently embedded in or connected to ERP and digital-twin solutions for scenario simulation and disruption response.<sup>10</sup>

For sustainability, companies increasingly use ESG and sustainability information systems, including life-cycle assessment tools, carbon and environmental management systems, and supplier sustainability or ESG-rating platforms, to evaluate environmental and social impacts across the chain and to link them to procurement and operations decisions.<sup>2</sup>

Resilience-oriented layers comprise risk management systems (RMS), supplier relationship management and digital procurement platforms, as well as tracking and visibility solutions (IoT, blockchain, digital twins) that enhance situational awareness, supplier risk assessment and predictive disruption management.<sup>1</sup>

Cutting across all these domains are business-intelligence platforms, data warehouses, product lifecycle management (PLM) and enterprise performance management (EPM), which integrate heterogeneous data, provide dashboards and KPIs, and connect operational events with strategic, sustainability and resilience metrics, thereby enabling data-driven decision-making for efficiency, sustainability and resilience in an integrated supply-chain viability landscape.<sup>11</sup>

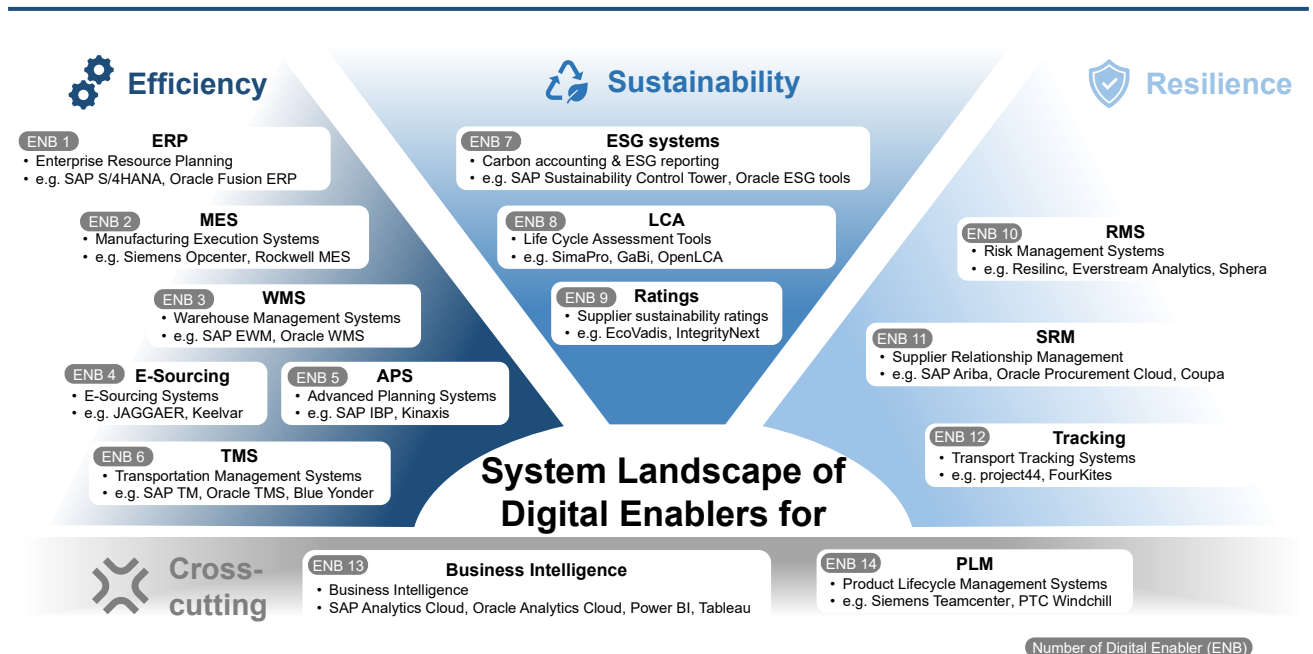
# Digital Enabler System Landscape

To structure the diverse range of digital enablers, the following system landscape provides an integrated overview of digital systems supporting SCV.

The upper part of the landscape groups digital systems based on the SCV dimension they primarily support. Efficiency-oriented systems focus on planning, execution, and operational optimization, sustainability-oriented systems support environmental and social assessment, and resilience-oriented systems enhance risk awareness, visibility, and supplier-related capabilities. While each system category is assigned to a dominant dimension, the landscape explicitly acknowledges that these systems are not exclusively limited to a single viability goal and often contribute to multiple SCV dimensions simultaneously.

In addition, the landscape includes a cross-cutting layer of digital systems that support SCV across all dimensions. These systems integrate and consolidate data, enable analytics and performance management, and support coordinated decision-making across efficiency, sustainability, and resilience considerations.

Figure 4  
System Landscape of Digital Enablers for SCV



# Technology Enabling SCV

In addition to the system landscape, numerous cross-cutting technologies also act as digital enablers for ensuring a viable SC. The digital transformation is driven by a broad set of Industry 4.0 technologies that work together from infrastructure to decision-making. Foundational technologies such as cloud computing and APIs provide scalable computing power and connectivity, enabling real-time data sharing across partners.<sup>2</sup>

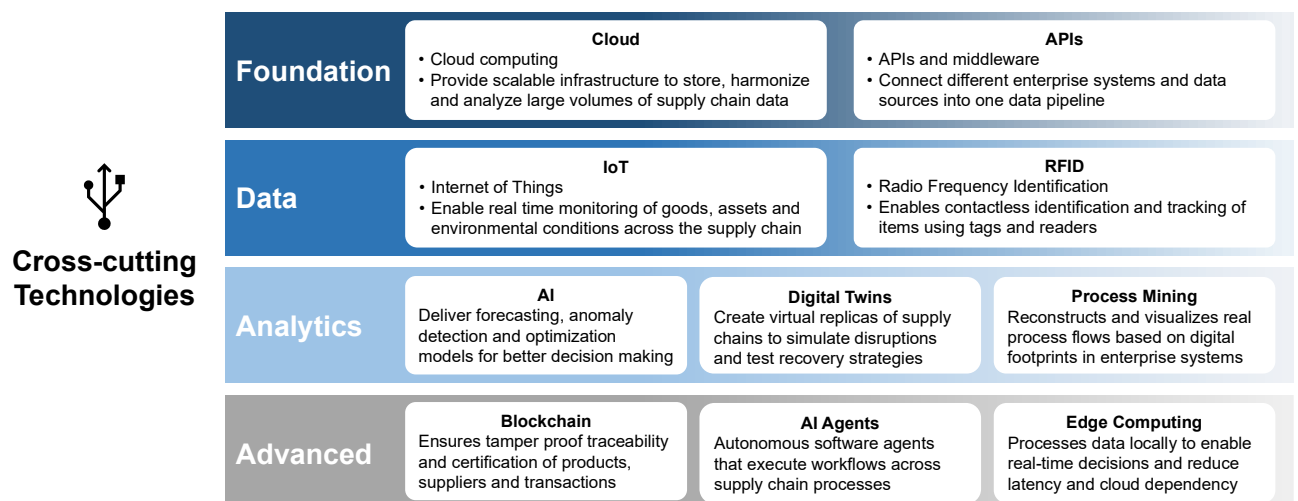
On top of this, data-generation technologies like the Internet of Things (IoT) and RFID capture continuous information on location, condition, and status of products and assets, greatly enhancing visibility and traceability.<sup>10</sup>

These data streams feed analytics-driven technologies including big data analytics, artificial intelligence and machine learning, digital twins, and data science tools, which support forecasting, optimization, and simulation for production, logistics, and inventory decisions.<sup>5</sup>

Finally, complementary technologies such as blockchain, edge computing, and autonomous AI agents address specific needs like secure traceability, low-latency control, and autonomous execution in complex, multi-stakeholder networks.<sup>4</sup>

Bringing these elements together, the figure structures key technology enablers for SCV into four layers: Foundation, Data, Analytics and Advanced.

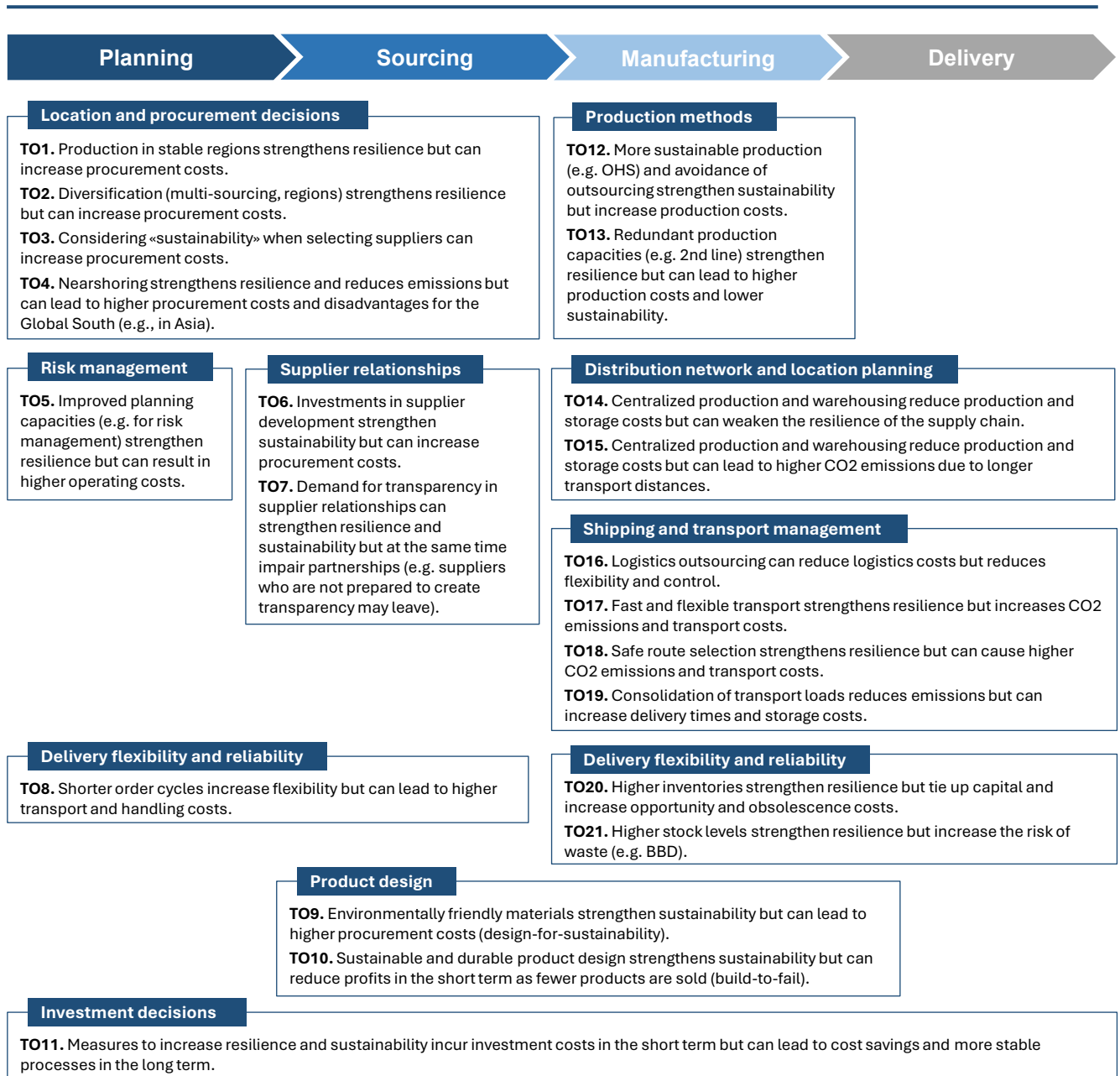
Figure 5  
Technology Landscape for SCV



# Review of the Trade-off Map

The system and technology landscapes presented are based on an extensive literature review and outline digital enablers relevant to SCV. Building on this foundation, the study subsequently examines how these digital enablers interact with the SC trade offs that were identified as a core element of SCV in Report 2. Figure 6 therefore illustrates the identified trade offs, which serve as the analytical reference for the subsequent empirical assessment.

Figure 6  
Trade-off Map for SCV

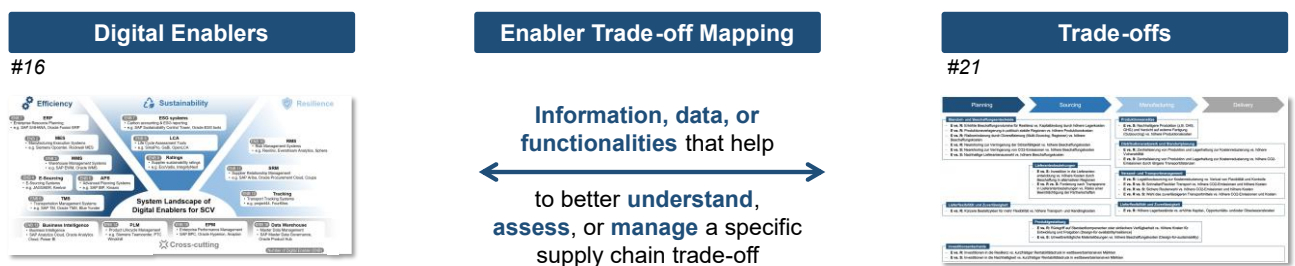


# Survey with Supply Chains Experts

The objective of the survey was to assess how digital enablers support the management of specific supply chain trade-offs that are central to SCV. In particular, the survey aimed to evaluate to what extent digital enablers provide information, data, or functionalities that help SC practitioners better understand, assess, or manage individual trade-offs.


To achieve this, SC experts were asked to evaluate the contribution of different digital enablers to a set of predefined trade-offs. The survey builds directly on the trade-offs identified in Report 2 and links them systematically to the digital enabler landscape developed in the literature review.

Figure 6  
**Survey Objective: Mapping the Enabler to the Trade-Offs**



To ensure practical relevance, the survey was conducted with >100 SC experts from a broad range of industries, roles, and companies. The following persona summarizes the typical profile of the participants and illustrates the professional background on which the empirical findings are based.

Figure 7  
**Typical Survey Participant**



<b>Role</b>	Mid- to senior-level supply chain managers and subject-matter experts
<b>Experience</b>	Solid professional experience, most commonly between 5 and 20 years
<b>Industry</b>	Strong representation from manufacturing, logistics, automotive, and retail sectors
<b>Company Size</b>	Primarily professionals from medium to large organizations (1,000+ employees)
<b>Geography</b>	Primarily Germany-based, complemented by international perspectives

# Impact of Digital Enablers on SCV

The results show clear and consistent patterns. Digital enablers differ substantially in their contribution to trade-off management, with particularly strong effects observed for enablers related to planning, data integration, and transparency. Advanced planning systems (APS), enterprise resource planning systems (ERP), and business intelligence solutions (BI) stand out across multiple functions, highlighting the central role of information availability and decision support in addressing SC trade-offs.

Across the dataset, digital enablers are perceived to address efficiency- and resilience-related trade-offs more strongly than sustainability-oriented ones. This indicates that digitalization is primarily viewed as an operational and risk-management lever, while sustainability impacts remain more indirect. In addition, the results reveal meaningful variation across SC functions, underlining that the effectiveness of digital enablers depends on functional context.

The analysis follows an exploratory expert-based approach and focuses on identifying robust patterns in expert perceptions. Trade-off–enabler combinations based on single expert responses were excluded to increase robustness. Figure 8 synthesizes the results in a heatmap, providing an integrated overview of the perceived impact of digital enablers across trade-offs and SC functions. Color intensity reflects impact strength, while empty cells indicate combinations not perceived as relevant.

Figure 8  
**Enabler – Tradeoff Heatmap**

Cluster	Tradeoff	Efficiency					Sustainability			Resilience			Cross		
		ERP	MES	WMS	eSourc.	APS	TMS	ESG	LCA	Ratings	RMS	SRM	Tracking	BI	PLM
Procurement / Purchasing	T 01	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 02	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 03	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 04	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 05	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 06	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
Supplier Mgmt. / Partnerships	T 07	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 08	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
Production / Operations	T 11	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 12	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 13	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 14	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
Transport / Logistics / Distribution	T 15	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 16	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 17	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 18	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 19	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
Inventory Mgmt. / Warehouse Mgmt.	T 20	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak
	T 21	Strong	Weak	Weak	Strong	Strong	Weak	Weak	Weak	Strong	Strong	Weak	Strong	Weak	Weak

Legend: Color intensity indicates the perceived strength with which a digital enabler addresses the respective trade-off; empty cells indicate no perceived relevance

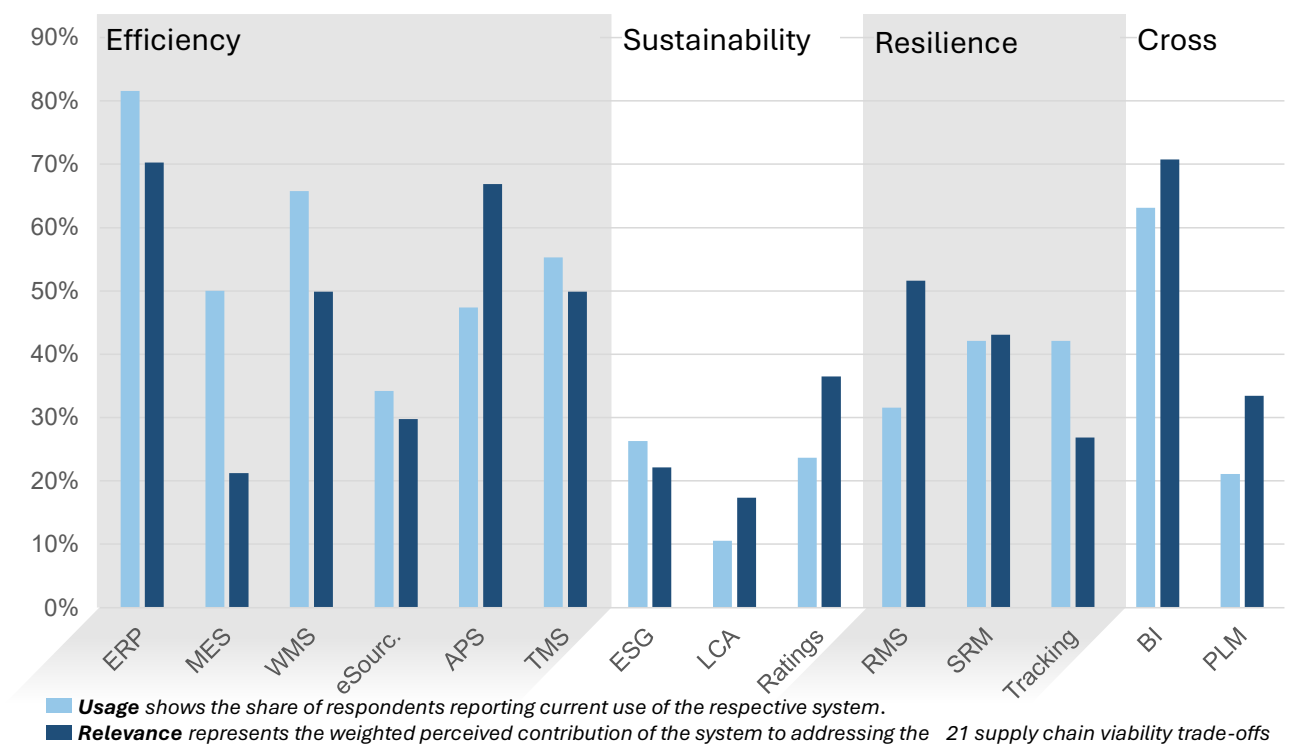
To complement the heatmap results, this section contrasts the current usage of digital enablers with their perceived relevance for addressing SCV trade-offs. The results reveal three clear patterns.

First, foundational systems such as ERP and WMS exhibit high usage combined with solid relevance, confirming their role as essential enablers of data integration and process stability. Second, several enablers show high relevance but comparatively low adoption, most notably Advanced Planning Systems (APS), Risk Management Systems (RMS), and Supplier Relationship Management (SRM). These systems are perceived as particularly valuable for managing complex trade-offs yet remain underutilized across many organizations.

Third, sustainability-focused tools (e.g., ESG or life-cycle assessment systems) display lower relevance and usage, suggesting that sustainability effects of digitalization are currently perceived as more indirect.

Overall, the comparison indicates that digital SC transformation is still largely driven by operational requirements rather than by a targeted focus on trade-off management. From a SCV perspective, the greatest potential lies in increasing the adoption of highly relevant but underutilized digital enablers.

Figure 9  
**Enabler – Tradeoff Heatmap**



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# Conclusion

This report examines how digital enablers are used to support the management of SC trade-offs and how this addresses SCV. The analysis builds on the trade-offs introduced in Report 2 and links them to the digital systems named by the respondents. The results suggest that digitalization contributes to SCV mainly by supporting transparency, planning activities, and decision-making across different SC functions.

Looking at the survey results in more detail, one pattern appears repeatedly. Digital enablers that support planning, data integration, and risk visibility are rated as particularly helpful. This includes systems such as ERP, Business Intelligence tools, and planning-oriented applications. According to the respondents, these systems help address tensions between efficiency and resilience, for example by improving coordination or enabling better-informed planning decisions. Sustainability-related systems show a different picture. Their perceived impact on trade-off management is lower, which suggests that their role is often indirect and linked to other processes rather than to daily operations.

One result stands out. Several systems are seen as highly relevant but are not widely used in practice. This applies in particular to **Advanced Planning Systems (APS)**, **Risk Management Systems (RMS)**, and **Supplier Relationship Management (SRM)** systems. Many respondents associate these systems with better handling of complex trade-offs, yet their adoption remains limited. This can be interpreted as an indication that the main challenge is not the lack of available technologies. Instead, difficulties seem to arise from **integration into existing IT landscapes** and from **how these systems are embedded in decision routines**.

The findings point to the need for a more coordinated use of digital enablers in SCs. Single tools on their own appear insufficient to support SCV. What seems to matter more is how planning, risk, and supplier-related systems work together in practice. For practitioners, this suggests that investment decisions should focus on systems that directly support trade-off-related decisions and can be integrated into existing processes. From a research perspective, the results provide a basis for further studies on how digital systems influence decision-making over time and how this affects long-term SCV under changing conditions.

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