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Integrating resilience and sustainability in new product development by Central European automotive firms: is there synergy or two independent concepts?

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Abstract

Purpose – This paper examines how automotive manufacturers in Hungary and Czechia have implemented resilience and sustainability measures within new product development (NPD).
Design/methodology/approach – Building on the resource dependence theory (RDT), it uses data from eleven in-depth interviews triangulated with suppliers' codes of conduct and non-financial reports.
Findings – Resilience considerations and dependencies, as expected by RDT, shape the NPD decisions and sustainability is embedded, especially when prompted by customers or company needs for higher efficiency.
Research limitations/implications – The research is limited by the selection of large companies as well as by the sample size, while the case study approach enables us to dive into the strategies.
Practical implications – The research pointed to the importance of strategic procurement and the role of original equipment manufacturer (OEMs) and multinationals' management in the operational process.
Originality/value – We contribute to extant literature by linking supply chain resilience and sustainability with NPD in an asymmetric and dependency-driven process.

Keywords Supply chain management, Resilience, Sustainability, New product development, Electromobility
Paper type Research article

Introduction

European automotive supply chains have been under pressure and subject to many external shock events in the past six years. It started with the COVID-19 pandemic in 2020 (Nagy *et al.*, 2020), the Ukraine–Russia war in 2022 (ECB, 2022), but included other issues such as the blockage of the Suez Canal, traffic disruptions in the Panama Canal, Houthi vessel attacks, the Strait of Hormuz crisis and many others. These are only examples of what the industry has been facing since 2020 and are termed economic policy uncertainty (OECD, 2025, based on Baker *et al.*, 2016). All this was compounded by an environment in which automotive companies were facing the challenge of transitioning to battery electric vehicle (BEV) manufacturing, so companies were forced to react on both the supply and demand sides, examining their sourcing capabilities (White *et al.*, 2022).

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Companies therefore implemented mitigating measures and developed resilience strategies to overcome crises and shocks, both internally and within their supply chains. Still, these are vulnerable due to dependence on sourcing from their supply chain partners and the constant risk of unexpected events magnified by the length and complexity of global supply chains (Belhadi *et al.*, 2021). More than ever, firms come to understand the benefits of resilience and its caveats, such as robustness, agility and flexibility. It is no longer sufficient to have only one most cost-effective solution that balances price and quality (Shishodia *et al.*, 2023). What matters is the long-term probability of a successful business operation or, in the case of our paper, new product development (NPD) (Dev *et al.*, 2021). Supply chain disruptions have taught us a valuable lesson: to switch from lean (Cox, 1999) to resilient (Miroudot, 2020).

In the post-pandemic years, the implementation of the European Green Deal (European Commission, 2023) has introduced new legislation on sustainability and its reporting, resulting in new uncertainties. Sustainability has been at the forefront in recent years, although it has suffered somewhat as a result of the new US president, Trump (Cosma *et al.*, 2025), and the consequent loosening of environmental, social, and governance (ESG) reporting requirements by the European Union (van Beest and Orij, 2025). Due to changes in car producers' product portfolios, supply chains have adapted to meet recent and future needs.

In general, NPD and innovation are tightly linked to sustainability, as every additional new product needs to match the new legal requirements and also meet pressures from lead firms and end consumers, all of which enable sustainable innovation in manufacturing (Ghobakhloo *et al.*, 2021). It is also intertwined with digitalization and Industry 4.0 transformation (Agarwal and Ojha, 2024). By its nature, new products will have more advanced, efficient and economical designs than the old ones (Diaz *et al.*, 2021). One of the good example is the automotive industry – new cars need to match tighter emission requirements, and there are plans to fully ban combustion engine vehicles in the EU after 2035, which is supposed to help the green transition (Seibert *et al.*, 2024); while it does not mean that petrol and diesel cars will stop circulating after this date. Still, unresolved challenges of electromobility within some automotive segments remain, such as heavy-duty vehicle fuel transition (Neagoe *et al.*, 2024).

Despite the fact that resilience and sustainability research are increasingly gaining ground in the literature on operations and supply chain management (SCM) as reviewed by Sauer *et al.* (2022) and Holgado *et al.* (2024), and significant results related to NPD have been published (Sinha and Anand, 2018; Kalish *et al.*, 2018; Oh and In, 2023), there is still considerable theoretical fragmentation. On the one hand, existing frameworks often examine post-crisis response capabilities, and it is rare for the three aspects outlined in our research to be analyzed together in an integrated operational strategy model. In this study, we advance the SCM literature by answering the following research questions:

RQ1. How are supply chain resilience and sustainability dimensions integrated in NPD?

RQ2. How can SCM resilience in NPD support sustainability and vice versa?

The contribution of our research lies in applying the resource dependence theory (RDT; Pfeffer and Salancik, 1978) to sustainability, resilience and NPD. Our research focuses on two Central European countries – Czechia and Hungary. We limit our investigations to the automotive sector and investigate how companies implement sustainability and resilience principles in NPD to maximize the benefits. We found that the manufacturers have already implemented this strategy, but based on various pressures. They take part in the transition when either they see a direct demand from their customer, or when it makes economic sense. Secondly, they often boost resilience with the objective of ensuring steady operations. Overall, the manufacturers do not operate in a vacuum and are driven by their mother companies and/or clients who, based on the RDT, rely on their supply chains to meet their sustainability and resilience goals.

The paper is structured as follows. We first introduce the RDT in the context of our research, review the existing research on the importance of logistics and sourcing in NPD, the

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role of resilience and sustainability in NPD, and study the relation between the concepts. We base our research on a qualitative approach with a multiple case study research on eleven companies, complemented by an analysis of non-financial reports and publicly available general procurement terms. We conclude with a discussion of results, limitations and suggest future research directions.

Literature review

Resource dependence theory as the overarching paradigm

This paper applies the RDT (Pfeffer and Salancik, 1978; Defee *et al.*, 2010) as the lens to interpret three concepts – NPD, resilience and sustainability; and the relationships among them. RDT postulates that in order to reduce uncertainty of outcomes and minimize the dependencies, companies tend to gain access to scarce resources by forming interorganizational alliances and other relationship-building options. NPD literature stresses "*the importance of introducing new products on the market for continuing business success*" (Bhuiyan, 2011, p. 747), and as early as the 80s (Takeuchi and Nonaka, 1986), it became clear that success can be achieved only by flexible and rapid innovation of the processes. It is in itself a process requiring new and innovative resources beyond the usual capabilities of a firm; therefore, new alliances, vertical integration or forming personal ties need to occur for this process to be successful (Drees and Heugens, 2013).

Supply chain resilience is a strategy to maximize flexibility, create redundancy, build collaborative ties within supply chains and boost agility with the objective to sustain and recover from shocks (Tukamuhabwa *et al.*, 2015). Again, the RDT can mean that supply chain dependence increases vulnerability; on the other hand, arrangements with partners and suppliers can be created to build adaptive measures (Drees and Heugens, 2013). Sustainability in our paper entails advancing technologies in order to reduce the environmental footprint of products and the externalities associated with the company's activities (Sims *et al.*, 2014). RDT focuses on external stakeholders affected by the externalities a company creates. In order to tackle wicked problems of today's world (Termeer *et al.*, 2019) and generate innovative ideas that reduce the footprint, cross-functional and cross-industry alliances need to be formed, as they are more complex than a single stakeholder or entity could handle in isolation (Simons and Nijhof, 2020). Stakeholders in the transition towards sustainable supply chains create pressure and legitimacy for claims that can only be addressed through measures across the supply chain, making manufacturers dependent on their suppliers' capabilities and resources (Kim *et al.*, 2022). The relationships noted are visualized in Figure 1.

The role of logistics and sourcing in new product development

The NPD process is complex, typically consisting of the planning and defining phase, product design and development, and product validation phase (Tuli and Shankar, 2015). The

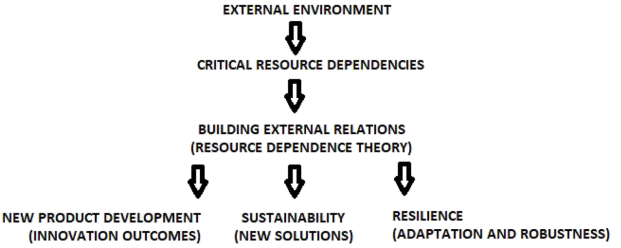

Figure 1. Relationship between resource dependence theory, NPD, sustainability, and resilience. Source: Authors' own work

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product's scale and complexity increase the number of people involved in product development and the time spent on development, not only within the company, but also across the supply chain as stipulated by the RDT (Kim *et al.*, 2022). In the automotive sector, NPD can concern new module development or innovation of their parts (Koppenhagen and Held, 2021). The trend leads towards increasing efficiency in developing and leveraging the increasing costs, shortening technology and product life cycles. We can also see a shift from linear planning (Brown and Karagozoglu, 1993) to agile and more flexible process planning in development with "jumping over phases" (Hölttä–Otto *et al.*, 2022). Product development processes require planning across the supply chain; any problems along the processes can result in delays or additional costs. Previous articles dealt with effective product innovation processes but considered stable and predictable conditions (Rogers *et al.*, 2004) or uncertainty in terms of technology development (Dugoua and Dumas, 2021).

Even if the external environmental conditions are predefined, companies deal with internal uncertainties (Hölttä-Otto *et al.*, 2022). Delays in introducing a new product lead to losses in expected profit (McNally *et al.*, 2011). New projects may involve new suppliers and sourcing new materials. Such materials' storage can be separate from other materials, and special handling and evidence may be required. The testing phase is another crucial moment prone to delays, which can result in extra transportation costs. People in the carefully planned process care to meet customer commitments, and the late transmission from the new project to the serial production phase can be associated again with additional costs.

SCM establishes "*networks of relationships between interrelated and interdependent organizations, as well as across business units internal to an organization*" (Stock and Boyer, 2009, p. 703). The role of logistics and supply chain partners in NPD has been observed since the 1980s (Meyers and Tucker, 1989; Clark, 1989), and significant work to define the role of logistics was done in the 1990s (Stank *et al.*, 1999; Bowersox *et al.*, 1999). The authors mention the benefits of logistics involvement in the early stage of NPD. Cases point to situations when this was not the case. "*The purchase commitments were made when the project was about 45% complete*" (Birou and Fawcett, 1994, p. 9), while the personnel involved in the NPD process included mainly engineering and manufacturing personnel. The positive impact of interdepartmental collaboration on performance was supported by Stank *et al.* (1999), who observed formal and informal collaboration between logistics and marketing personnel. The risks associated with the launch phase can be greatly reduced when logistics and SCM are involved in the planning, implementing and controlling processes (Bowersox *et al.*, 1999). Some decisions that impact the logistics process are make-or-buy decisions, supplier selection, product development solutions and choice of materials (Andersson, 2007). The involvement of supply chain partners results in better resource utilization, efficiency, quality and development time (Clark, 1989; Birou and Fawcett, 1994).

Collaboration with suppliers in NPD has proven beneficial (Oh and In, 2023). Suppliers are more likely to be present in NPD when there is increased knowledge or technology uncertainty (Petersen *et al.*, 2003). Quality is important when the supplier is involved in the development or needs to be replaced due to a disruptive event. original equipment manufacturer (OEMs) delegate tasks to suppliers who prove significant capabilities in engineering, modularization and flexibility (Oh and Rhee, 2010). Developing capabilities for quality improvement is, therefore, very important for TIER 1 suppliers. Besides the factors internal to the supply chain, the recent literature includes the external environment's influence that leads to uncertainty in innovation processes (Hoeft, 2021; Hölttä-Otto *et al.*, 2022).

Supply chain resilience and new product development

Resilience is the ability of a supply chain to return to its previous or even better state after a disruptive event (Christopher and Peck, 2004). Large-scale disruptive events have been proven to have long-term effects on organizations, their financial health (Gulati and Chaklader, 2025), operations and SCM (Fan *et al.*, 2023; Badar *et al.*, 2024). Trunschke *et al.*

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(2024) emphasize the long-term effects of COVID-19, highlighting the negative financial impact on companies and its effects on innovation. Ginn and Saadaoui (2025) note that, in terms of the long-term impact of COVID-19, it has become particularly important for decision-makers in future economic planning to address the vulnerability of global supply chains and strengthen their resilience, as well as to intensify cooperation between companies and policymakers. Companies with stronger supplier relationships and back-up solutions had the upper hand in solving the crises (Miroudot, 2020; Rahbari *et al.*, 2024; Nakandala *et al.*, 2025).

The impact of disruptive events on companies' innovation activity is not clear. Some authors pointed to a postponement of technological development projects (Barrett *et al.*, 2009; Graham, 2010) or a temporary reduction of development expenditures (Cincera *et al.*, 2012). During the crisis, cost reduction is the most important consideration for companies, and therefore, the company's financial situation is the determining factor in restructuring spending (Ernst, 2002; Cincera *et al.*, 2012). Indeed, it cannot be said that the crisis caused firms to reduce their R&D expenditure. In many cases, downsizing or reallocating in the production department results in maintenance or even an increase in highly skilled R&D staff (Sass *et al.*, 2022). In favor of this decision is that firms with higher R&D activity perform better in times of crisis (Lome *et al.*, 2016). Furthermore, the reallocation of expenditure shows a differential effect, intending to preserve firm competitiveness. Technological leadership and increased competition lead firms to restructure their spending to ensure the continuity of innovation activity. During the COVID-19 crisis, differences were observed across industries and firm size (Nyikos *et al.*, 2021; Andoh, 2020).

In terms of the macro picture, according to the annual analysis of the European Innovation Scoreboard (European Commission, 2022), the evolution of the innovation situation in the countries covered by the survey is not uniform. The turbulent economic environment impacted both government and business innovation activity. There was a decline in exports of high-tech, high-value-added products, as well as a decline in specific corporate R&D spending. A dramatic decline in the importance of environment-related technologies is relevant for long-term competitiveness and can be observed in the long term for almost all Central European countries.

According to White *et al.* (2022), analysts and entrepreneurs agree that the period ahead will be uncertain and volatile, with companies unable to make responsible long-term development decisions. Miroudot (2020) nuances the negative picture of complexity in the context of global value chains' adaptability (resilience). Firms' reactions, or adaptations, to disruptions and new realities can be threefold – in relation to the external market, internal and collaborative change of the whole environment (Ferreira *et al.*, 2011). In order to respond to new competition or a changing business landscape, firms can decide to internalize some of the processes or directly acquire new entrants (Dunning, 2003; Rugman and Verbeke, 2008). In other cases, they will decide to externalize, i.e. outsource (Di Gregorio *et al.*, 2009; Buckley and Stage, 2011).

Externally, supply chain visibility is *"the extent to which actors within a supply chain have access to or share information which they consider as key or useful to their operations and which they consider will be of mutual benefit"* (Barratt and Oke, 2007, p. 1230). It can foster increasing quality, availability and competition of solutions within a supply chain (Kalaiarasan *et al.*, 2022) and performance (Bartlett *et al.*, 2007). Quality issues can be detected at an early stage, and packing can be adapted (Scholten and Schilder, 2015). Lead firms can invest in building alliances, improving relationships and fostering long-term collaboration with suppliers to make them their partners. This will allow them to monitor the supply chain more closely (Cozzolino *et al.*, 2018; Duong and Chong, 2020). Other responses towards external partners include supply chain diversification (Lin *et al.*, 2021) or integration (Danese *et al.*, 2020). SCM processes can also be automated and digitized, currently also with the use of artificial intelligence (Dash *et al.*, 2019).

Supply chain engineering is another way to achieve business resilience (Christopher and Peck, 2004). In large-scale disruption events, customers have jointly resolved supply (Éltető

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et al., 2023), and subsidiaries have increased cooperation by sharing raw material stocks (Černá *et al.*, 2022). Thanks to their geographically extensive production systems, global suppliers have been able to ensure continuity of supply of parts by shifting production in a relatively short time (Wall Street Journal, 2022). Similarly, nearshoring or reshoring shortens the supply chain, reduces distance and enables more control over it (Hartman *et al.*, 2017). Likewise, involving more levels of subsidiaries has a more positive effect on the disruption reaction (Villar *et al.*, 2018). Also, it has been demonstrated that more supplier involvement during product development enhances supply chain resilience and reduces associated risks (Wieteska, 2020).

Internally, lean management shall be supported through quicker response times and flexibilization of processes. Flexibility and agility are the dimensions of resilience. Agarwal *et al.* (2007, p. 444) mention nine different ways to understand agility, ranging from *"being ready for change"* to exploiting *"profitable opportunities in a volatile marketplace."* Agility can be measured in the stages of product development, procurement, manufacturing and distribution (Swafford *et al.*, 2006) by a variety of indicators, which are delivery speed, data accuracy, new product introduction, use of IT tools, lead time reduction, cost minimization, customer satisfaction, trust development, quality and service level improvement, market sensitiveness, centralized and collaborative planning, and minimizing resistance to change (Agarwal *et al.*, 2007). Cross-functional collaboration can support resilience through visibility, agility and adaptability (da Silva Poberschnigg *et al.*, 2020). Silva and Ruel (2022) also stress the importance of procurement, sourcing management and competition building. The collaborative approach enables intensified communication activities and information sharing. When unexpected events occur, well-experienced and interlinked teams are more agile and react faster. Planning can be adjusted, lead time reduced and potential problems minimized.

In general, we can support pre-emptive measures and have alternative options at hand (Ash and Smith-Daniels, 2004). From the process perspective, firms will have to choose between incremental and radical (one-time) NPD (Chao and Kavadias, 2008), and the authors argue that the more stable and complex the environment in which firms operate, the more they will support the use of radical innovation. The same authors also stress the role of goal setting, weighing different scenarios and having alternatives for potential situations. Firms that have overcome product development disruptions most successfully share some characteristics. They have an integrated organizational model, have internalized (i.e. own) an important asset or a feature, and have a strong corporate identity (Gans, 2016).

Role of sustainability in new product development

Sustainability encourages the implementation of such policies that sustain or expand the environmental resource base so that present and future generations' needs can be satisfied (UN, 1987). Sustainability concerns the environmental, social and economic pillars. The major issues in the manufacturing industry and NPD focus on the ecological pillar (Kalish *et al.*, 2018). Along the same lines, research calls for more attention to be dedicated to the social pillar (Eggert and Hartmann, 2023). Sustainable principles need to be integrated throughout the product life cycle, while the NPD phase is critical as it affects the achievability of goals throughout the cycle (Hallstedt, 2017). Integrating goals in planning and operations requires integrity with the firm's strategy and culture (Kalish *et al.*, 2018). With the implementation of changes in technology, management and waste or emissions treatment, some of the key debates concern product characteristics and quality, as well as the intensity of supply chain partners' involvement.

Reducing the "*environmental impacts with the same value proposition*," as stated by Brones *et al.* (2014, p. 113), is creating a new challenge for companies worldwide. Kalish *et al.* (2018) demonstrate that American companies that the customers need to be addressed as along with their requirements for quality and sustainability, while product characteristics can change

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due to the use of new materials or methods. A more intensive collaboration with supply chain partners turned out to be positively linked to environmental performance and high-quality performance, delivery and flexibility (Vachon and Klassen, 2008). In this sense, the collaboration of OEMs with TIER 1 suppliers in NPD can play a crucial role in achieving sustainable goals. On the other hand, no positive correlation was proven between environmental collaboration and cost performance (Vachon and Klassen, 2008). This means that the changes can elevate prices. The new requirements for suppliers, including certification, lower the number of potential suppliers and may hinder the diversification strategy.

Global producers must comply with the legislation when deciding on final market destinations. The upcoming Corporate Sustainability Reporting Directive (CSRD) will go hand in hand with the NPD, despite it being updated as we speak in 2025 (Council Directive, 2022/2464; van Beest and Orij, 2025). In particular, carbon emissions in Scope 3 (requirement E1) and workforce in the supply chain (requirement S2) are amongst the topics included in the reporting standard. As CSR activities are often associated with progressive processes and firms (Murcia, 2021), they must be embedded in the NPD. The effect is stronger for more vertically integrated firms, but as the reporting requirement tightens, theoretically, such effects will be evidenced even in arm's-length relationships within supply chains. This is even stronger in cases of firms with high R&D expenditures (Murcia, 2021). The relationship is mediated by strong external networks (such as among supply chain members) and advanced internal capabilities (Jang *et al.*, 2023), providing evidence for the need to collaborate and share scarce resources and knowledge even among competitors or partners within the same industry, according to RDT, in accordance to which the relationships are described as symbiotic or competitive (Küffner *et al.*, 2022).

Relationship between sustainability and resilience

Studies defining the relationship between resilience and sustainability are emerging. Some of them consider resilience a necessary precondition for sustainability (Ji *et al.*, 2020). Holgado *et al.* (2024) highlight the recovery phase of resilience, which creates the opportunity to become more sustainable. Other studies see both concepts as equally important but still independent. Evidence of a positive relationship between sustainable SCM and a resilient supply chain was proven by Eggert and Hartmann (2023), who found that companies with a higher intensity of sustainable SCM decreased economic losses during the pandemic. Companies with higher sustainability intensity proved to be better prepared for unexpected events. Resilience was mainly built through integration with supply chain partners and jointly built information networks. The benefits arising from the closer involvement of suppliers were also presented by Ji *et al.* (2020). This relationship can positively affect both resilience and sustainability through knowledge sharing. Resilience, sustainability perspectives and agility are integrated into a viable supply chain model introduced by Ivanov (2022). Still, some resilience measures can go against sustainable strategies. For example, inefficiencies and waste can be generated with increased safety stocks (OECD, 2025).

Papert *et al.* (2024) identified innovations in SCM as a potential driver for responsible sourcing and reduced consumption of natural resources. Product design and processes along the supply chain (e.g. recycling and reuse of resources) decrease dependence on natural resources and support sustainability as well as resilience. Another example is renewable energy, which decreases the carbon footprint and dependence on fossil fuels with potentially volatile market prices, which might be the subject of supply chain disruption (OECD, 2025). Sourcing management and increased visibility are integrated into the suggested Ecosilient index designed to assess automotive firms' sustainable and resilient activity (Azevedo *et al.*, 2013). It includes seven sustainability indicators (e.g. environmental collaboration with suppliers, reduced energy consumption and environmental collaboration with customers) and seven resilience indicators (e.g. sourcing strategies, supply chain visibility and collaborative

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planning with customers). The complexity of the supply chain partner relationship is important for both concepts (Papert *et al.*, 2024). In addition, it can drive sustainability practices across the triple bottom line. The social sustainability pillar has also gained considerable attention in the SCM literature (Saeed and Kersten, 2020). In regard to the supplier relationship, the selection, evaluation and monitoring of the supply base support sustainable and resilient practices (Ruiz-Benitez *et al.*, 2017; Silva and Ruel, 2022). It is also in line with the lean principles (Ruiz-Benitez *et al.*, 2017) commonly adopted in the automotive sector.

Positioning of the analysis

To summarize the literature review, there has been a wealth of research to identify the individual concepts of sustainability, resilience or NPD. Our paper brings these together and uses the lens of RDT to explain all three of these endeavors within the supply chains. The second novelty would be to apply these concepts to specific cases in the CEE region in the automotive sector, using specific and empirical data directly from various levels of the automotive supply chain. Thirdly, we explore the effects of communication, collaboration, supplier integration and dependencies, information sharing, recovery capability building, risk mitigation, sustainability solutions, innovation, speed of response and anticipation on the three abovementioned concepts. All in all, RDT seems to be a valid lens to analyze these and their operationalization in the supply chain setting.

Methodology

To answer our research questions, we have adopted a qualitative approach, which is particularly suitable when dealing with "how" and "why" questions and when a deep understanding of the phenomena and the linkages inside the organizational context is needed (Yin, 2017). Furthermore, this method enables triangulation of the data from the investigation with additional company documents to avoid biases and get a better understanding of the inter-company relationships. We proceed with eleven exploratory case studies, seven from Czechia and four from Hungary. The companies were selected based on convenience sampling, allowing us to take advantage of the relationship between the researchers and respondents and gain access to more detailed information. The companies were accepted if they work in the automotive industry as an OEM or a Tier 1–Tier 3 supplier, with a majority of production destined for the automotive industry. Following the adopted protocol (Yin, 2017), we conducted in-depth interviews with company managers to collect data about NPD processes in automotive companies and the adopted resilience and sustainability strategies. Each interview started with a question about the subjective evaluation of the overall situation in supply flows, because the real-world context is particularly important for SCM, and was followed by a group of questions related to resilience measures applied in SCM. The last group of questions asked about the implementation of sustainability measures in NPD and the involvement of SCM in NPD. The questions are enclosed in the attachment, along with the interview script sample in Supplement 1. We further collected companies' annual reports from 2024, including the non-financial reporting, and the publicly available procurement terms that sum the conditions imposed on suppliers. With the adopted methodology, our research will overcome the gap between experience gained in SCM and the implementation of resilience measures and sustainability in NPD.

The investigation is a continuation of a larger study on the impact of large-scale disruptive events on automotive supply chains, which began during the COVID-19 pandemic and continued with a second round after the outbreak of the Ukraine–Russia war. The data were collected from April to June 2024. Continuity with the previous study enabled us to use established contacts, and we therefore applied convenience sampling. The previous investigation built trust between the respondent and the investigator, which was necessary when investigating sensitive information such as NPD, given that the respondents' and the

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companies' identities were promised to be kept hidden. To ensure confidentiality, we identify the companies by country code and the individual capital letter for each company. All the involved companies were large companies with more than 250 employees. This enabled access to additional information, such as annual reports, which are not always available from smaller companies or are limited to financial data. This means they should have developed formal policies regarding NPD, sustainability and resilience so we can explore their position on these topics. The research mainly included Tier 1 suppliers. The previous research brought evidence of pressure customers create on higher-tier suppliers regarding implementation of environmental sustainability in SCM, and of OEMs' dependence on suppliers' capabilities (Kim *et al.*, 2022). This is in line with the context of our research embeddedness in the RDT. The limited number of interviews does not necessarily pose a problem (Elmholdt *et al.*, 2026). The sample overview is provided in Table 1.

The coding process was performed as follows. The interviews were transcribed into a shared document and cleaned for irrelevant parts. To analyze the transcribed interviews and additional documents, we combined inductive and deductive coding. As resilience and sustainability are well-defined in academic research, deductive coding was applied. This means using the predefined codes to search the transcription. This is theory-driven, structured and prepared *a priori*, reducing the risk of coder bias. The main groups of codes were taken from the Ecosilient index (Azevedo *et al.*, 2013) and reviewed based on our literature review. The coders searched for the codes in the transcription and cut the necessary phrases to be used in our analysis and presentation of the results in this paper. To identify links between the concepts as such and the NPD and product innovation, we subsequently proceeded with inductive coding to uncover the words, expressions, and phrases describing this and explore new links (Elo and Kyngäs, 2008). These expressions and other parts of the text were again used for the analysis and presentation of results. The concepts and NPD that are included as codes are captured in Figure 2. The figure further groups the codes into categories and highlights potential synergies between them. The information from interviews was triangulated with the company's non-financial reporting and the general procurement terms. Twenty-four documents were included to triangulate the data from the interviews; these were non-financial reports, non-financial and sustainability parts of the annual reports, general purchasing terms and supplier codes of conduct. This triangulation was done with the objective whether the interview responses matched the official information in the company documents. The number of interviews and studied documents is also included in Figure 2. The qualitative data were coded in Atlas.ti software, which was particularly useful to centralize and share data

Table 1. Information on cases and interviewees

Case	Classification of economic activity	Supply chain position	Interviewee position	Country	Length of interview
CZ-A	2,910	OEM	Project manager	Czechia	45 min
CZ-B	2,932	TIER 1	Project manager	Czechia	90 min
HU-C	2,453	TIER 1	Head of Finance and Accounting	Hungary	30 min
HU-D	2,611	TIER 1	CEO	Hungary	20 min
HU-E	2,553	TIER 3	CEO	Hungary	25 min
HU-F	2,932	TIER 1	CEO	Hungary	30 min
CZ-G	2,932	TIER 1	Supply chain manager	Czechia	25 min
CZ-H	2,932	TIER 1	Supply chain manager	Czechia	50 min
CZ-I	2,932	TIER 1	Innovation director	Czechia	60 min
CZ-J	2,932	TIER 1	Supply chain manager	Czechia	30 min
CZ-K	2,800	TIER 1	Project manager	Czechia	45 min

Source(s): Authors' own work

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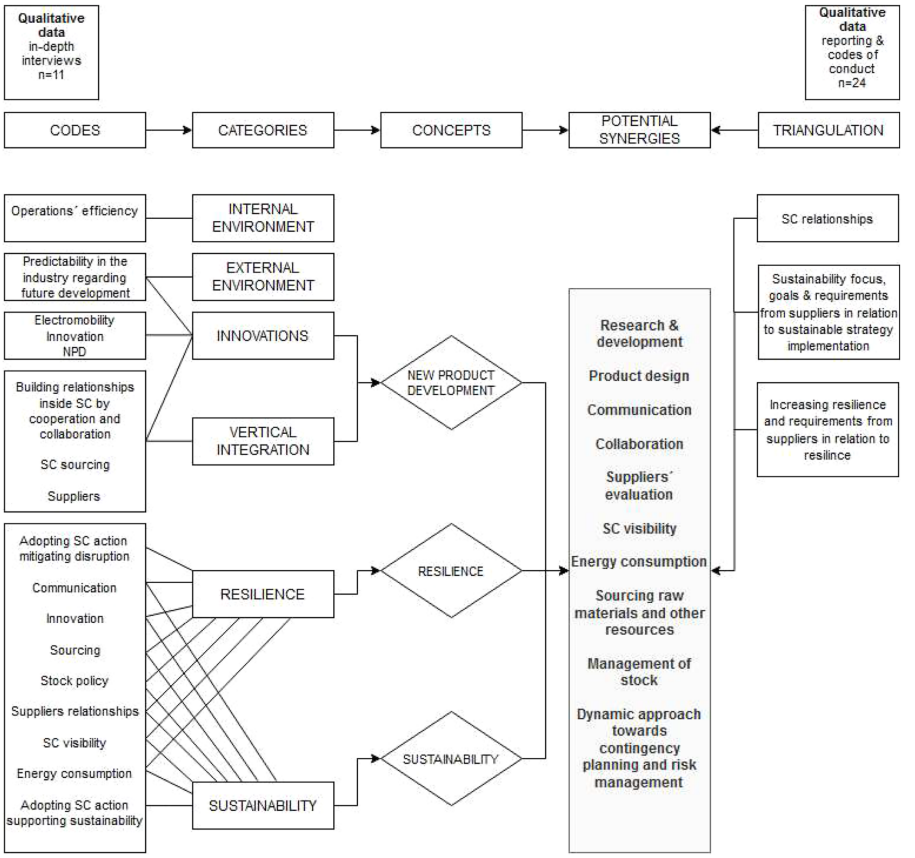

Figure 2. Research design to study potential synergies between the concepts. Source: Authors' own work

within the research team and to enhance data visualization. It was also used for cross-case analysis and to identify relationships between the codes to allow for a synthesis of results and understand the impact of various concepts on each other or on the success of the firm, in terms of revenue or firm size (Darby *et al.*, 2019). The data were coded by two team members, and the findings were discussed within the team of authors. The first step was the analysis by the interviewer; the second coder was then used as a quality check; and the outcomes were then discussed among the three authors to increase objectivity and, above all, to seek common patterns, establish relationships between concepts and group the answers thematically. This is further reflected in Figures 3 and 4. The grouped data was then synthesized and reported in this paper, along with explanation and interpretation.

Findings

We have structured the overview of findings in the following manner: First, we reflect on the external environment. Second, we advise how supply chain resilience is embedded in NPD. Third, we comment on supply chain sustainability and NPD. All of the interpretations are done in light of the RDT as a connecting lens.

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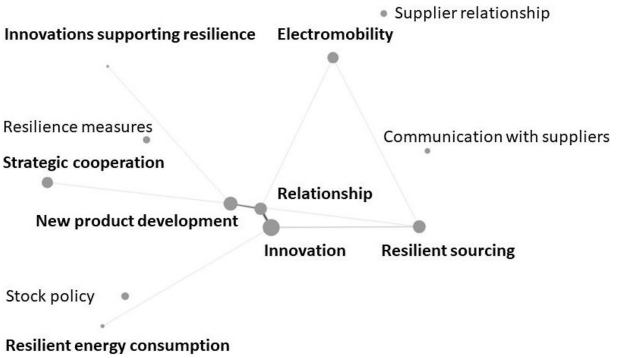

Figure 3. Supply chain resilience dimensions integrated in new product development. Source: Authors' own work

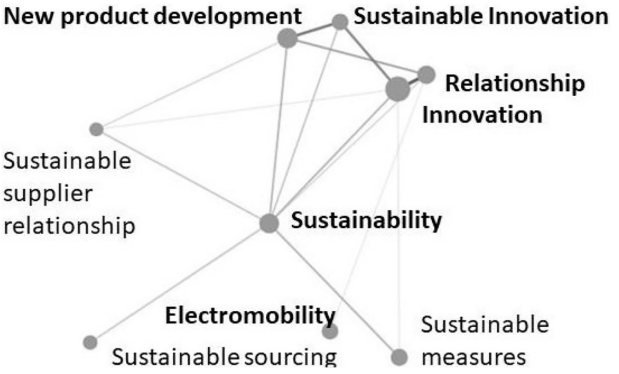

Figure 4. Supply chain sustainability dimensions integrated in new product development. Source: Authors' own work

Impact of the external environment

The previous research and data pointed to the impact of the external environment on the innovation activities of the firms (Ferreira *et al.*, 2011; European Commission, 2022). Some research has demonstrated that companies develop capabilities in times of crisis, learn from disruptions and maintain the introduced processes when reasonable (Křenková *et al.*, 2023). Therefore, the first question related to the overall situation was included in our interviews. The research was conducted in a period without any large-scale systemic disruption. On the other hand, individual supply chain disruptions persisted, and companies had to deal with them.

> There is still a shortage of components, especially for electronic components. (HU– D)
>
> At the moment, we only have a problem with plastic regranulate – there is not enough of it on the market. (CZ-B)
>
> The situation is difficult due to inflation, which is really putting pressure on all departments across the board. (CZ-J)
>
> Right now, with everything in the Suez Canal being under an attack, and lead times for deliveries from China and Asia in general being really long, a lot of cargo is being put on a train. That represents a great financial burden on the profitability of projects. Some cargo must be even sent by plane, which is enormously expensive. (CZ-J)

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The major challenges were related to the implementation of the Green Deal policy in Europe. The transition to electromobility impacted the entire supply chain, not only OEMs. The companies reported pressure from either the European Commission or OEMs.

> We feel a lot of pressure from the European Commission. (CZ-A)

> CO_2 and other pollutant emission regulations determine our development direction. (HU-F)

> As a supplier, satisfying customer needs both in production and R&D activities is important. (HU-D)

The technological transition had effects on NPD. At the same time, the companies mentioned increased uncertainty and difficulties in establishing any future projections regarding technology and demand development. These changes occurred under circumstances when the number of newly registered cars in Europe grew slightly, but had not reached the level before the COVID-19 pandemic. In addition, in Germany and France, the number of newly registered cars decreased year-on-year in 2024, and the growth of global car production was mainly driven by production in China (ACEA, 2025).

> The drop in sales is felt not only for electric cars but also for conventional, i.e. internal combustion cars. There is general uncertainty in the industry, which can also be seen in the evolution of orders; there are fewer and uncertain order developments. Companies can only plan for the short term. This sets back improvements. (HU-E)

Besides the push for technological changes, the companies admitted pressure to shorten the development time of the new product and simplify processes. To keep pace as new products become obsolete in a shorter time, the investigated companies mainly mentioned parallel processing of independent tasks and the inclusion of advanced digital technologies to speed up the simulations and calculations to increase productivity in research.

Supply chain resilience dimensions integrated into new product development

The NPD in our respondents' answers is partly linked to electromobility and partly to innovations in terms of technological sophistication.

> The current big challenge is electronics in cars, IT systems, and above all, electronics are creating a problem; software requires development; electromobility is changing supply chains – until now, car manufacturers developed internal combustion engines themselves, and now they outsource electric motors. (CZ-G)

Customer-supplier relationships are a key factor in NPD from the SCM perspective. Tasks related to NPD are delegated along the supply chain, while in our research, collaboration between OEMs and TIER 1 suppliers was evident.

> We are an independent company with entirely local decision-making. At the same time, there are decisions in which we are also influenced by the strategy of our partners (OEM). We cooperate (R&D) with our customers (i.e. OEMs) already in the development phase. We work on assignments where the client determines what they want. (HU-C)

> Basically, we only formulate our expectations towards our suppliers, cooperation is only with our customers. (HU-F)

> We cooperate in development; from the beginning of development, we cooperate in production, design and concept; we get the test reports and then test at the car level. (CZ-A)

> Together with suppliers, we are looking for ways to ensure trouble-free supply. (HU-F)

To meet the needs of a lean and resilient supply chain, one TIER 1 supplier reported an effort to reduce the number of materials used. Other suppliers mentioned the desire to substitute fully or partly for some materials. Besides, the strategies to enhance resilience that were mentioned included communication, collaboration, increased SC visibility and diversification strategy.

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In general, the OEMs select their suppliers, and suppliers build relationships and communication strategies to secure supplies of the desired quality and within the required time. To ensure the desired quality of supplies, the general rules are set in the procurement terms. Additionally, some companies include onboarding and training for their suppliers.

The relationships between actions enhancing resilience and resilience are presented in Figure 3. Communication and information sharing were deemed important by all respondents, but no recent progressive development was described. This is why there is no direct connection between communication with suppliers and resilience in Figure 3. In our research, no increased supply chain visibility was described in relation to NPD. On the other hand, the triangulation in the case of general procurement terms shows the embedded right to audit suppliers and the obligation to meet the given rules by the suppliers' subcontractors. Nevertheless, the visibility of lower-tier suppliers may still remain limited.

Rich discussions concern the adoption of a supplier diversification strategy. Producers mentioned that higher diversity of components is hindering greater resilience. Some strategic components are even purchased directly by the OEMs. This is, for example, the case of semiconductors. Parts procured by suppliers still need to undergo testing and certification, which represent another barrier to diversity. Diversification is not limited to, but concerns mainly, the procurement of raw materials. Triangulation with available documents confirms strict policies, including requirements for reporting and approving changes in materials and suppliers.

> For new products, we strive to implement the multisource principle, i.e. several suppliers should be able to meet our expectations. (HU-F)

> Different models have different equipment from different suppliers. (CZ-A)

> Sometimes, we have other alternative suppliers, sometimes, we don't. The OEMs assign us the suppliers. (CZ-I)

> There is quite limited room for manoeuvre in terms of diversifying suppliers; during development, components are adapted so that the finished product can be assembled from the available elements. Due to the number of parts, stocking is not possible or minimal. (HU-D)

Supply chain reengineering was not explicitly mentioned by representatives of Czech and Hungarian affiliates of multinational companies, but two respondents mentioned that the division of tasks is decided by the mother company located abroad. This relates to R&D activities, the production of new products and also strategic sourcing. This resilience strategy, therefore, has only limited relevance for Central European companies.

> The technological transition in the automotive industry has an impact on production, and the parent company has significant developments in the field of electromobility. These products have not yet been introduced at the Hungarian subsidiary. (HU-F)

Stock policy remains a proactive measure rather than a strategic one, as the investigated automotive producers stick with lean management and strive for low parts inventory. From their supply chain members, they request agility and flexibility. Lastly, we asked about potential collaboration with universities and research centers. Universities are considered rather a source of potential workforce, and research institutes are places that provide services such as testing.

Supply chain sustainability dimensions integrated in new product development

All investigated companies mention that sustainability is becoming increasingly embedded in NPD and operations planning, yet we are not in a position to evaluate the scale of the change. The drivers include electromobility, legislation, and OEM requirements for lower-tier suppliers.

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> Regulation is the impetus for greater sustainability. (CZ-A)
>
> There is a noticeable tendency that sooner or later all elements of the supply chain will be covered by the sustainability criteria/regulations formulated by the OEM. (HU-E)
>
> We are entering the electromobility market, I don't think we feel pressure from customers or put pressure on suppliers. The pressure is coming from the EU. (CZ-G)

The coding results are interpreted in Figure 4. They emphasized the relationship between the customer and the supplier in relation to NPD and sustainability. The interviews stress the role of OEMs in relation to, first, the motivation toward change, second, the maneuvering possibilities in terms of, for example, material innovations or costs of new or innovative products.

> Yes, when developing new products, we consider product sustainability. (CZ-I)
>
> The sustainability expectation also applies within the value chain and needs to be enforced. We cooperate with suppliers on CO_2 emissions. (HU-C)
>
> Yes, we have supplier KPIs to measure product sustainability; the supplier base was not affected. (CZ-H)

Beyond the interview data, the data used to triangulate the results confirm and further specify the requirements of customers for decarbonization of supply chains, responsible management of resources and reduction of energy use. At the same time, the suppliers' actions are monitored based on the information provided and KPIs, or can be verified during a customer or a third-party audit. Thus, we can see that sustainability was incorporated into the supplier requirements. This concerns the ecological, social, and governance pillars of sustainability. On the other hand, the scope of the obligations varied significantly among the companies.

In spite of this, respondents often mentioned drawbacks to sustainability, one of them being the administrative burden. Companies proceed with information gathering from external partners, internal audits and non-financial reporting. The supply possibilities to meet sustainability targets, including certification and reporting, may be limited. Another important aspect is the price, which may increase, as reported. In addition, internal resistance to new materials or processes may exist.

> Regulations are only a paperwork burden. It is self-reporting. There is an ongoing relationship between business partners, but when there is a meeting, there are more important topics to discuss. (CZ-J)
>
> There are not enough companies that can make clean enough plastic from recycled material, and there is enough of it. We are addressing sustainability with suppliers, but the problem is that there are fewer of them, and some have dropped out due to the COVID-19 pandemic and the war. Many suppliers dropped out; they could not meet the criteria of the Green Deal – they did not have certificates, and they could not reach for support. (CZ-B)
>
> Logistics – you have to hire another person. Products become more expensive. It is difficult for us to get a discount. A number of suppliers have reached the brink. They are in a situation where they are wondering if they should still do it. Negotiations are tough on the part of both suppliers and customers. We have no alternatives, there are fewer of them. If the supplier is able to have certification, we buy from him, even if the price has gone up. (CZ-B)
>
> A few years ago, we required suppliers to comply with sustainability measures. However, several suppliers are now bankrupt, so complying with sustainability principles is not a priority. (CZ-K)

Even though the drawbacks of sustainability remain, all companies have progressed in integrating sustainability in NPD and operations. The common denominator besides the discussed customer interest is the motivation to increase efficiency. Thus, we can see that companies implement sustainable measures, which often represent a significant investment if

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they are motivated by increasing the efficiency of their operations or creating value for customers. The example generally provided was the investment in energy-saving measures. Some companies even mentioned water and pressured air savings.

> We have company-wide KPIs for reducing the ecological burden. With the suppliers we select, we monitor it; we do carbon footprint calculations, how they produce and social responsibility. We do not have suppliers from third countries. Our suppliers did not have a problem with social responsibility. We do an internal audit. (CZ-I)

> Low carbon footprint is a consideration during investments. This is primarily a question of efficiency. If we use less energy, our costs also decrease. (HU-E)

Discussion

This paper investigated potential synergies between sustainability and resilience in NPD. Interestingly, we have seen the interplay between the concepts in a similar manner as we expected by the RDT (Pfeffer and Salancik, 1978). Amongst respondents, the cited capabilities during the NPD process in relation to SCM included communication, collaboration and information access (e.g. supplier visibility and exchange of data). The named capabilities may help to boost both resilience and sustainability. The collaboration amongst our respondents was not cited to happen at the industry level horizontally as suggested by Simons and Nijhof (2020), but rather within the supply chains in the vertical direction.

For some respondents, the NPD activity comes as a response to the increasing competition coming from China and Asia–Pacific region. The era is indeed characterized by rapid change, as noted by Hölttä-Otto *et al.* (2022), but others noted a preference for resilient solutions. Collaboration in activities with uncertain outcomes, as outlined by Petersen *et al.* (2003), is limited, while we rather see long-term relationships between buyers and sellers. That underlines the importance of resilience building. The priority has been to build strong relationships with their suppliers (Miroudot, 2020). On the supply side, the effect is not particularly prevalent, but maintaining a stable inflow of materials remains a strategic activity for our respondents, as expected by Ginn and Saadaoui (2025). When it comes to sustainability efforts, respondents usually act when mandated by their clients or legislation; the pressure being a consequence of resource and capability dependence, as explained by Kim *et al.* (2022). Sustainability requirements propagate along the supply chain. Sustainability is less associated with the business strategy itself (Hallstedt, 2017) or integrity with the company culture (Kalish *et al.*, 2018), but rather as a result of the business relationships the companies have (Jang *et al.*, 2023).

Interplay of resilience and sustainability in SCM

The interviews provided evidence that producers include long-term resilience measures as well as sustainability actions in their strategic procurement. Some long-term measures supporting resilience were collaboration and communication. Closer links between companies can help to navigate the supply chain more effectively in the event of disruptions and bring sustainability efforts to successful implementation. These findings are in line with previous research and the RDT (Küffner *et al.*, 2022).

First, collaboration can enhance both resilience and sustainability. As cited in previous research, resilience in NPD can be achieved through new collaboration strategies, the promotion of strategic alliances and the adaptation of supply chain networks. It is also about an MNE's organizational structure that improves the company's end result, such as involving "springboard subsidiaries" and effectively tapping their knowledge (Pla-Barber *et al.*, 2018). Creating such structures is a long-term project and was not mentioned by our respondents. On the other hand, joint R&D activities, collaboration in supplier selection and joint strategies in

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CO_2 emissions reduction were named by our respondents, who stressed cooperation with OEMs. Such a collaboration, also investigated by Oh and In (2023), can increase suppliers' performance.

Second, communication and information sharing are key to successful cooperation and joint innovation. During the COVID-19 pandemic, communication was recognized as a necessary means to increase resilience. Attention was dedicated to easing communication and supporting data flows and analysis (Éltető *et al.*, 2023). In the current investigation, the companies admitted that there was no change in information sharing and communication. Still, there is potential to further ease information flows beyond the escalated communication exchange that represents intensified communication during any disruption. It is not rare that suppliers' codes of conduct include a call for proactive communication and on-time information sharing about any changes in the supply chain. This is also the case in the NPD stage, when emphasis is put on information exchange, and a close collaborative relationship can develop.

The transition towards sustainable supply chains is conditioned by information access. Increased visibility of the supply chain, achieved by sustainable practices, serves to gather information from suppliers. According to our research, intensive information sharing with customers has the potential to reduce costs, time delays and resource waste. A potential bottleneck to developing synergy between the different information flows may be represented by internal communication imperfections (e.g. information reaches the person responsible for ESG reporting and not the supply chain manager).

Besides collaboration and communication, the company's culture and diversification in sourcing were mentioned in relation to both studied concepts. In accordance with Kalish *et al.* (2018), we found that the company's culture is an important factor in the successful implementation of process changes. Employees need to understand the reasons for change, such as the substitution of old material for new, for successful implementation. Communication is key in building resilience and incorporating sustainability principles into new products. Kalish *et al.*'s (2018) research explains the importance of strategy alignment and cultural embeddedness, but they do not mention that the implementation challenges arise with the global presence and the number of subsidiaries in which you implement the processes. This is the case of our sample TIER 1 companies.

Diversification in sourcing has limited applicability in the automotive sector. Negotiating a new contract offers the opportunity to integrate principles from the two distinct concepts to support sustainability goals and achievements and increase resilience. On the other hand, long-term cooperation enables the integration of internal functions and supply chain members to support resilience by enabling agile and fast reactions (da Silva Poberschnigg *et al.*, 2020; Silva and Ruel, 2022) and sustainability by collaboration when trust, logistical and technological integration that are considered enablers of sustainable SCM are developed (Gimenez and Tachizawa, 2012). Our research brought evidence that sustainability principles are integrated into negotiations with suppliers, though in some cases, their importance was secondary to quality and price. Nevertheless, strengthening relationships represents an opportunity to develop the capabilities of the supplier base as diversification has become limited. Where certification and innovation activities are expected, the suppliers' base may also be limited, and costs may be elevated. The relationships derived from the qualitative analysis are shown in Figure 5.

Conclusions and implications

By analyzing eleven empirical case studies from automotive sector enterprises in Czechia and Hungary, this study investigated how resilience and sustainability are embedded in NPD decisions related to SCM and how resilience affects sustainability considerations and vice versa.

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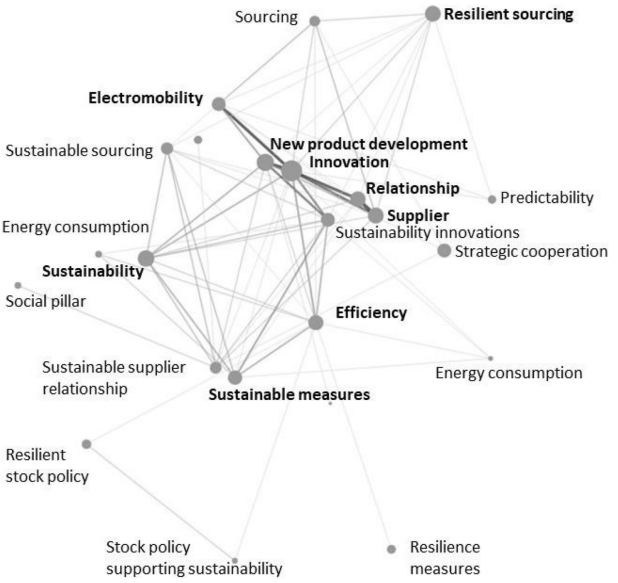

Figure 5. Code co-occurrence analysis – linkages between resilience and sustainability. Source: Authors' own work

To answer RQ1, the research provided evidence that the triple bottom line within sustainability in NPD is being followed; however, sustainability is rather pressure-driven and efficiency-driven; companies take part in sustainability innovations when they are pushed to do so by the regulatory environment or their clients. The environmental pillar was the most often mentioned when our respondents spoke about sustainability actions. Resilience is a more commonly used factor during NPD, which is perfectly explained by RDT.

To answer RQ2, we did not find a strong argument to support the relationship between sustainability and resilience in NPD. Based on our observations, these two concepts again appear simultaneously but do not necessarily depend on each other; all depends on the resources as mandated by RDT. Companies and suppliers engage in sustainability or resilience measures only in cases where it makes economic sense or where the resources are available.

In specific cases, investing in sustainability measures by producers is considered when either the customer accepts the higher price or efficiency increases, which means that either cost savings or resilience are achieved. Resilience in different forms was described by Holgado *et al.* (2024). Investigated companies mentioned resilience in supply and examples of savings, e.g. from alternative energy sources. Increasing efficiency with a positive impact on sustainability and operational resilience needs to be considered by manufacturing companies as well as policymakers who might influence the business environment through adopted policies. Besides that, the transition to electromobility and alternative mobility is fueled by policymakers' pressure to decrease CO_2 emissions, air and noise pollution, and pressure on the responsible use of chemicals and the water economy. This creates pressure on NPD to meet market expectations and requirements. Therefore, R&D will play a crucial role during the transition. We learned that in many cases, it is the multinationals, not the affiliates in the given country, that decide on the R&D location. Therefore, the conditions for R&D in the given country can positively impact the decision on the activity allocation. The research potential of universities and national research centers is not fully used. They can play a more active role in future transition efforts, for which they need to develop the necessary capabilities, including the employment of experts in different stages of research.

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Our qualitative research contributed to the theory by exploring the relationship between resilience and sustainability in the setting of automotive supply chains in the Central European region. The analysis focused mainly on factors included in the Ecosilient index, which proved to be well-targeted as the respondents discussed mainly customer–supplier relationships. We used the RDT theory lens, which was materialized by a series of relationships created in our conceptual model (Figure 1) that was confirmed by our data, while it revealed important asymmetries between the concepts and varying levels of importance (e.g. more focus on resilience, higher importance for communication, collaboration and information access). We have also demonstrated greater dominance of vertical relationships, while horizontal collaboration among competitors seems to be of limited importance. The future implications for TIER 1 suppliers can be affected if the OEM selects TIER 2 suppliers, as mentioned in our research as well as by Azevedo *et al.* (2013). The strategic decisions will, therefore, influence the transformation of the supply chain towards resilience and sustainability. Besides this fact, both concepts are linked by efficiency-seeking. Concepts that strive for increased efficiency are more likely to be adopted while supporting goal achievement. The examples named were waste minimization or reuse of scrapped materials, energy savings and minimization of stock obsolescence.

The relationship between sustainability and resilience needs to be further investigated, as our research didn't provide any significant evidence for the sustainability–resilience relationship, whether one is the antecedent of the other. It demonstrates that companies consider both concepts, but independently of each other. Longitudinal study research is suggested to assess the impact of different external factors. For future research, it would be worthwhile to assess the extent to which the concepts are implemented in operations.

Our sample consisted solely of large firms. We do not consider this a limitation but rather a benefit. Still, differences among large firms are huge. Future research should involve SMEs, as the impact of disruptive events and their innovation activity may differ from our results. It is suggested to dive deeper and explore the relationships between buyers and suppliers at various supply chain levels. Qualitative research is beneficial when answering questions such as how and why (Yin, 2017), but the generalization of results is limited. Also, a larger sample of companies representing more regions of the world can fill this gap. More research needs to be done to assess the impact of strategic procurement on new projects. The ongoing war, Red Sea security situation, and other recent or potential disruptive events pose challenges to supply chain managers whose mission is to secure timely delivery for reasonable costs and who are under constant pressure for efficiency. Logistics costs impact NPD, and seeking further efficiencies is another topic of future research with a high level of managerial implication and applicability.

Supplementary material

The supplementary material for this article can be found online.

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