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Navigating Global Automotive Logistics: A Case Study of Dacia's AILN Supply Chain Performance

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Abstract. *The purpose of this research is to analyze Dacia's AILN (Alliance International Logistics Network) performance metrics and provide an overview of its main distribution centers (via road haulage, rail freight and sea shipping) and the operational logistics challenges faced by its supply chain alternatives. Other research articles deal with issues of logistics operations and/or supply chains of either one particular manufacturing facility (partial optimization) or focus on topics like sustainability, network optimization (re)design and/or resilience strategies to reduce specific automotive industry risks, providing less applicable solutions (overly broad). Relevant production, sales and distribution data (capacities, volumes and lead times) is analyzed at Dacia's main plants in the last 10 years (2015-2024) using quantitative and qualitative methods to provide a comprehensive overview of its logistics competitiveness. The case study's main results show an accelerated sales growth in the last 20 years with over 90% of vehicles being exported, whilst the top 5 international markets account for over a half of Dacia's total sales volumes. Dacia's AILN handles outbound logistics operations of assembled vehicles as well as shipping parts to other Renault or Nissan manufacturing sites through Constanta Port (TEU containers), Curtici Cargo Center (freight trains) and Nadlac II border crossing (car-carrying trailers). Heavy road traffic and congestion, low average speed and inconsistent reliability of freight trains, as well as lengthy loading times of ships affect delivery lead times which can reach 30-45 days, on average. The paper highlights practical insights of Dacia's complex logistics and supply chain management challenges, sourced from automotive industry professionals, adding a real-life impact to the research findings.*

Keywords: Finished Vehicle Logistics (FVL), Automotive Logistics, Supply Chain Management (SCM), Performance Metrics, Intermodal Transportation, Just-In-Time (JIT) Production, Distribution Centers.

Introduction

Romania is ranked 6th in the EU for direct automotive manufacturing jobs (166,851) after Germany (868,870), France (226,927), Poland (210,366), Italy (175,810) and the Czech Republic (175,791) and 2nd as share of direct automotive employment (15.2%) in the EU, after Slovakia (16%), according to data from ACEA (2023). The presence of Dacia and Ford manufacturing sites underscores the automotive industry's crucial role in the Romanian economy. In 2024, the sector contributed significantly, representing over 13% of GDP and 47% of exports. With over 500 domestic suppliers and a workforce exceeding 230,000 specialized employees, the automotive industry constitutes 20% of Romania's manufacturing sector, according to ACAROM (2024).

The dynamic of the automotive industry sector is also reflected in recent production data: after 2019's peak of 490,412 vehicles produced, Romania marked its third consecutive year of record production volumes of over half a million units produced in Mioveni and Craiova. No less than 560,102 vehicles (9.17% growth, year on year) were manufactured in 2024, after similar levels in 2023 (513,050 units) and 2022 (509,465 units), almost three times the output of 2005 (194,802 units), the first year of the Logan, or 7 times the amount before Renault invested in the Dacia plant (78,165 units in 2000). Dacia exported only 2,270 vehicles in 2000, a level of international sales it currently matches in less than 2 days, according to APIA (2024). The importance of the automotive

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industry and its growth can also be attributed to the influx of multinational automotive suppliers who have established operations in Romania (mostly Western and Center regions), driven by Renault and Ford's investments in Mioveni (over 3 billion euros since 1999) and Craiova (2008).

The unexpected increase of Dacia's sales on international markets has prompted capacity increase at Mioveni, but also additional outbound logistics challenges. Distributing vehicles abroad (finished vehicle logistics, FVL) has to be done in conjunction with shipping CKD-SKD kits (TEU containers), both being slowed down by infrastructure hurdles. Trucking faces the issue of clogged roads due to an incomplete A1 highway (detours of 150 km on E81 Pitesti-Sibiu and 15 km on 68A, Margina-Holdea, national roads), whilst rail freight is still hindered by very low average speeds on its network (16.70 km/h, 2024), despite some recent modernizations. Renault postponed its plan to extend production capacity in Mioveni to 406,000 vehicles/year in May 2020, due to its global cost reduction plans. After the pandemic, other crises affected the automotive industry: the semiconductor chip shortage and the sudden rise in raw material prices. These were followed by an increase in transportation costs due to rising energy costs (electric, gas and fuel prices) and double-digit inflation in the EU.

Despite these important setbacks, Automobile Dacia continues its above average performance (increasing its sales volume and market share) on almost all markets and celebrated over 10 million vehicles manufactured (over 7 million units in Mioveni) on April 20, 2022 (Dacia, 2022). These sales figures are supported by Dacia's Alliance International Logistics Network (AILN) in Mioveni, which ensures the inbound supply of parts needed for Just in Time production in Romania as well as the outbound distribution of CBU (Completely Built Unit), CKD (Completely Knocked-Down) and SKD (Semi Knocked-Down) kits towards other manufacturing sites assembling Dacia models.

The paper seeks to determine the extent of and quantify how Dacia's AILN manages the complex logistics of distributing over 90% of its production (Research Question 1) and what specific challenges it mitigates when using road transportation, rail freight and/or sea shipping in balancing delivery times requirements and cost optimization constraints (Research Question 2).

Literature review

The automotive sector's substantial economic and societal impact positions it as a key contributor to GDP growth and societal well-being. It fosters high-skilled employment and generates positive indirect effects across horizontal-related industries, including the development of local supplier networks, the creation of modern infrastructure, and the provision of competitive wages. According to recent data release by ACEA the EU's automotive sector alone accounts for 2.4 million jobs in direct manufacturing and an overall 13.8 million Europeans work within the industry, representing 7% of total employment in the European Union, driven by major manufacturers such as Volkswagen, BMW, Mercedes-Benz, Renault and Stellantis.

In the EU Germany is the leading automotive industry driver. Despite slightly slowing down on the electric vehicle agenda, sustainability is still an important topic, or more specifically how to actually implement sustainable supply chain management (SSCM) practices that work (Wissuwa & Durach, 2023). Information sharing and connectivity among supply chain partnering companies, especially suppliers networks, is an important asset in overall cost-competitiveness (Shibin et al., 2020), facilitating vertical supply chain visibility and harmonizing data access. Performance measurement and management involves balancing trade-offs: designing the supply chain business model to include sustainability metrics from the development phase will reduce

potential future add-on costs and pull similar business models from partnering companies, both vertically and horizontally (Zimon et al., 2019).

The automotive industry generates an important amount of greenhouse gas emissions from its overall logistics processes, prompting measures by authorities to force more sustainable options (Chocholac et al., 2021). Inbound and outbound logistics thus adapt and redesign flows to integrate alternative routing and/or transportation choices, mostly through intermodal rail freight integration and/or river transportation. Internal logistics challenges however (Thanou & Matopoulos, 2021) and generalized Just-in-Time production management still drive the importance of reliable deliveries, most often hauled by trucks, and alleviating disruptions (Rokicki & Szeberenyi, 2024). Distribution centers and logistics hubs are essential to a supply chains degree of efficiency and source cost-competitive, environmentally friendly (or friendlier) options, by also ensuring timely and quality business performance (Fabry et al., 2024).

Modern automotive factories function primarily as assembly plants, relying on a vast global supplier network, and need to also account for risk mitigation strategies (Cikmak & Ungan, 2022). Managing the long-distance transport of numerous components presents a significant logistical challenge crucial to efficient factory operations and performance metrics (Cildoz et al., 2024). Coordination of inbound supplier deliveries is the most challenging problem for all manufacturing plants, as efficient methods and solutions are rarely scalable since optimization is usually carried out manually by each facility, according to their specific constraints (Baller et al., 2022). Sometimes outsourcing logistics operations (inbound and/or outbound) is chosen by certain plants, but this depends on the quality of the logistics service providers' (LSP) services. Outbound logistics can involve finished vehicle logistics (FVL) or shipping of already assembled cars or CBUs (Completely Built Units) or the spare parts: CKD (Completely Knocked-Down) and SKD (Semi Knocked-Down) kits are a collection of all parts, either only parts (CKD) or parts and subassemblies (SKD) that are sent out towards other manufacturing sites assembling the same (or similar) models on a shared platform.

Spare parts management related topics (Achetoui et al., 2022) mostly focus on inventory management issues and/or demand forecasting methods for improved accuracy of order quantities, with less emphasis on the spare parts supply chain performance measurement metrics. Existing research on automotive supply chains often focuses on either inbound logistics (supplier management) or outbound logistics (distribution), rarely considering the complex integration and trade-offs between the two. Furthermore, studies often rely on theoretical models or aggregated industry data, lacking the granular detail needed to understand the practical challenges faced by individual manufacturers.

This paper directly addresses this gap by investigating Dacia's AILN, providing a unique case study that combines empirical data on both inbound and outbound logistics with insights from automotive professionals, offering a more nuanced and realistic perspective on the complexities of managing a global automotive supply chain.

Methodology

The research paper analyzes primary and secondary data on production and sales from the last 25 years, with more emphasis on the last decade (2015-2024), to provide a comprehensive overview upon the scale and recent development of Automobile Dacia's logistics and supply chain management capabilities in the automotive industry. The case study method was chosen to explore

the intricacies of real-world logistics contexts and gain a more in-depth understanding of the supply chain challenges faced by Dacia's AILN in Mioveni.

Raw and primary data is sourced through own empirical research, gathered during on-site fieldwork and observational study at Renault Group factories in France and Romania (7 days), Port of Constanta (3 days) and intermodal terminals in the West of Romania (4 days) between 2014-2015 (total of 7 months) and 2022-2024 (total of 7 weeks). Attendance at 18 automotive industry private events (2016-2019), professional (2022-2023), and scientific conferences (2023-2024) provided insights into industry challenges, reports on best practices, and information on infrastructure needs in Romania. Observations and data collection at the Mioveni factory focused on inbound logistics activities (reception, truck loading/unloading, standard times), production logistics (balancing material flow between work stations and updating layout) and outbound logistics (loading assembled vehicles, CKD and SKD parts onto trucks and/or trains).

Data on production, logistics, and supply chain metrics were obtained through discussions and consultations with 12 industry professionals, including logistics and supply chain managers from Dacia, the Renault Group and their main logistics service providers (GEFCO, Romcargo Maritim). These individuals were selected based on their expertise in automotive industry and because of their collaboration with Automobile Dacia and its AILN in Mioveni, Romania. While semi-structured interviews were initially planned, many potential interviewees declined due to concerns about disclosing confidential information. Instead, data was gathered through ongoing dialogue and consultations, focusing on publicly available information and industry best practices. All participants were informed of the research purpose, including the intention to publish the findings, and provided explicit consent for the use of their data in this research. No confidential data (or data for which no permission was granted) is not used within the body of the paper.

Secondary data (historic sales and production data, EU and Romanian automotive industry reports and official releases) is cross-referenced with Dacia, Renault and partnering logistic service providers' records (some of which declined their identity disclosure), with some marginal data cleaning being required to resolve occasional discrepancies and confirm results. Found discrepancies (production data from different plants reported differently, sales for same Dacia model sometimes reported as Renault, Nissan or other brands) were resolved by corroborating evidence from independent sources (industry reports) and focusing on data provenance (directly from plant production and internal sales reports). The paper's collected and compiled data is thus sourced from and reviewed by automotive industry professionals to validate its accuracy (checking data and figures) and render additional context (factors influencing patterns and variations), providing it with high accuracy and pertinence.

Descriptive statistics is applied to investigate the evolution of the 2 manufacturing plants' time-series data (2012-2024) on operational performance metrics. Year-to-year variations (absolute, relative, percentage changes from the previous year dynamics, 5 and 10-year averages) are collated, relative share in total production output and sales of Dacia vehicles are analyzed to contextualize the AILN's role in logistics operations (CBU, CKD and SKD units). The qualitative data from observations and consultations was analyzed using thematic analysis to identify key themes and patterns related to Dacia's logistics operations and supply chain challenges. Qualitative and quantitative methods are used to demonstrate the significance of empirical findings by documenting the actual locations of used distribution centers and intermodal hubs (for road haulage, rail freight and sea shipping), their respective handling capacities, volumes and estimated

lead times, in addition to further supply chain linkages, thus providing a holistic perspective on the case study.

Results and discussions

Renault developed the 5,000 euro car project with a completion target of 5 years (1999-2004), after buying the Dacia factory. With ongoing plant investments under way, Renault launched 2 transition models, the SupeRNova (2000-2003) and Solenza (2003-2005), which helped Dacia almost double its sales in less than 5 years, from 52,403 (2000) to 95,296 units (2004), an 81% increase which outlined the capability of the staff to adapt to new projects.

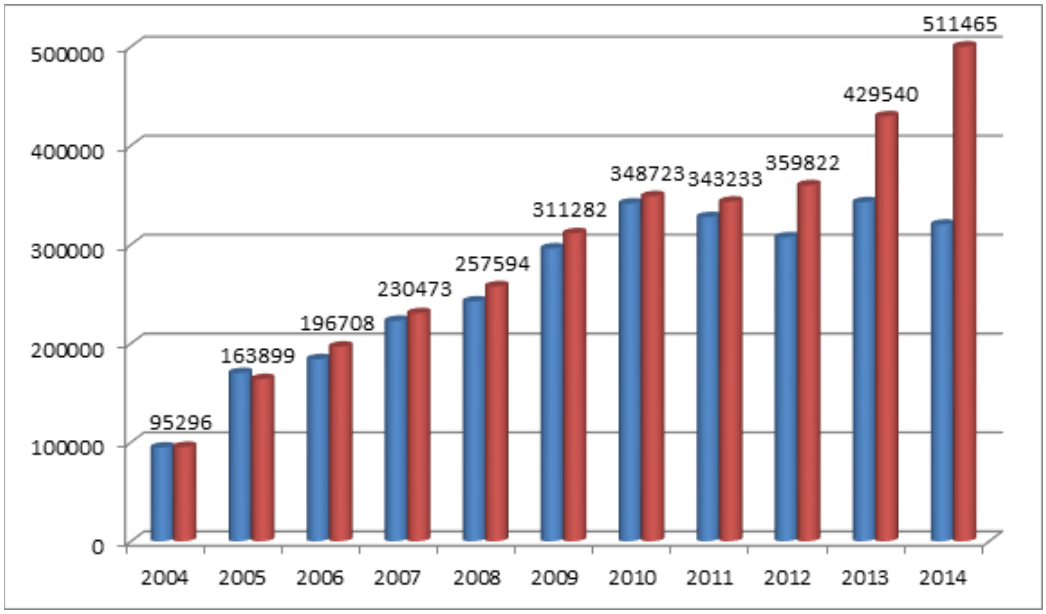

Figure 1. Evolution of internal production (blue) and global sales (red) of Dacia

Source: Automobile Dacia – Annual Reports (2004-2014).

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After launching the new Logan (X90) model in September 2004, Dacia started to see an accelerated boost in sales (see Figure 1) and checked milestone after milestone, almost every 2 years, over the next decade: over 100,000 cars sold (2005), over 200,000 units (2007), over 300,000 units (2009), over 400,000 units (2013) and over 500,000 units (2014). The unexpected success of the new Logan model, especially on international level, enabled a capacity increase at the plant in Mioveni (Romania) from 220,000 units to 350,000 units (2008). With signs of continued growth, Renault decided a further increase of capacity was necessary to support sales of its low-cost brand and chose Tangier (Morocco) as a greenfield investment for the new production location with an initial capacity of 170,000 vehicles year (2012). Since 2015 both Dacia plant are operating with a maximum capacity of 350,000 units/year, as well as high output ratios, to support the brand's sales.

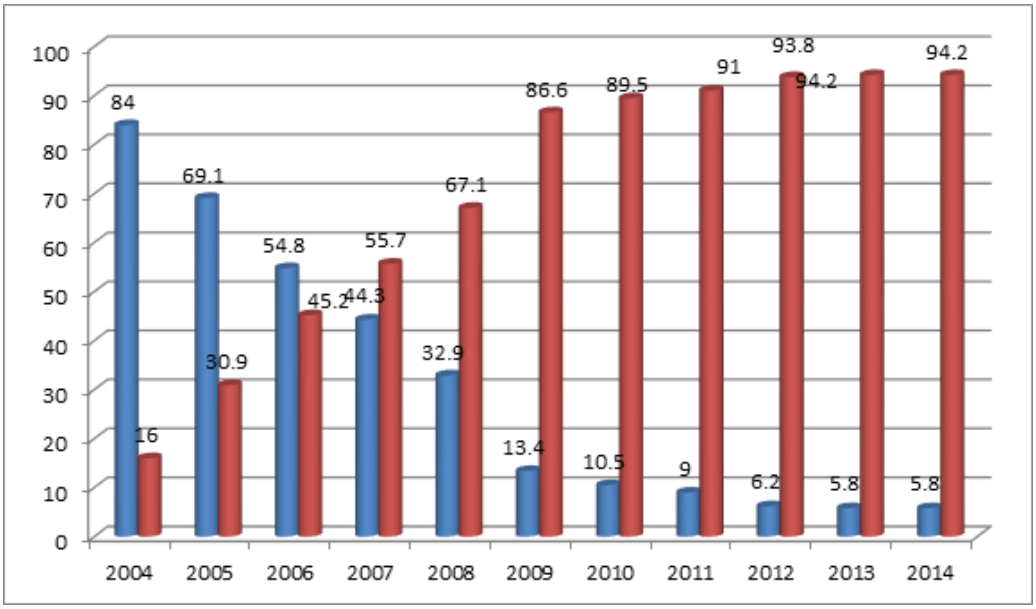

Figure 2. Proportion of Dacia's sales on national (blue) and international markets (red)

Source: Automobile Dacia – Annual Reports (2004-2014).

After launching the Logan by Renault, Dacia's sales in Romania achieved record figures of over 100,000 units for 3 consecutive years (2005-2007) before a slight decrease (17%) in the first year of the economic crisis (84,708 units, 2008). The proportion of its sales in Romania was decreasing in favor of international sales (see Figure 2), from over 80% (2004) to under 10% (2011) in less than a decade. With only 22,148 units sold (6.2% share of total sales), Dacia's sales marked an absolute trough on the Romanian market in 2012 after the financial crisis (2008-2009). Sales figures slowly recovered in the following years, but are still far from reaching its peak levels after the launching of the Logan more than 20 years ago. A comprehensive overview of Dacia's global sales and proportion of internal and international split is provided in Table 1.

Table 1. Evolution of Dacia's sales on national and international markets

year	**2015**	**2016**	**2017**	**2018**	**2019**	**5-year average (2015-2019)**	
total sales	550,920	584,219	655,235	700,798	736,570	**645,548**	
dynamic [%]	7.71	6.04	12.16	6.95	5.10	*33.69*	
internal	36,946	38,861	43,262	54,593	55,463	**45825**	
dynamic [%]	24.71	5.18	11.32	26.19	1.59	*50.11*	
international	513,974	545,358	611,973	646,205	681,107	**599,723**	
dynamic [%]	6.67	6.11	12.21	5.59	5.40	*32.51*	
year	**2020**	**2021**	**2022**	**2023**	**2024**	**5-year average (2020-2024)**	**10-year average (2015-2024)**
total sales	520,765	537,095	574,073	658,321	676,340	**593,318**	**619,433**
dynamic [%]	-29.30	3.14	6.88	14.68	2.73	*29.87*	*22.76*
internal	47,380	38,120	40,179	46,124	45,729	**43,506**	**44,665**
dynamic [%]	-14.57	-19.54	5.40	14.80	-0.86	*-3.48*	*23.77*
international	473,385	498,975	533,621	612,197	630,611	**549,812**	**574,767**
dynamic [%]	-30.50	5.41	6.99	14.67	3.01	*33.21*	*22.69*

Source: Automobile Dacia/Renault Group – Annual Reports (2015-2024) and authors' own research.

Dacia continued to reach new milestones with sales of over 600,000 units (2017) and over 700,000 units only 1 year later (2018) and an overall growth of 50.11% between 2015-2019. The first year of Covid-19 caused a 30% decrease in sales, but the dynamic in the last 3 years shows levels are approaching 700,000 units again with the Sandero model being the best-selling vehicle (309,392 units) in Europe in 2024. The Sandero is the first Dacia brand model to reach sales of over 300,000 units/year and is the best-selling vehicle in Europe since 2017 showcasing the Romanian brand's market importance. A slight decrease (0.86%) in sales in Romania (45,729 units) meant that over 93% of all Dacia models are sold on international markets (as of 2024). An overview of Dacia's top 5 best-selling markets and their share in overall sales is presented in Table 2.

Table 2. Share of Dacia's sales on its main international markets

year	**2015**	**2016**	**2017**	**2018**	**2019**	**5-year average (2015-2019)**	
France	100,035	112,111	119,356	141,525	140,568	*122,719*	
Germany	47,453	50,973	64,918	74,525	83,518	*64,277*	
Italy	55,168	54,543	56,301	65,102	70,189	*60,260*	
Spain	46,792	52,382	63,374	66,330	88,499	*63,475*	
Morocco	37,392	43,408	45,599	49,649	49,041	*45,017*	
top 5	**294,260**	**317,538**	**352,319**	**397,131**	**431,815**	**358,612**	
share [%]	*53.41*	*54.35*	*53.77*	*56.67*	*58.63*	*55.55*	
top 10	**430,513**	**444,131**	**499,098**	**532,313**	**537,872**	**488,785**	
share [%]	*78.14*	*76.02*	*76.17*	*75.96*	*73.02*	*75.71*	
total sales	550,920	584,219	655,235	700,798	736,570	**645,548**	
year	**2020**	**2021**	**2022**	**2023**	**2024**	**5-year average (2020-2024)**	**10-year average (2015-2024)**
France	98,370	125,220	132,137	156,390	119,230	*126,269*	*124,494*
Germany	52,310	40,340	60,390	68,585	71,424	*58,609*	*61,443*
Italy	49,771	36,762	37,682	34,527	40,520	*39,852*	*50,056*
Spain	56,848	61,700	67,383	85,568	97,253	*73,750*	*68,612*
Morocco	38,173	44,029	38,885	33,830	39,330	*38,849*	*41,933*
top 5	**295,472**	**308,051**	**336,477**	**378,900**	**367,757**	**337,331**	**347,972**
share [%]	*56.74*	*57.36*	*58.61*	*57.56*	*54.37*	*56.86*	*56.17*
top 10	**398,121**	**406,897**	**446,292**	**491,917**	**498,932**	**448,431**	**468,608**
share [%]	*76.45*	*75.76*	*77.74*	*74.72*	*73.77*	*75.58*	*75.65*
total sales	520,765	537,095	573,800	658,321	676,340	**593,264**	**619,406**

Source: Automobile Dacia/Renault Group – Annual Reports (2015-2024) and authors' own research.

France is Dacia's top-selling market with an average of over 120,000 units/year sold in the last decade and an aggregate 20% of overall sales. Spain has an overall 11% share with an aggregate average of just under 70,000 vehicles/year and an important recent dynamic (57% increase in volumes in the last 3 years), whilst sales in Germany are at an average of just over 60,000 units/year with a 77% increase over the last 3 years and an aggregate share in sales of 10% (2015-2024). France, Spain and Germany thus account for over 40% of sales, whilst the top 5 markets (including Italy and Morocco) account for a total of 56.17%. Dacia's first 10 international markets (including Turkey, Poland, Belgium, UK and Algeria) have an overall share in sales of 75.65% over the last decade. By adding its sales in Romania (45,729 units and 6.7% share, 2024), Dacia sells over 80% of its vehicles on its first 11 markets, as of last year. A total of 676,340 vehicles were sold in 2024 on all markets, models produced mainly in Romania and Morocco at its 2 dedicated manufacturing

sites (around 90%) with other worldwide Renault sites compensating for the differences. An overview of Dacia's production outputs (Mioveni and Tanger) over the past decade is presented in Figure 3 (2012-2014).

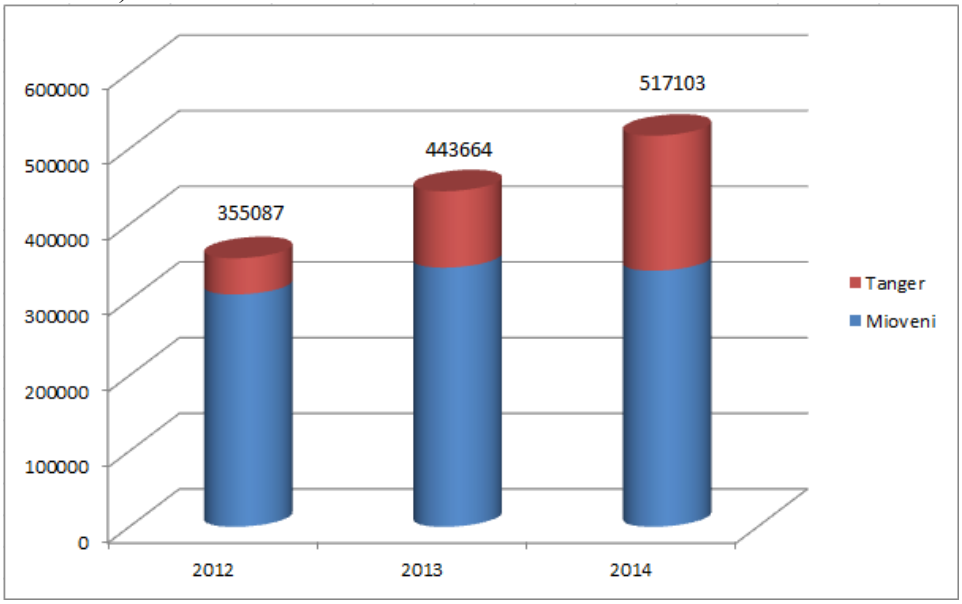

Figure 3. Dacia's production volumes in Romania (blue) and Morocco (red)

Source: Automobile Dacia – Annual Reports (2012-2014).

Starting 2012 Dacia models were either assembled in Mioveni or Tanger. The new plant in Morocco doubled its maximum capacity from 170,000 units (2012) to 350,000 units (2015) in its first 3 years and increased its share of total production progressively: 13% (2012), 22% (2013) and 34% (2014). An overview of the 2 manufacturing plants production metrics in the last decade (2015-2024) is presented in Table 3.

Table 3. Dacia's production metrics in Romania and Morocco, 2015-2024

year	**2015**	**2016**	**2017**	**2018**	**2019**	**5-year average (2015-2019)**	
Mioveni output [units]	339,204	320,457	313,883	335,262	349,528	*331,666*	
capacity utilization [%]	96.91	91.55	89.68	95.78	99.86	*94.76*	
production share [%]	*59.70*	*53.98*	*51.09*	*51.27*	*53.51*		
Tanger output [units]	228,932	273,176	300,476	318,600	303,559	*284,948*	
capacity utilization [%]	67.33	80.34	88.37	93.70	89.28	*83.80*	
production share [%]	*40.29*	*46.01*	*48.90*	*48.72*	*46.48*		
total output [units]	**568,136**	**593,633**	**614,359**	**653,862**	**653,087**	**616,615**	

year	2020	2021	2022	2023	2024	5-year average (2020-2024)	10-year average (2015-2024)
Mioveni output [units]	259,099	257,405	314,678	322,086	309,432	*292,540*	*312,103*
capacity utilization [%]	74.028	73.544	89.908	92.025	88.409	*83.583*	*89.17*
production share [%]	*55.26*	*50.18*	*55.19*	*52.80*	*49.76*		
Tanger output [units]	209,769	230,002	255,494	287,860	312,381	259,101	272,024
capacity utilization [%]	61.69	67.64	75.14	84.66	91.87	*76.20*	*80.00*
production share [%]	*44.73*	*47.18*	*44.81*	*47.19*	*50.23*		
total output [units]	**468,868**	**487,407**	**570,172**	**609,946**	**621,813**	**551,641**	**584,128**

Source: Automobile Dacia/Renault Group – Annual Reports (2015-2024) and authors' own research.

The Dacia plant in Mioveni achieved an exceptional capacity utilization ratio (99.86%) in 2019 by producing a record number of 349,528 units, nearly reaching its maximum capacity (350,000 vehicles). Except the pandemic years (2020-2021) the Mioveni plant's capacity utilization has always ranged between 90-95%, making it one of the most productive manufacturing facilities in the world. The factory's overall rate of automation (around 30%) is mainly focused on improving workstation ergonomics and productivity, reducing weary and repetitive tasks, avoiding safety and quality risks, increasing digitization and real-time communication by replacing pen and paper use. In Tanger output ratios steadily increased until a peak in 2018 (318,600 units and 93.70% output ratio) and an expected drop during the Covid-19 pandemic years. Overall, in the past decade (2015-2024) the manufacturing plant in Mioveni had an aggregate output ratio of 89.17%, averaging 312,103 vehicles/year, whilst the Tanger site reached 80% with its average of 272,024 units/year. The combined output of the 2 plants reached its peak in 2018 with 653,862 vehicles produced, whilst 2024 was the first year when production in Morocco (312,381 vehicles) was higher than in Romania (309,432 vehicles).

Dacia models are mainly produced in their dedicated manufacturing plants (Mioveni and Tanger), but also in other Renault and Nissan plants around the world which share the same platform. Mioveni mainly builds the Duster, Sandero Stepway, Jogger and Logan models, whilst Tanger assembles Sandero, Dokker, Lodgy and Logan. The same Dacia model is thus sometimes branded as a Renault model on other markets (Logan, Duster, Sandero), in some cases having even a different model name than the original designation: Tondar (Renault branded), Aprio, NP200, Terrano (Nissan branded models) or others (Lada Largus, Mahindra Verito). This makes Dacia's worldwide presence even more widespread, despite these alternative brandings not being added up to its part of the Alliance's sales, as is shown in Table 4. The electric Dacia Spring is the only model manufactured exclusively in China, at the Shiyan plant, and uses Renault's City K-ZE platform (also assembled in China). Only 22,884 Spring models were sold in 2024 (a significant 63% year-on-year decrease), mainly due to the reduction of government grants for electric vehicles.

Table 4. Evolution of production volumes at Dacia's main and other production sites

	2012	2015	2019	2023	2024
Mioveni, Romania	307,152	339,204	349,528	322,086	309,432
Tanger, Morocco	47,935	228,932	303,559	287,860	312,381
other sites (world)	298,108	366,725	357,165	338,793	329,143
production (aggregate)	**653,195**	**934,861**	**1,010,252**	**948,739**	**950,956**
dynamic [%]	*N/A*	*43.12*	*8.06*	*-6.08*	*0.23*
CKD-SKD kits (est.)	412,018	836,179	615,293	566,070	590,682
dynamic [%]	*N/A*	*102.95*	*-26.42*	*-8.00*	*4.35*
Dacia (branded)	359,822	550,920	736,570	658,321	676,340
Dacia (others)	286,325	378,553	263,305	286,805	270,553
sales (aggregate)	**646,147**	**929,473**	**999,875**	**945,126**	**946,893**
Unsold vehicles [%]	*1.08*	*0.58*	*1.03*	*0.38*	*0.43*

Source: Renault Group/Renault-Nissan Alliance – Annual Reports (2012-2024) and authors' own research.

Nevertheless, as data from Table 4 shows, aggregated output of Dacia models from other Renault or Nissan sites around the world have a share of over a third of total production (34.61%, 2024). Producing Dacia models at other sites around the world is possible by sending complete knocked down (CKD) and/or semi-knocked down (SKD) kits to plants using the same platform or having a flexible design, allowing them to produce multiple models. The estimated CKD-SKD kits from Table 5 are for all Alliance models (Dacia, Renault, Nissan), as well as for Mitsubishi since 2016 in different proportions. On average, around 60% of all shipped CKD-SKD kits through the Port of Constanta are for Dacia models, the rest are mainly supplying other Renault branded models produced across the world. Since 2015 Dacia produces around 950,000 vehicles/year (a record of over 1 million units, 2019), except for the pandemic years when its output dropped to 775,201 and 790,522 vehicles, before recovering in the last 3 years. Dacia practically sells its entire production with an average level of unsold units below 1%, which is due to the manufacturing flexibility of its other manufacturing sites across the world, capable of increasing or lowering the brand's volumes, according to their actual demand.

In 2005 the Alliance International Logistics Network (AILN) was set up in Mioveni, shortly after the launch of the Dacia Logan, Renault's venture of a modern, reliable and affordable vehicle (5,000 euro new car project). The AILN's role was to provide a range of components manufactured in Romania to other Renault sites, as a project to challenge Dacia's suppliers and increase their competitiveness. Less than 150,000 CKD kits were delivered to 3 other Renault sites in the first year (2005), an average that almost doubled in the next 4 years (284,265 CKD kits in 2009), reaching 8 sites from 4 different continents. Despite the economic crisis, this average continued increasing (298,125 vehicles/year, in 2012) and reached a milestone of over 5.2 million CKD kits delivered to 17 sites by its first decade of operations (2015), before peaking at a record amount of 836,179 CKD-SKD kits delivered to 24 sites of the Renault-Nissan-Mitsubishi Alliance (2019). After the complicated pandemic years (chip shortage, energy crisis, surge in price of raw materials) when volumes dropped by almost a third, the AILN is currently delivering kits to 18 manufacturing units and is steadily handling increased volumes with 590,682 units (2024), a 4.35% year-on-year increase from 566,070 CKD-SKD kits in 2023.

Dacia uses a mix of road transportation, rail freight and sea shipping (as highlighted in Table 5) to distribute its cars across Europe and worldwide. Most vehicles are loaded onto trucks

or use an intermodal transport solution (trucking and rail freight) from the plant in Mioveni (over 70%), whilst the rest is shipped towards the Constanta Port, mostly by rail freight.

Table 5. Breakdown of Dacia's outbound shipments by transportation mode

Main mode of transportation	Road transportation	Rail freight	Sea shipping
CBU volumes	550-600 trucks/week 23,842 trucks (2024)	11-15 trains/week 698 trains (2024)	1-2 ships/week 70 ships (2024)
average loading capacity (vehicles)	6-10 cars/truck 160,220 vehicles (2024)	224-294 cars/freight train 149,212 vehicles (2024)	2,000-6,000 cars/ship 117,225 vehicles (2024)
distribution center (main destination)	Berlin, Germany Budapest, Hungary	Valenton, France Zeebrugge, Belgium	Tanger, Morocco Southampton, UK
distance (total)	Germany: 1570 km Hungary: 725 km	France: 2287 km (rail) Belgium: 2577 km (rail)	Morocco: 3741 km (sea) UK: 5809 km (sea)
lead time range and average (total)	18-24 hours (20 hours) 11-15 hours (12 hours)	56-72 hours (60 hours) 60-78 hours (66 hours)	12-45 days (30 days) 16-21 days (18 days)
intermodal hub(s)	Constanta Port (sea) Railport Arad (rail)	Railport Arad, Curtici Cargo Center (RO-HU border crossing)	Constanta Port (Black Sea)
distance (intermediate)	375 km (road) 738 km (rail)	495 km (road) 738 km (rail)	375 km (road) 353 km (rail)
lead time range and average (intermediate)	road: 6-10 hours (8 hours) rail: 28-42 hours (33 hours)	rail: 28-42 hours (33 hours) road: 8-10 hours (9 hours)	road: 6-10 hours (8 hours) rail: 10-16 hours (12 hours)

Source: Automobile Dacia/Renault Group/Renault-Nissan Alliance personal communications (March-October 2024).

Road transportation is mainly used for domestic deliveries (all 10 regions in Romania, CEE countries and Turkey), whilst for customers willing to pay a premium for shorter lead time deliveries (up to 20-30 days) trucking is used for faster delivery towards Eastern, Central and Western Europe, mainly towards distribution hubs in Berlin and Budapest, before final delivery routing is performed by freight forwarders. The delivery times usually range within the estimates provided, with the most likely lead time being added in brackets for each type of transportation. Truck departures from the Dacia plant are scheduled every 5 minutes in order for their convoy not to block the DN7 (Olt valley stretch), a major national road linking the West and East of Romania. The provided duration for road transportation only includes the actual driving time, without factoring in mandatory breaks or unexpected events (traffic congestions, border checks, weight control, route restrictions).

Rail freight is used with 2 alternatives, either towards the port of Constanta for sea shipping or towards the border with Hungary for further train haulage towards main distribution centers in Europe or overseas (Koper, Valenton, Neuss, Bremerhaven, Ghislenghien, Zeebrugge). Loading and unloading a train requires between 2-4 hours of handling operations, on average. Prior to Romania's entry in the Schengen Area (January 1, 2025), border checks for freight trains between Curtici-Lokoshaza would mean an extra 5-7 hours had to be added to the estimated lead time and would increase overall cost for any road-rail combined shipping solution. The number of rail freight shipments increased to almost 700 trips in 2024, representing a 24% year-on-year increase (from 563 trains, 2023) with expected modernization works potentially further developing this option in upcoming years.

Sea shipping (usual load of 3,000-4,000 cars/ship) is mainly performed via the port of Constanta, once a week, with inbound freight trains from the plant in Mioveni. Most common are shipments towards Tanger, for Mediterranean customers (Spain, Southern France, Italy) at the Renault-managed terminal (RVT) and the UK (Southampton, Bristol and Tyneside ports), where Nissan manages the regional distribution. A record 6,000 vehicles (loading time: 4 days) was shipped in 2013 towards Algeria (Port of Algiers) from Constanta, Dacia's largest ever Ro-Ro shipment from Romania. GEFCO and Romcargo Maritim are Dacia's main logistics providers in this segment with an average of 300 cars/day and volumes of up to 105,000-130,000 vehicles/year with average ranging between 90,000-110,000 vehicles/year in the last 15 years. On average, less than 0.5% of all shipped cars incur various forms of damage (minor, usually caused by weather factors) during transportation by trucks, trains or ships.

An overview of Dacia's AILN-related operations (inbound, production and outbound logistics (FVL), spare parts, CKD and SKD shipping) is presented in Table 6.

Table 6. overview of Dacia's AILN supply chain management metrics

inbound logistics	incoming locations	partnering carriers	unloading volumes
	2,418 sites	60 transport partners	700-1,000 trucks/day
	domestic suppliers	International suppliers	part numbers
	108 suppliers (17%)	543 suppliers (83%)	22,978 references
production logistics	Maximum capacity	Daily output	Takt time
	350,000 vehicles/year	1,392-1,410 vehicles/day	56 seconds (2024)
	Yearly shipments equiv.	current spare part numbers	Dock traffic
	344,564 vehicles (2024)	30,000 references	16,128 trucks (2024)
outbound logistics	Manufacturing plants	Distribution centers	Vehicle compounds
	18 sites	22 sites	79 sites
	TEU containers	CKD-SKD kits	Plant locations (regular)
	1,643 units/week	590,682 vehicles (2024)	14 sites
	Europe (32 countries)	Overseas (73 countries)	Service rate (overall)
	> 1,000,000 units	> 2,000,000 units	91.24% (2024)
	Lead times (Africa)	Lead times (South America)	Lead times (Asia)
	Algeria: 10 days Morocco: 12 days South Africa: 27 days	Brazil: 21 days Colombia: 23 days Argentina: 24 days	India: 28-36 days Iran: 32-38 days South Korea: 32-45 days

Source: Automobile Dacia/Renault Group/Renault-Nissan Alliance personal communications (March-October 2024).

Inbound logistics manages up to 25,000 trucks arrivals/month (more than 700 trucks/day) from 2,418 different supplier delivery locations with its 60 partner carrier companies. Suppliers have 2 hour slots for departure, a real-time end-to-end visibility software tool enabling reliable delivery schedules at the Mioveni plant for a coordinated Just-in-Time production system. Only 762 shortage files (2024) were handled by inbound logistics, these supplier risk management issues and challenges being successfully solved with no consequences for production. Dacia's high tier suppliers have an overview on orders (over 12 months), a monthly process which is updated weekly to ensure delivery of the right amount of parts. The AILN handles 22,978 references for the Alliance's models (7,626 are Dacia unique references) which arrive from its 651 suppliers, most of which (83%) are international. At its maximum pace, the manufacturing plant in Mioveni delivers 1 car every 50 seconds, but depending on the number of daily changeovers needed to switch from one model to the other this pace is slowed down to 55-56 seconds, meaning daily

output can range between 1,392-1,410 vehicles/day. Counting its plants in North Africa (Tanger, Casablanca, Oran), around 3,100 Dacia branded models are produced, on average, every day.

The manufacturing plant in Mioveni, Romania assembles up to 350,000 vehicles/year and regularly delivers over 20,000 part number references to other 14 manufacturing plants (mainly Renault sites), including sites in Spain (Palencia and Valladolid), Slovenia (Novo Mesto) and Turkey (Bursa). Dacia manages an assembly plant (Mioveni), the largest spare parts distribution center in Eastern Europe (Oarja, 28 km from Mioveni on the A1) and the AILN for shipping of CKD-SKD kits (Global Access shared platform). Spare parts are managed at the largest Renault Group distribution center outside of France, the CPS in Oarja with 30 docks and over 16,000 trucks loading and unloading parts at the center (as of 2024). The CPS in Oarja can deliver parts in as fast as 36 hours (for current models), but also holds inventory of parts from previous models which can reach a total of 70,000 references at a given time and has the lowest percentage of logistics complaints per 10,000 order lines among all similar Renault Group storage centers.

CKD-SKD parts spend a maximum of 48 hours at the AILN before being shipped with one of the outbound 625-875 trucks/week (loading time/container: 30 minutes). The outbound CKD-SKD units (590,682 vehicles, 2024), shipped with 1,500-1,750 TEU containers/week, are equivalent to almost double the amount of the Romanian plant's yearly output and need between 2-6 weeks to reach their designated assembly units in Africa, South America or Asia. In terms of CBUs shipped, Dacia's AILN FVL handles shipments of around 3 million vehicles/year through 22 distribution centers (11 in Europe and 11 overseas) and 79 vehicles compounds with an OTIF service rate of 91.24% (2024). Dacia mostly organizes its own outbound logistics, but also partners with GEFCO for rail transportation and with Romcargo Maritim for sea shipping from their dedicated terminal at Constanta Port. Lead times range from 12 days (Morocco, 2 plants) to 28-36 days (India), or up to 45 days for deliveries to South Korea. Trucking is sometimes used for faster deliveries towards India (9-11 days), as well as rail freight (14 days). Deliveries to South America (Argentina, Brazil, Colombia) or South Africa are usually made from the port of Hamburg (Mioveni-Hamburg lead time: 4 days, via train) and need between 21-24 days (South America) and 27 days (South Africa).

Conclusion

This research has explored the complex dynamics of Dacia's Alliance International Logistics Network (AILN) in managing the distribution of over 90% of its near one million annual vehicle production across its own and other Renault-Nissan Alliance factories. This case study offers unique empirical data and insights, quantifying Dacia's success in navigating a global automotive supply chain marked by rapid expansion and increasingly international markets. Following the Logan's launch, Dacia's sales exploded, with international sales soaring to over 90% in just over 7 years. This surge in demand necessitated significant capacity increases at the Mioveni plant, the establishment of a new facility in Tanger (Morocco) and shared platform production across other Renault-Nissan Alliance sites (in North Africa, South America and Asia).

The AILN, established in 2005, has proven crucial not only for Dacia's growth but also for the entire Renault-Nissan-Mitsubishi Alliance. Beyond managing Dacia's outbound finished vehicle logistics (over 300,000 units, 2024), the AILN handles CKD and SKD kit volumes equivalent to nearly double the CBU units produced at the Mioveni factory, underscoring its pivotal role in global production support. Leveraging the combined rail (Renault) and port (Nissan) infrastructure of its partners, Dacia achieves average delivery times of 30-45 days through a

strategic multimodal transportation approach. Trucking serves shorter hauls within Romania (Eastern Europe and Turkey), rail-road intermodal transportation connects Central, Northern and Southern Europe and maritime shipping facilitates delivery to overseas markets (North Africa, UK, South America).

Despite the challenges posed by Romania's infrastructure, Dacia's AILN has effectively mitigated these limitations through the use of intermodal transportation, balancing the economies of scale offered by rail freight and sea shipping with the speed and flexibility of trucking. This optimized approach ensures efficient parts supply to the Mioveni factory and streamlined vehicle distribution through key logistics hubs like the Port of Constanta (Black Sea), Curtici Cargo Center (Railport Arad) and Nadlac II (A1 motorway) border crossing. The AILN's success demonstrates that effective logistics management is achievable even in constrained environments, offering invaluable lessons for companies navigating similar challenges.

This study's strength lies in its extensive field observation and access to industry experts, providing valuable practical insights into real-world logistics operations. While the multi-year data collection process and the restricted accessibility of such professional networks present notable limitations and affect its replicability, these are significantly outweighed by the study's unique empirical contribution. The findings highlight the strategic importance of collaborative partnerships, multimodal solutions and a highly responsive network for supporting rapid growth and global market penetration in the intensely competitive automotive sector. The challenge for the AILN, and the automotive industry as a whole, will not just be adapting to these changes, but proactively shaping them. Future research could explore the long-term resilience of the AILN's strategies in the face of increasing globalization and technological disruption, particularly the potential impact of emerging technologies like autonomous vehicles and advanced analytics on its future operations.

References

ACAROM – Asociatia Constructorilor de Automobile din Romania (2024). Productia de automobile in Romania a inregistrat un nou record in 2024, Retrieved from *https://acarom.ro/productia-de-automobile-in-romania-a-inregistrat-un-nou-record-in-2024*, [Accessed on 17.01.2025].

ACEA – European Automobile Manufacturers' Association (2023). Share of direct automotive employment in the EU, by country, Retrieved from *https://www.acea.auto/figure/share-of-direct-automotive-employment-in-the-eu-by-country*, [Accessed on 23.01.2025].

APIA – Asociația Producatorilor si Importatorilor de Automobile (2024). Analiza detaliata a inmatriculărilor de autovehicule in luna decembrie si pe intreg anul 2024, Retrieved from *https://static.apia.ro/uploads/comunicate/Comunicat-de-pres%C4%83-APIA-_-Pia%C8%9Ba-Auto-Decembrie-2024.pdf*, [Accessed on 10.01.2025].

Achetoui, Z., Mabrouki, C. & Mousrij, A. (2022). A balanced performance measurement system for automotive spare parts supply chain, *Scientific Journal of Silesian University of Technology. Series Transport*, 116, 25-55.

Automobile Dacia (2022). Press release: 10 million vehicles produced since 1968, Retrieved from *https://media.dacia.com/10-million-dacias*, [Accessed on 05.12.2024].

Baller, R., Fontaine, P., Minner, S. & Lai, Z. (2022). Optimizing automotive inbound logistics: A mixed-integer linear programming approach, *Transportation Research Part E: Logistics and Transportation Review*, 163, 102734.

Chocholac, J., Hruska, R., Machalik, S., Sommerauerova, D. & Sohajek, P. (2021). Framework for Greenhouse Gas Emissions Calculations in the Context of Road Freight Transport for the Automotive Industry, *Sustainability*, 13(7), 4068.

Cikmak, S. & Ungan, M.C. (2022). Supply chain risks and mitigation strategies in Turkey automotive industry: findings from a mixed-method approach, *Supply Chain Forum*, 25(1), 75-95.

Cildoz, M., Mateo, P.M., Alonso, M.T., Parreno, F., Alvarez-Valdes, R. & Mallor, F. (2024). The optimal container selection problem for parts transportation in the automotive sector, *Expert Systems with Applications*, 247, 123321.

Fabry, J., Zapletal, F. & Machacova, T. (2024). Location selection for logistics centre using PROMETHEE method, *Acta Logistica*, 11(3), 409-419.

Renault-Nissan Alliance (2024). Automobile Dacia Annual Reports (2004-2024) and Automobile Dacia/Renault Group/Renault-Nissan Alliance personal communications (March-October 2024), Retrieved from *https://media.renaultgroup.com/in-2024-all-the-groups-brands-are-growing-thanks-to-10-launches* [Accessed on 16.01.2025]

Rokicki, T. & Szeberenyi, A. (2024). Disruptions in Supply Chains in the Automotive Industry During the COVID-19 Pandemic. The Case of Polish Companies - the Perspective of the Main Supply Market, *Management and Production Engineering Review*, 15(3), 151489.

Shibin, K.T., Dubey, R., Gunasekaran, A., Hazen, B., & Roubaud, D., Gupta, S. & Foropon, C. (2020). Examining sustainable supply chain management of SMEs using resource based view and institutional theory, *Annals of Operations Research*, 290(1), 301-326.

Thanou, E. & Matopoulos, A. (2021). Improving efficiency of material flows in an automotive assembly plant: A case study, *CIRP Journal of Manufacturing Science and Technology*, 35, 959-967.

Wissuwa, F. & Durach, C.F. (2023). Turning German automotive supply chains into sponsors for sustainability, *Production Planning & Control*, 34(2), 159-172.

Zimon, D., Tyan, J. & Sroufe, R. (2019). Implementing Sustainable Supply Chain Management: Reactive, Cooperative, and Dynamic Models, *Sustainability*, 11(24), 7227.