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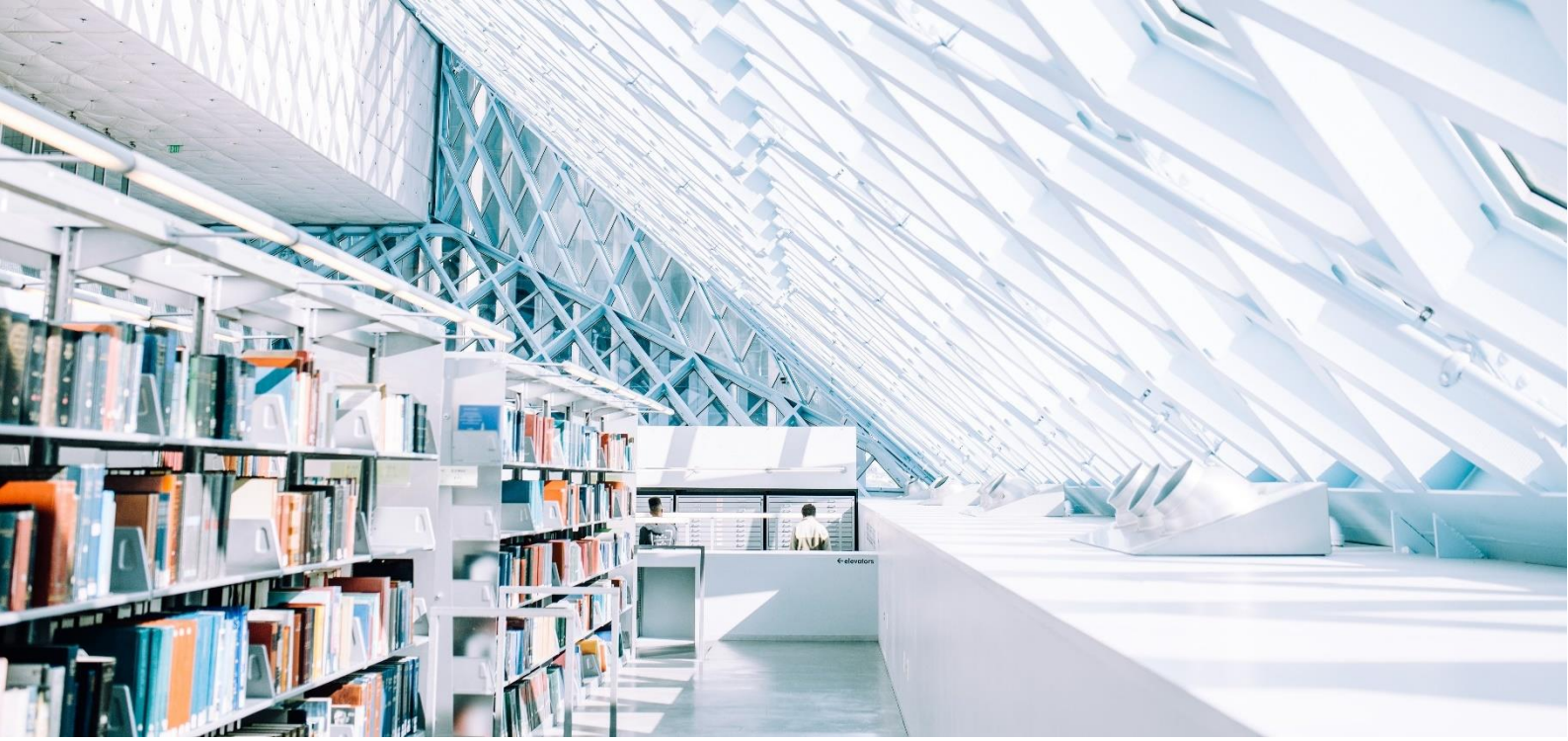
RAIL VEHICLE MAINTENANCE – GLOBAL MARKET TRENDS IN THE AFTER-SALES MARKET

Markets – Trends – Players

2023



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Markets – Trends – Players

Cologne, November 2023

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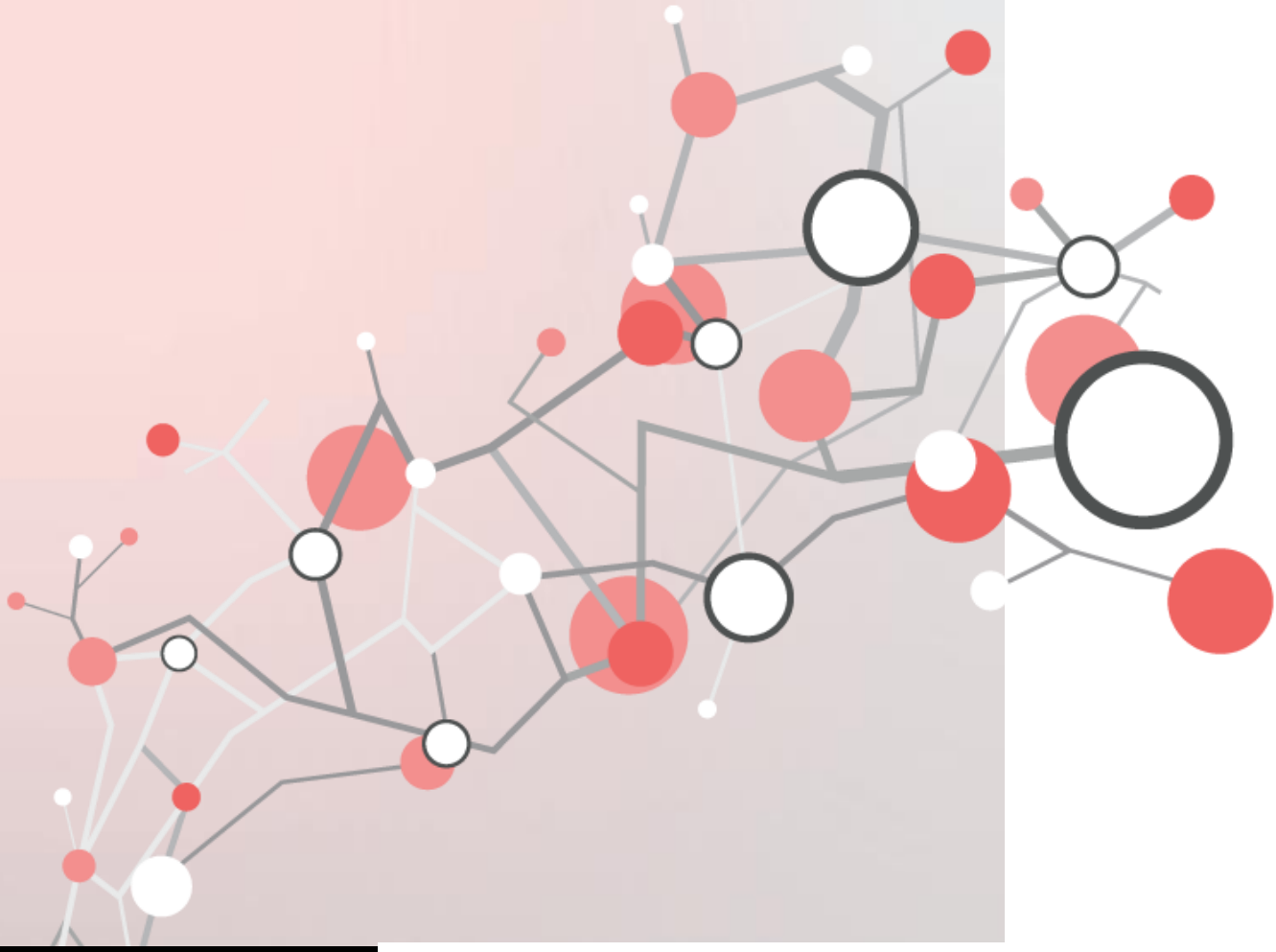


1 Executive Summary

Executive Summary

The worldwide rolling stock after-sales market reached a total volume of around EUR[redacted]bn in 2022 and will grow at a rate of +[redacted] p.a. on average through 2027.

While the rolling stock maintenance volume exceeded the volume of the new railway vehicle market (OEM), the latter should experience a faster growth rate of [redacted] p.a. through 2027. In fact, the fleet is expanding in all segments through additions of modern vehicles, with the only exceptions being diesel multiple units and diesel locomotives.

After-sales EUR[redacted] Billion

New vehicles EUR[redacted] Billion

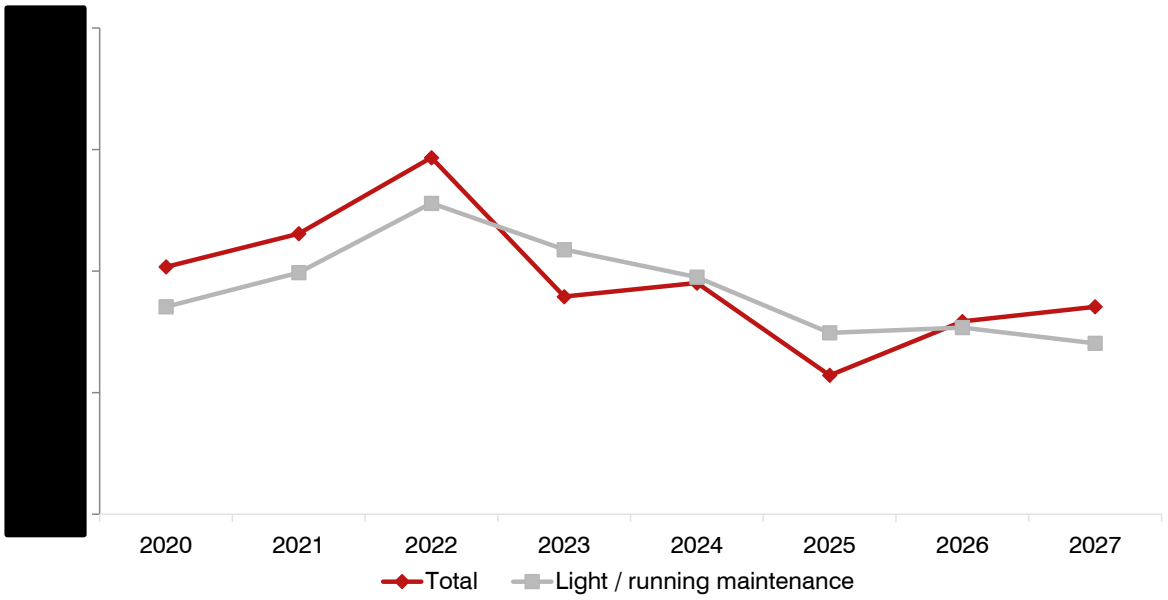
Market volume 2022 (EUR million)

After-sales +[redacted]%

New vehicles +[redacted]%

Market development 2022-2027

Development of market volume of world rolling stock after-sales services 2020-2027
(y-o-y growth rates in %)



Source: SCI Database

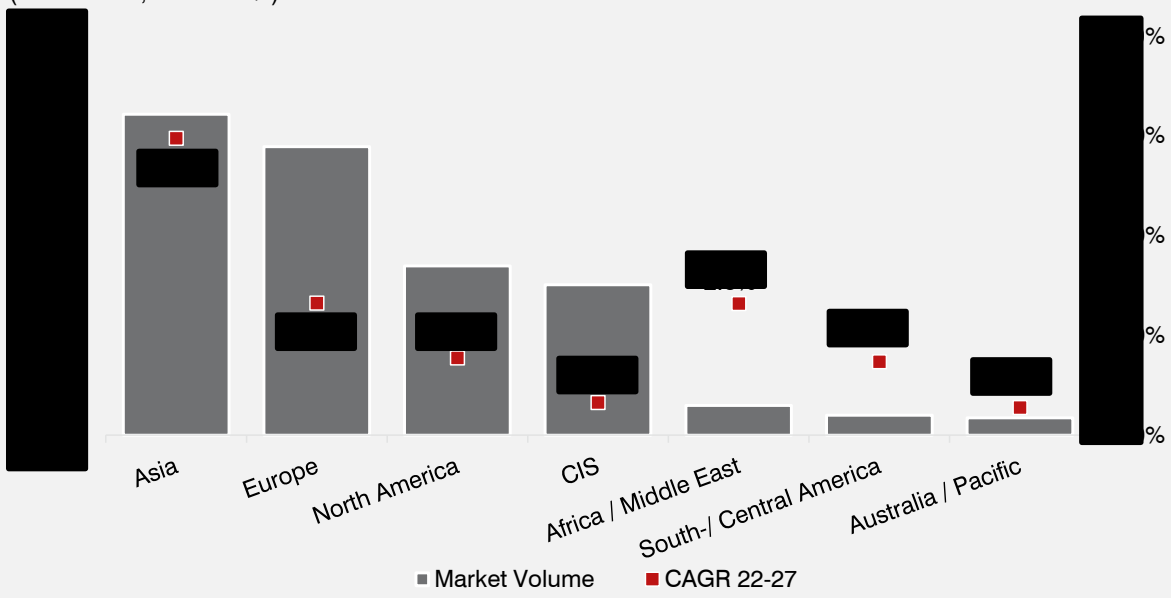
Figure 1: Development of market volume of world rolling stock after-sales services 2020-2027

An analysis of the annual growth rates reveals that the after-sales market has proven to be resilient to exogenous shocks, and it continued developing positively between 2020 and 2022. In fact, even during the COVID-19 pandemic, y-o-y growth rates remained constant when taking price dynamics into account. Furthermore, future growth rates are expected to remain above [redacted]% on average through 2027. Despite an apparent slowdown in growth rates after 2022, this is mostly to be explained by a reduction in inflation: after-sales volumes will grow at an average rate of [redacted] y-o-y between 2023 and 2027.

Running maintenance accounts for about [redacted] of total maintenance services, while heavy maintenance accounts for [redacted]. Running maintenance is going to grow at an average y-o-y growth rate of [redacted], while heavy maintenance is expected to grow at an average y-o-y growth rate of [redacted]. This is mostly because heavy maintenance is influenced by revision cycles and is therefore more volatile. In contrast, running maintenance is carried out throughout the whole vehicle lifecycle, thus growing steadily with fleet expansion.

Regional outlook – Asia consolidates its leading position

Market volume and CAGR of rolling stock after-sales services in 2022
(EUR million, CAGR in %)



Source: SCI Database

Figure 2: Market volume and CAGR of rolling stock after-sales services in 2022

The regions with the highest impact on the worldwide rolling stock after-sales market are Asia ([redacted]%), Europe ([redacted]%), North America ([redacted]%) and the CIS ([redacted]%), with a combined share of almost [redacted]%. All of them are characterised by a very individual market structure in terms of both their regional diversification and their vehicle segments.

SCI Verkehr observes the following relevant trends at a regional level:

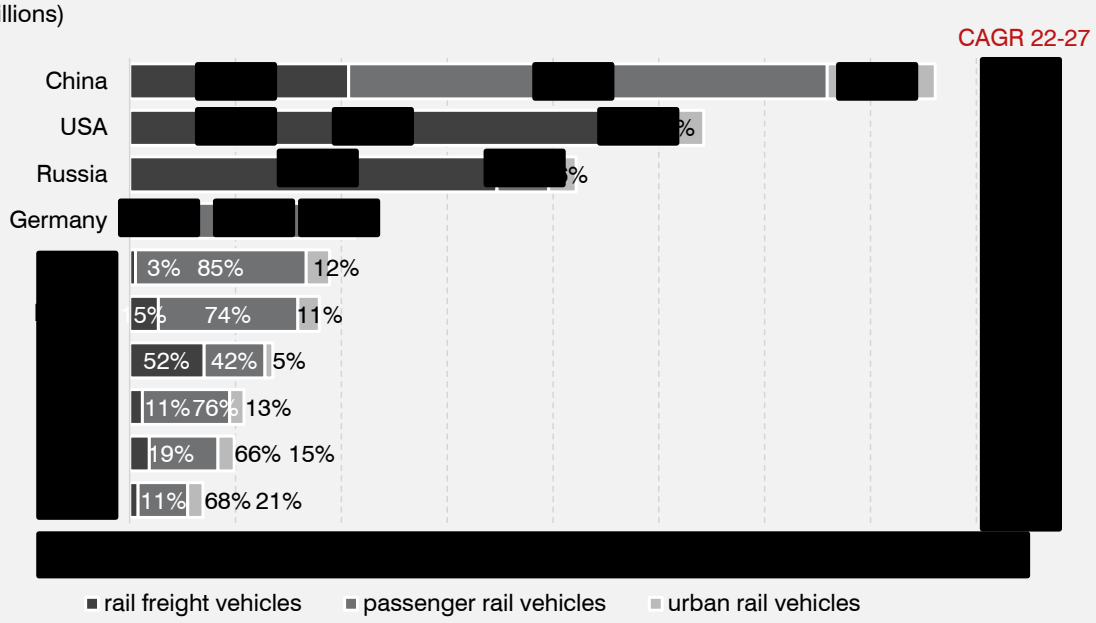
The largest market, **Asia**, will also show the highest growth rate of +[redacted]% per year for the next five years. The main driver is the Chinese market, where the expansion of commuter rail networks and high-speed services is progressing. However, impetus is also coming from India, where the maintenance of passenger coaches (replacement of old ICF passenger coaches by LHB

coaches, enabling higher average speeds and providing higher safety standards), EMUs and metros are supporting market growth.
The markets in **Europe** and **North America** will show moderate growth rates below [redacted]%, mainly driven by fleet expansions and modernisations in passenger transport. In Europe, after-sales volume in the passenger and urban segments is going to be primarily driven by fleet expansion. Furthermore, cross-border freight operations require an expansion of the capillarity of maintenance networks, resulting in the construction and upgrade of maintenance facilities.

In **North America**, the moderate but stable growth in after-sales volume is expected to be driven by fleet expansion and technological upgrades in the passenger and urban segments. The rail freight fleet should decrease in size due to fleet rationalisation; this causes increasing fleet utilisation, and maintenance volume is going to grow moderately as a result.

Country outlook – China grows further, India catches up, Germany drives Europe

Market volume of world rolling stock after-sales services in 2022 in top 10 countries
(EUR millions)



Source: SCI Database

Figure 3: Market volume of world rolling stock after-sales services in 2022 in top ten countries and CAGR 2022-2027

SCI observes the following developments in the top ten country markets, which account for 73% of global after-sales volume.

With EUR [redacted] bn, **China** was the largest country market in 2022, accounting for a share of [redacted] and it is expected to keep growing at [redacted]% p.a. through 2027. Within the passenger segment, high-speed trains accounted for EUR [redacted] bn and are expected to grow at [redacted] p.a. through 2027. Metro vehicles

accounted for [redacted] of the total after-sales market volume in 2022 and are expected to grow by [redacted] p.a. through 2027. As a result, metro is going to be the second-largest vehicle segment in terms of after-sales volumes in China in 2027.

[redacted]

Russia is responsible for 11% of global after-sales volume, with an after-sales volume of EUR 8.44 bn in 2022. Within rail freight vehicles, the after-sales volume generated by freight wagons is expected to grow by +4.9% through 2027, while diesel locomotives should exhibit a negative annual growth rate of -5.3% p.a. through 2027.

Germany [redacted] ranks fourth and is expected to grow by [redacted] p.a. through

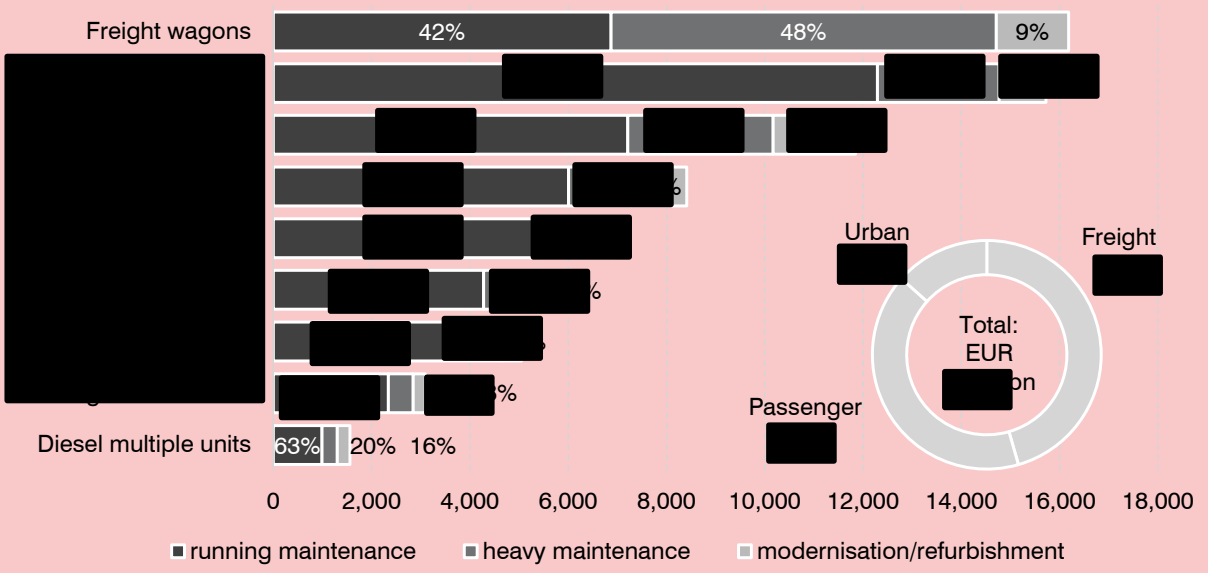
[redacted]

Segment outlook – high-speed is making it to the top

Passenger	Urban	Freight
high-speed trains, electric multiple units, diesel multiple units and passenger coaches.	metro vehicles and light rail vehicles	electric locomotives, diesel locomotives and freight wagons. Note that for simplicity, all locomotives were categorised within the freight segment due to their predominant operation for

Within this study, SCI Verkehr adopted the rolling stock segmentation regarding the categorisation of rolling stock within transport segments.

Market volume of world rolling stock after-sales services in 2022 by vehicle segment
(EUR millions)



Source: SCI Database

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Figure 4: Market volume of world rolling stock after-sales services in 2022 by vehicle segment

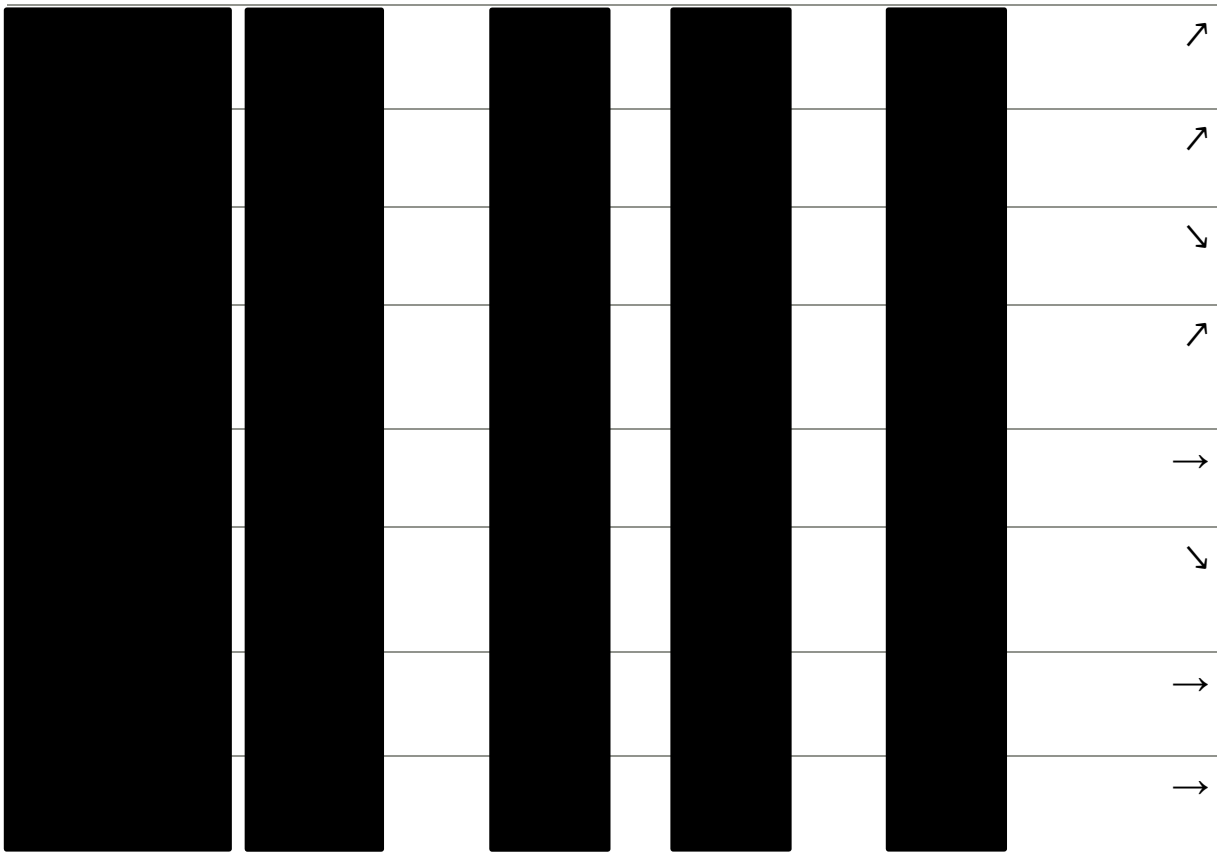
Segment	World: after-sales market volume (EUR million, p.a.)			Trend
	Current after-sales market volume 2022	Future after-sales market volume 2027	CAGR 2022-27 (% p.a.)	
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Metro (urban segment)	[redacted]	[redacted]	[redacted]	↑
Electric locomotives (freight segment)	[redacted]	[redacted]	[redacted]	↗
Passenger coaches (passenger segment)	[redacted]	[redacted]	[redacted]	→
Light rail (urban segment)	[redacted]	[redacted]	[redacted]	↗
Diesel multiple units (passenger segment)	[redacted]	[redacted]	[redacted]	↓
Total	[redacted]	[redacted]	[redacted]	↗

5-year trend: ↑ = strongly increasing (> +5% p.a.), ↗ = increasing (+2 to +5% p.a.), → = constant (0 to +2% p.a.), ↘ = decreasing (-2 to 0% p.a.), ↓ = strongly decreasing (< -2% p.a.)

[…]

Installed base – The worldwide fleet is expected to grow by +XX% p.a. through 2027

The worldwide installed base of rail vehicles has recorded a positive trend. The fleet of high-speed trains in particular will continue to grow significantly, driven by the expansion of numerous networks. On the other hand, a decline can be observed in diesel-powered vehicles due to the ongoing electrification of networks. A slight decline in light rail vehicles is due to the replacement of short vehicles by long units, so that capacity in this segment is nevertheless increasing.



Vehicle segment	Installed base, 2022 (in units/cars rounded)	Installed base development CAGR 2022–2027 (%, p.a.)	Average age 2017 (in years; rounded)	Average age 2022 (in years; rounded)	Fleet age trend 2017 vs 2022
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	↗
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	↗
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	↘
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	↗
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	→
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	↘
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	→
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	→
Diesel multiple units (cars)	27,960	-1.7%	21	20	↘

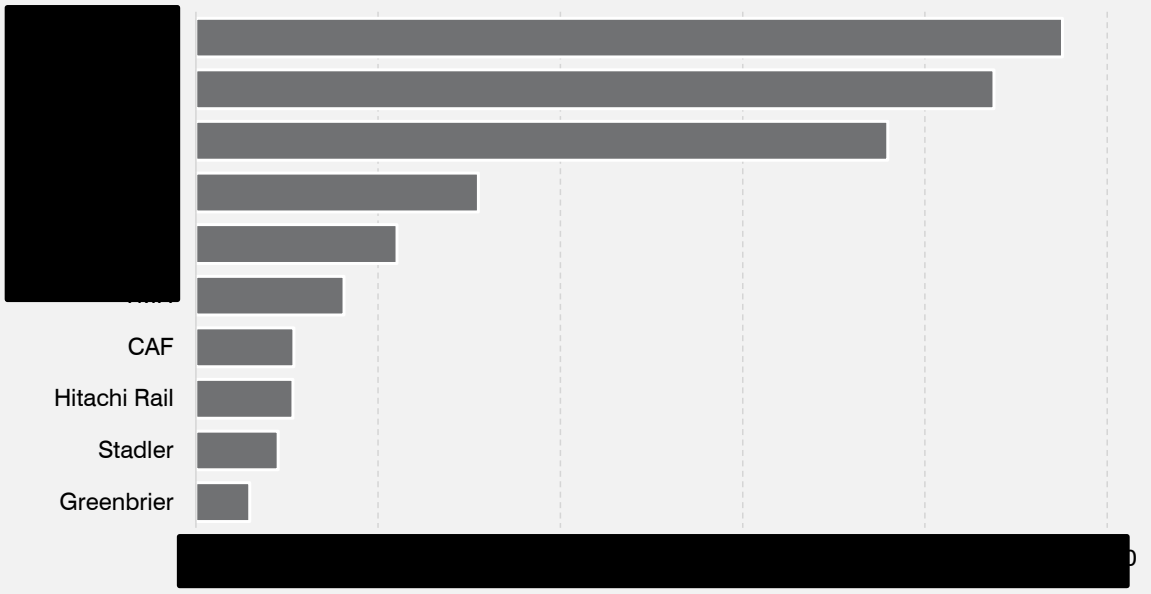
5-year trend: ↗ = increasing, → = constant, ↘ = decreasing

Developments in the installed base, sorted by product segment

Vehicle segment	Brief description
Electric locomotives	– […].
Diesel and alternative drive locomotives	– […]
High-speed trains	– […]
Electric multiple units	– […]
Diesel multiple units	– […]
Passenger coaches	– […]
Freight wagons	– […]
LRVs	– […]
Metro systems	– […]

Companies and contracts – manufacturers are focusing on maintenance services

Top ten manufacturers in the rolling stock after-sales market worldwide by turnover[1] in 2022
(EUR millions)



Source: SCI Database, [1]Rolling stock after sales services, spare parts & components; Partially estimated by SCI Verkehr © SCI Verkehr

Figure 5: Top ten manufacturers in the rolling stock after-sales market worldwide by turnover in 2022

Rolling stock manufacturers keep increasing their involvement in the after-sales market. In fact, multiple contracts for the provision of maintenance services have already been signed. These include both full-service maintenance contracts signed in conjunction with the procurement of new vehicles and modernisation services. Manufacturers also provide maintenance services as part of consortia within turnkey projects. These are mostly relevant for projects involving the realisation of infrastructure (including maintenance depots) and the development of maintenance capabilities.

Share of total revenue accounted for by after-sales services for three manufacturers 2019-2022
(%)

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Figure 6: Share of total revenue accounted for by after-sales services for three manufacturers 2019-2022

A deep dive into the revenue figures of three major rolling stock manufacturers – […] – shows that the share of total revenues accounted for by maintenance services increased between 2019 and 2022. Figures for XX prove to be rather volatile, displaying a significant increase in the share of maintenance services in 2020 compared to 2021; this is also due to a reduction in after-sales volumes in 2018, and figures for 2019 show a rebound effect.

Manufacturer	Total turnover 2022 (EUR m)	After-sales turnover 2022 (EUR m)	Share after-sales services 2019 (%)	Share after-sales services 2022 (%)	Share after-sales services 2019 vs 2022
XXX	XXX	XXX	XXX	XXX	↗
XXX	XXX	XXX	XXX	XXX	↘
XXX	XXX	XXX	XXX	XXX	↗
XXX	XXX	XXX	XXX	XXX	↘
XXX	XXX	XXX	XXX	XXX	→
XXX	XXX	XXX	XXX	XXX	↗
CAF	XXX	XXX	XXX	XXX	↗
Hitachi Rail	XXX	XXX	XXX	XXX	↘
Stadler	XXX	XXX	XXX	XXX	↗
Greenbrier	XXX	XXX	XXX	XXX	↘
5-year trend: ↗ = increasing, → = constant, ↘ = decreasing					
© SCI Verkehr GmbH					

[…]

[…]

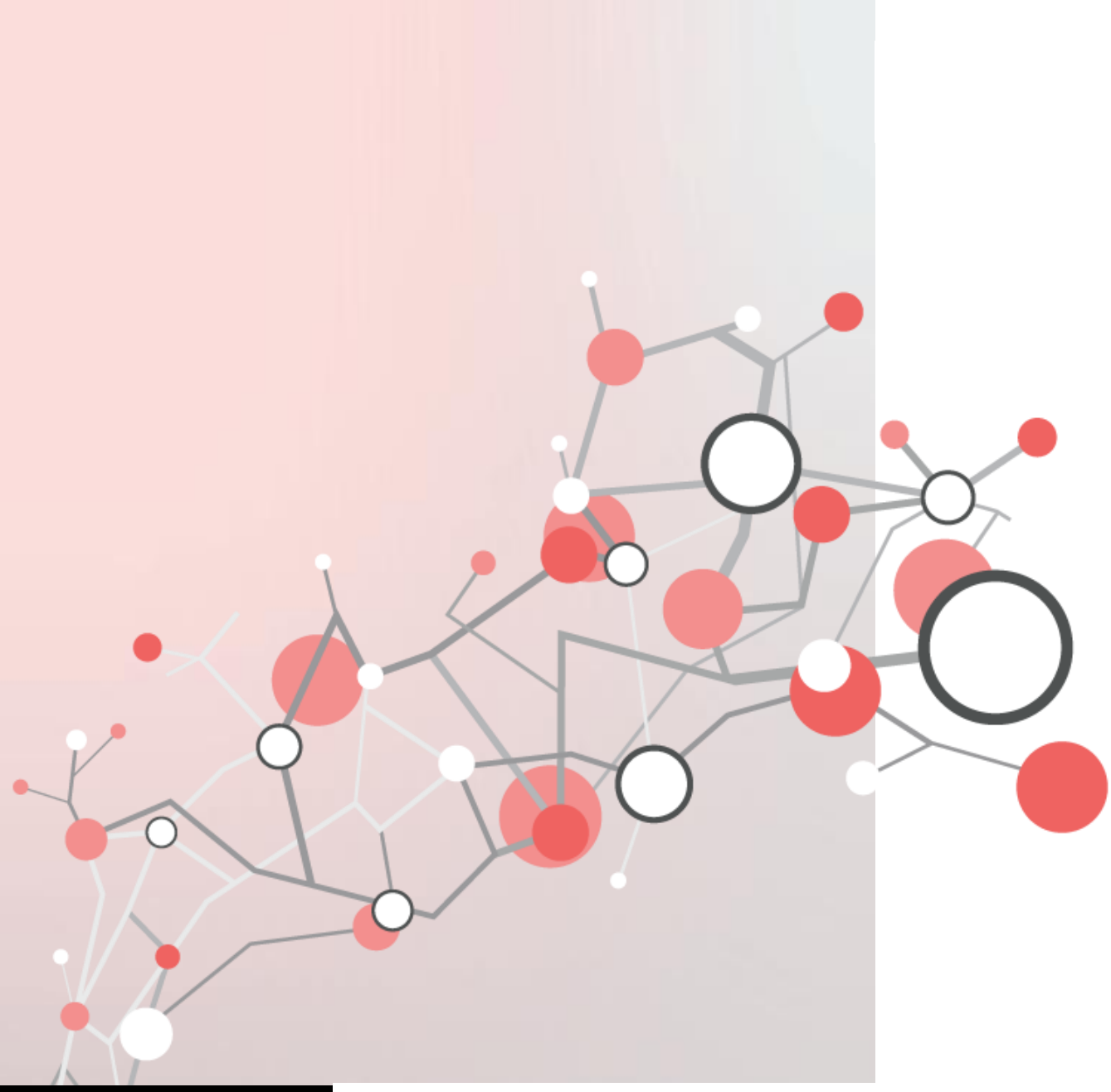
[…]

[…]

World: Most important recently-concluded maintenance contracts (full-service and modernisation/overhaul)

Country/ Region	Segment	Maintenance provider	No. (units)	Time period	Contract volume (EUR m)	Remarks
EG (Africa/Middle East)	Diesel locomotives	Skoda Transportation	280	2026-2041	1,000	[…]
USA (North America)	Diesel Locomotives	Wabtec Corporation	600	2023-2025	903	[…]
ES (Europe)	High-speed trains	Hitachi Europe	20	2022-2052	737	[…]
UK (Europe)	Diesel multiple units	Siemens	51	2023-2031	530	[…]
Germany (Europe)	Hydrogen EMU	Alstom	27	2023-2048	320	[…]
SA (Africa/Middle East)	High-speed trains	CAF	18	2022-2027	200	[…]

1. The increasing size of the fleet of vehicles with alternative traction
2. Leasing companies' investments in their own maintenance facilities
3. The gradual disappearance of know-how and spare parts for older series
4. The application of big data and digital analytics to process optimisation in order to foster high availability
5. The implementation of ESG criteria in maintenance processes and operations



5 The market for vehicle maintenance in Asia

2 The market for vehicle maintenance in Asia

2.1 Market volume and development

Segment	New vehicles 2022 (EUR m)	New vehicles CAGR 2022-2027 (%)	After-sales 2022 (EUR m)	After-sales CAGR 2022-2027 (%)
Passenger rail vehicles	XXX	XXX	XXX	XXX
Rail freight vehicles	XXX	XXX	XXX	XXX
Urban rail vehicles	XXX	XXX	XXX	XXX
Total	XXX	XXX	XXX	XXX

Asia accounts for almost one-third of the rolling stock after-sales market worldwide, with a market volume of EUR XXX billion in 2022. Therefore, Asia is the region with the highest after-sales volume.
Passenger rail transport accounts for a majority of the overall after-sales volume (around XXX %), followed by rail freight (XXX %) and urban (XXX %) rail transportation. Therefore, the passenger vehicles segment is the main driver of the region's after-sales market. The segment of high-speed trains plays a particularly important role in shaping after-sales volume, accounting for over XXX % within the passenger rail sector. Notably, high-speed train fleets are predominately located in China and Japan.

Transport market	Unit	Data 2022	CAGR 2022-2027 (%)
Mainline railway network	km	296,000	-
Passenger rail transport performance	Billion pkm	2,680	XXX
Rail freight transport performance	Billion tkm	4,040	XXX
Urban rail transport performance	Million pkm	390	XXX

Asia is by far the largest market worldwide in terms of transport performance. With XXX billion pkm of passenger and urban rail transport combined in 2022, it represents about XXX % of global transport performance.

Segment	Main segment dynamics	Intensity	Trend
Passenger rail vehicles	– Predominant role of operators (national incumbents) in the maintenance business, with extensive capacities and capabilities. – Strong focus on high-speed trains and EMUs. – Very high utilisation overall, usually with operation in shorter intervals and high yearly mileage, leading to high regular maintenance demand. – Increasing focus on passenger level of service. – Population growth drives transport demand.	●	↑
Urban rail vehicles	– Demand is driven by the increasing number and population of metropolitan areas, ensuring a high level of vehicle utilisation and leading to correspondingly high maintenance demand. – The presence of LRVs in Asia remains relatively limited, while around half of the world's metro installed base can be found in Asia. – Relatively low age structure, due to high procurement levels in China. – Recent trends include more focus on passenger comfort and transport process optimisation, leading to higher utilisation and more intensive maintenance procedures. – Maintenance is usually done by the operators of urban rail systems within their own workshops.	◑	↑

Segment	Main segment dynamics	Intensity	Trend
Freight rail vehicles	– Asian rail freight transport performance is expected to grow through 2027, driven by increasing coal and intermodal transport and infrastructure expansion projects in several countries. – In some country markets, freight rail vehicles are regularly taken out of service before reaching their modernisation interval and replaced with new ones. – The development of existing freight corridors and establishment of new ones will support freight transport market growth. – Maintenance is often secured directly within new procurement and covered by investment.	◕	↗

Intensity of the effect on the after-sales market: ● = very high, ◕ = high, ◑ = medium, ◔ = low, ○ = none

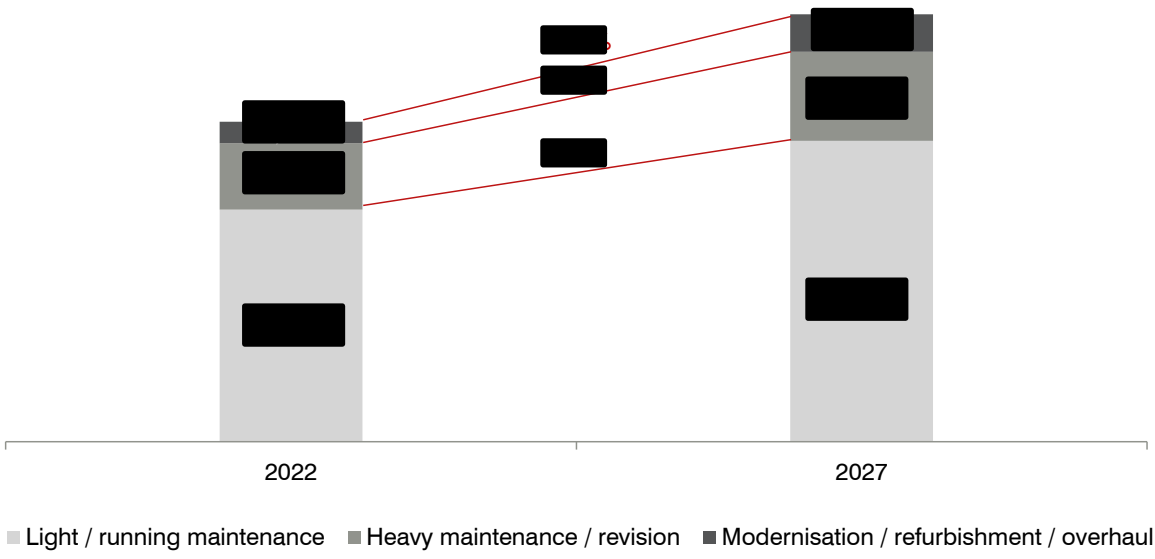
5-year CAGR trend: ↑ = strongly increasing (> +5%), ↗ = increasing (+2% to +5%),

→ = constant (0% to +2%), ↘ = decreasing (-2% to 0%), ↓ = strongly decreasing (< -2%)

SCI Verkehr expects the after-sales volume in Asia to grow by XXX % p.a. between 2022 and 2027.

– **Modernisation/refurbishment/overhaul services** are expected to have the highest annual growth in this period. However, they account for the smallest share of services, with a comparatively lower starting base in 2022 than other services.
– **Modernisation for older rolling stock** series is expected to become **more demanding** (higher operating speeds, air-conditioning, more efficient traction drive systems), leading to higher cost levels for corresponding maintenance services. However, in some markets and vehicle segments (e.g. high-speed trains in Japan and passenger coaches in India), the market for modernisation services is practically non-existent, since vehicles are being regularly replaced with new units.
– **Higher technical complexity** of rolling stock (high-speed trains, multiple units, locomotives), as well as increasing overall prices of electricity and spare parts **will drive heavy maintenance/revision and light/running maintenance service** volumes.

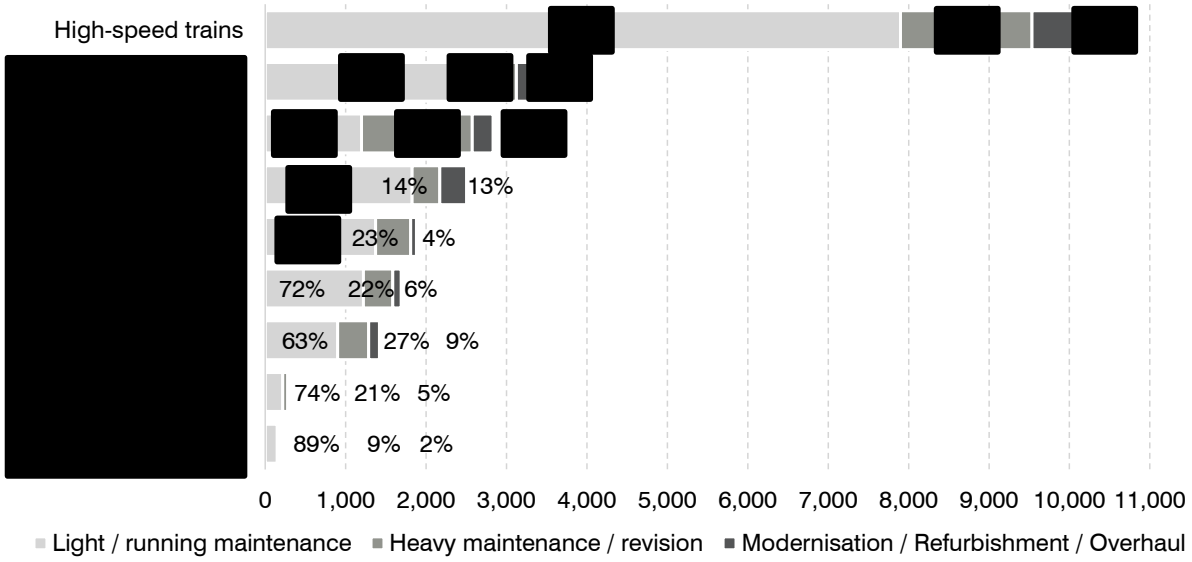
Market volume and 2022-2027 CAGR by maintenance type in Asia (EUR million)



Source: SCI Database

Figure 7: Market volume and 2022-2027 CAGR by maintenance type in Asia

Market volume of rolling stock after-sales services in 2022 in Asia by vehicle segment
(EUR millions)



Source: SCI Database

Figure 8: Market volume of rolling stock after-sales services in 2022 in Asia by vehicle segment

[…]

Segment	After-sales market volume (EUR million)			Trend
	Current after-sales market volume 2022	Future after-sales market volume 2027	CAGR 2022-27 (%)	
High-speed trains	XXX	XXX	XXX	↑
Metro vehicles	XXX	XXX	XXX	↑
Freight wagons	XXX	XXX	XXX	↗
Electric multiple units	XXX	XXX	XXX	↗
Electric locomotives	XXX	XXX	XXX	↑
Passenger coaches	XXX	XXX	XXX	↗
Diesel locomotives	XXX	XXX	XXX	→
Diesel multiple units	XXX	XXX	XXX	↓
Light rail vehicles	XXX	XXX	XXX	↑
Total	XXX	XXX	XXX	↑

5-year trend: ↑ = strongly increasing (> +5% p.a.), ↗ = increasing (+2% to +5% p.a.), → = constant (0% to +2% p.a.), ↘ = decreasing (-2% to 0% p.a.), ↓ = strongly decreasing (< -2% p.a.)

The expected development of after-sales for the rolling stock segment is described below.

– […]

2.2 Overview of the most important maintenance suppliers

The following table presents a selection of the most relevant maintenance suppliers in Asia.

Category	Company	Headquarters					Focus countries
			FW	Locos	Passenger	Urban	
Incumbent	CR	Beijing	x	x	x	x	China
Manufacturer	Alstom Shanghai (JV SHBRT)	Shanghai				x	China
Manufacturer	Alstom Sifang (Qingdao) Transportation	Qingdao			x		China
Incumbent	IR	New Delhi	x	x	x	x	India
Incumbent	JR	Tokyo, Sapporo, Nagoya, Osaka, Takamatsu, Fukuoka	x	x	x	x	Japan

2.3 Passenger rail vehicles

2.3.1 Volume and drivers

Indicator	Volume 2022 (EUR m)	CAGR 2022-2027 (%)
After-sales	XXX	XXX
New vehicles (OEM)	XXX	XXX
Total	XXX	XXX

[…]

Drivers	Brief description	Relevance	Trend
Transport market	[…]	●	↗
Fleet structure	[…]	[…]	→
Fleet utilisation	[…]	◕	↗
Technological development/ operational requirements	[…]	◔	↗
Investment funds	[…]	◑	→

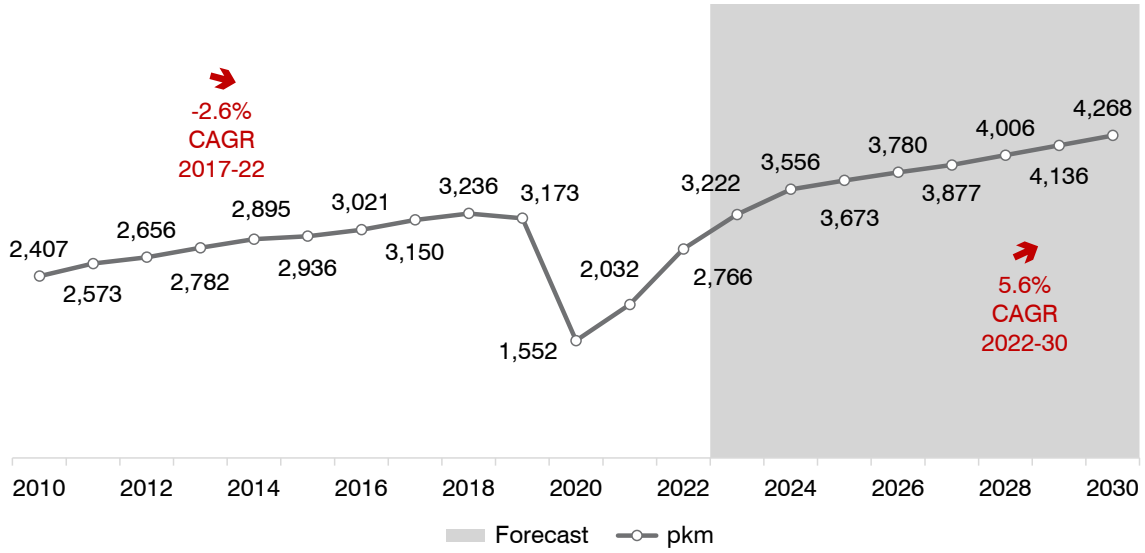
Relevance for the after-sales market: ● = very high, ◕ = high, ◑ = medium, ◔ = low, ○ = none

5-year trend: ↑ = strongly increasing, ↗ = increasing, → = constant, ↘ = decreasing, ↓ = strongly decreasing

2.3.2 Transport market

[…]

Development and forecast of rail passenger transport performance in Asia
(bn pkm)



Source: Statistical institutes, SCI Verkehr forecasts

Figure 9: Development and forecast of rail passenger transport performance in Asia

[…]

Country	Transport performance (bn pkm)	Share of total region performance	CAGR 2022-2027	Drivers
China	1,250	45%	6.9%	– The world's largest rail passenger market – Growing middle class, steady urbanisation and population – Volume of passenger rail services constantly increasing
India	940	35%	8.2%	– Infrastructure/fleet improvements, increasing system attractiveness – First high-speed line scheduled for construction
Japan	390	15%	4.2%	– Continuous network development with a strong focus on HST – Transport performance growth despite declining population – Inflation effects comparably lower with positive outlook
South Korea	50	< 5%	5.8%	– Increasing importance of high-speed trains – Strategic carbon neutrality goals for 2050 promote rail transport – Approved nationwide investment plan in the railway network
Other	130	< 5%	11.3%	– Population and infrastructure development in other countries such as Indonesia, Pakistan, Thailand and Vietnam
Total	**2,760**	**100%**	**7.1%**	– **The largest market worldwide, continues to increase infrastructure and rail services, growing HST segment**

2.3.3 Installed base

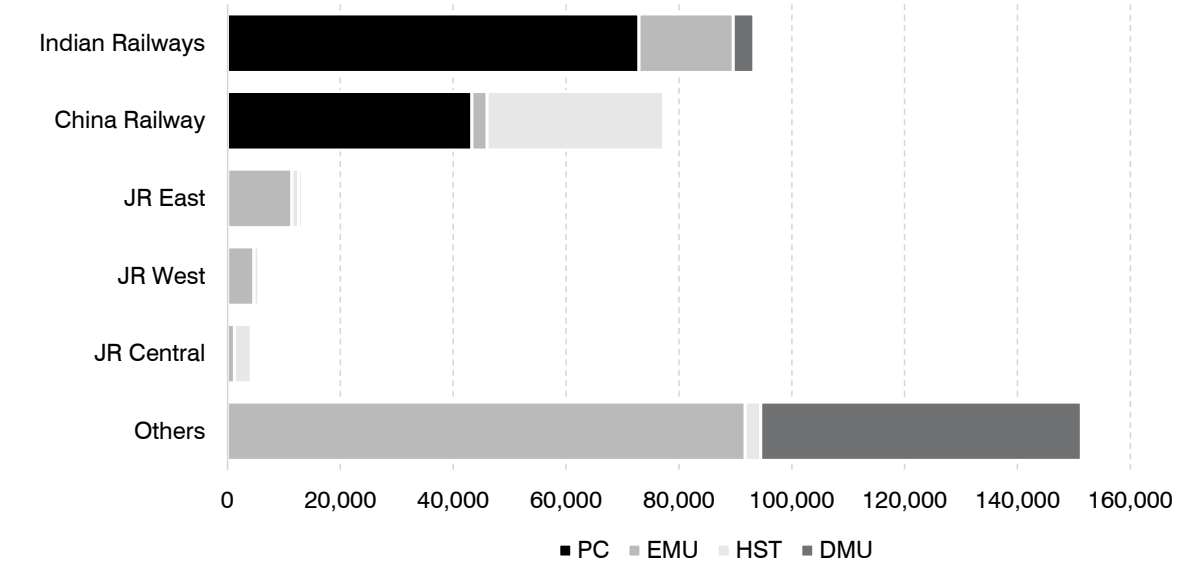
[…]

Vehicle segment	Installed base, 2022 (in cars; rounded)	Installed base development CAGR 2022–2027 (%)	Average age 2017 (in years; rounded)	Average age 2022 (in years; rounded)	Fleet age trend 2017 vs 2023
PC	XXX	XXX	XXX	XXX	↗
EMU	XXX	XXX	XXX	XXX	↘
HST	XXX	XXX	XXX	XXX	↗
DMU	XXX	XXX	XXX	XXX	↘

5-year trend: ↗ = increasing, → = constant, ↘ = decreasing

The recent decrease in fleet age between 2017 and 2023 for all vehicles is indicative of overall fleet rejuvenation efforts; this has a positive effect on light/running maintenance services. The installed base growth (except for the diesel multiple unit segment) will foster the heavy maintenance and revision service market, as part of the old fleets will be kept operational.

Multiple units, high-speed-trains and passenger coaches in Asia in 2022 – installed base by operator
(cars)



Source: SCI Database

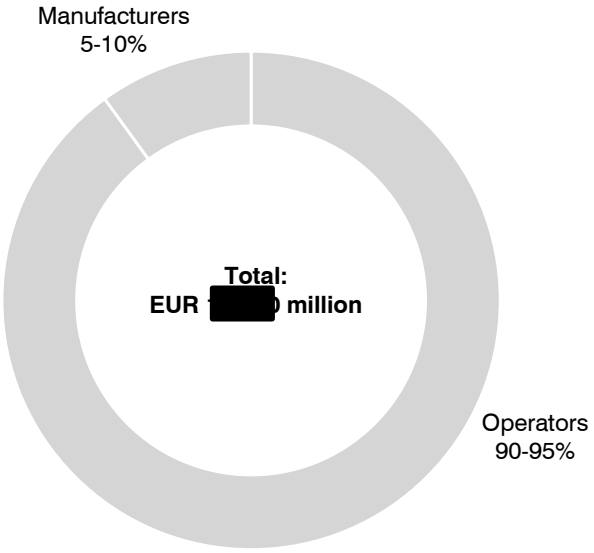
Figure 10: Multiple units, high-speed trains and passenger coaches in Asia in 2022 – installed base by operator

[…]

2.3.4 Market shares

[…]

Market shares of companies for passenger rail rolling stock after-sales services in Asia in 2022
(EUR million)



Source: SCI Database

Figure 11: Market shares of companies for passenger rail rolling stock after-sales services in Asia in 2022

[…]

2.3.5 Projects

A selection of the most relevant full-service and modernisation projects in the passenger rail vehicle segment in Asia is presented in the following table, without core markets – these are analysed in detail in the respective sections.

Country	Rolling stock segment	Maintenance segment	Company	Status	No. (units)	Time period	Contract volume (EUR m)	Brief description
SG	Metro	Full-service	Alstom	Ongoing	n/a	2021-2031	n/a	Maintenance of 636 Movia metro cars
SG	Metro	Modernisation	CRRC	Ongoing	25	2019-2024	75	Modernisation of Alstom's C751A metro vehicles
SG	Metro	Modernisation	Alstom	Completed	92	2021-2022	n/a	Communication system upgrade for the Movia metro vehicles
MY	EMU	Full-service	CRRC Zhuzhou	Ongoing	48	2015-2025	52	Delivery and maintenance contract

2.4 Urban rail vehicles

2.4.1 Volume and drivers

Indicator	Volume 2022 (EUR m)	CAGR 2022-2027 (%)
After-sales	XXX	XXX
New vehicles (OEM)	XXX	XXX
Total	XXX	XXX

[…]

Drivers	Brief description	Relevance	Trend
Transport market	[…]	●	↗
Fleet structure	[…]	◑	→
Fleet utilisation	[…]	◕	↗
Technological development/ operational requirements	[…]	◑	→
Investment funds	[…]	◑	→

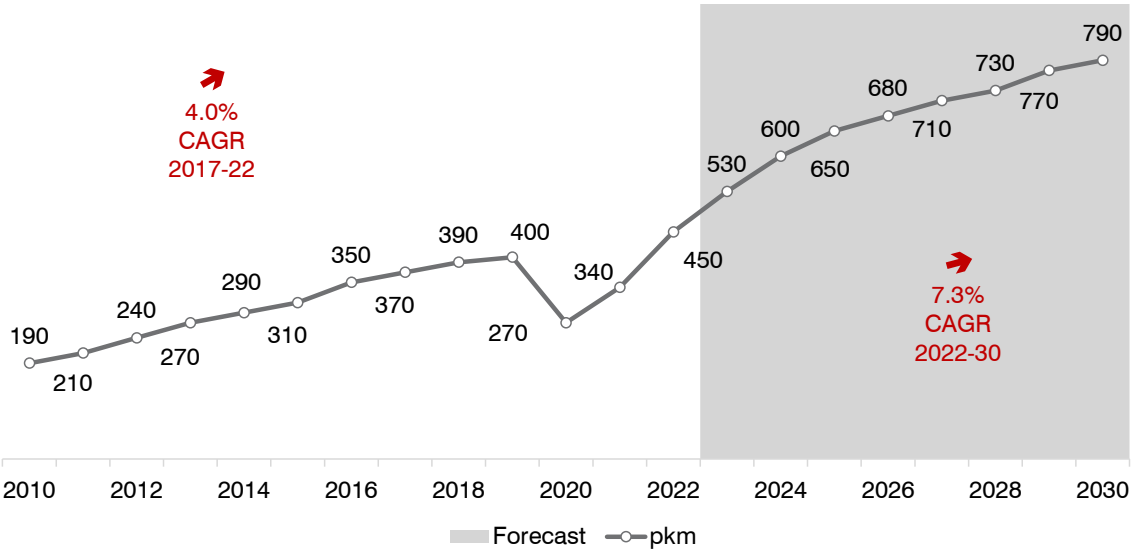
Relevance for the after-sales market: ● = very high, ◕ = high, ◑ = medium, ◔ = low, ○ = none

5-year trend: ↑ = strongly increasing, ↗ = increasing, → = constant, ↘ = decreasing, ↓ = strongly decreasing

2.4.2 Transport market

[…]

Development and forecast of urban rail passenger transport performance in Asia
(bn pkm)



Source: Statistical institutes, SCI Verkehr forecasts

Figure 12: Development and forecast of urban rail passenger transport performance in Asia

[…]

Country	Transport performance (bn pkm)	Share of total region performance	CAGR 2022-2027	Drivers
China	280	61%	+1.4%	[…]
India	10	3%	+4.3%	[…]
Japan	60	14%	+4.0%	[…]
South Korea	40	10%	+2.9%	[…]
Others	60	12%	+7.1%	[…]
Total	**450**	**100%**	**+2.1%**	[…]

2.4.3 Installed base

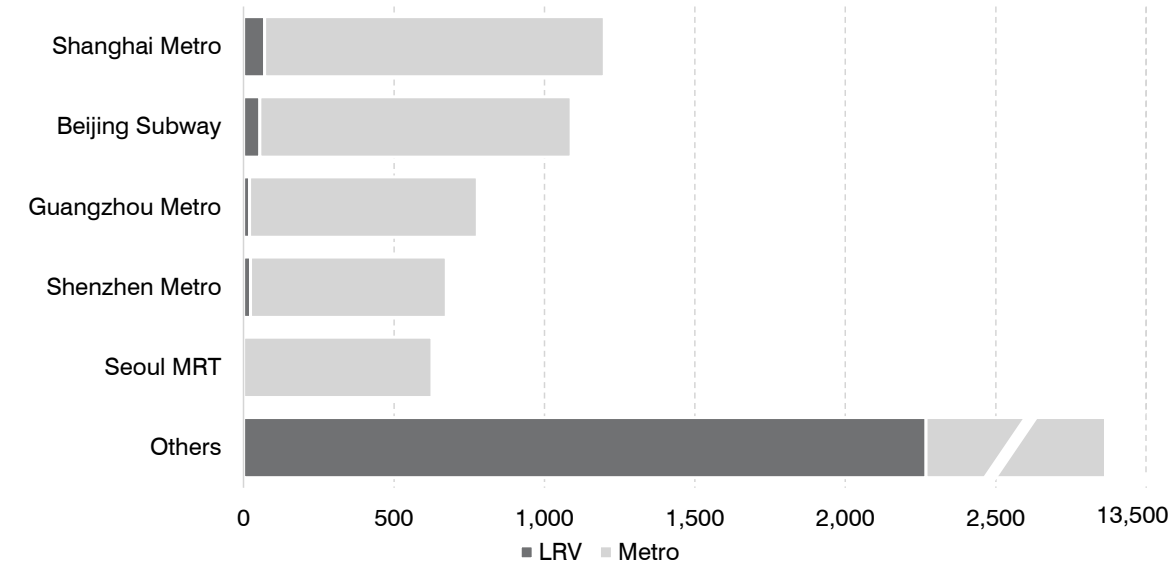
[…]

Vehicle segment	Installed base, 2022 (in units; rounded)	Installed base development CAGR 2022–2027 (%)	Average age 2017 (in years; rounded)	Average age 2022 (in years; rounded)	Fleet age trend 2017 vs 2023
LRV	XXX	XXX	XXX	XXX	↘
Metro	XXX	XXX	XXX	XXX	↘

5-year trend: ↗ = increasing, → = constant, ↘ = decreasing

[…]

Urban rail vehicles in Asia in 2022 – installed base by operator (units)



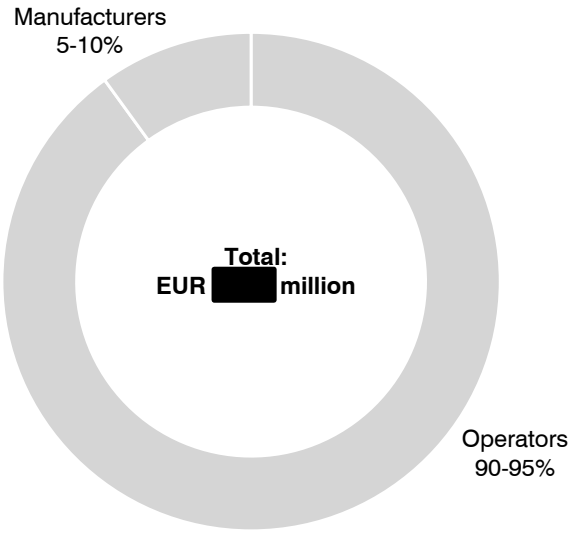
Source: SCI Database

Figure 13: Urban rail vehicles in Asia in 2022 – installed base by operator

2.4.4 Market shares

[…]

Market shares of companies for urban rail rolling stock after-sales services in Asia in 2022 (EUR million)



Source: SCI Database

Figure 14: Market shares of companies for urban rail rolling stock after-sales services in Asia in 2022

2.4.5 Projects

[…]

Country	Rolling stock segment	Maintenance segment	Company	Status	No. (units)	Time period	Contract volume (EUR m)	Brief description
TH	Metro	Full-service	Siemens/ Bozankaya	Ongoing	22	2019-2035	n/a	Delivery and 16-year maintenance contract with Bangkok Mass Transit

2.5 Freight rail vehicles

2.5.1 Volume and drivers

Indicator	Volume 2022 (EUR m)	CAGR 2022-2027 (%)
After-sales	XXX	XXX
New vehicles (OEM)	XXX	XXX
Total	XXX	XXX

[…]

[…]

Drivers	Brief description	Relevance	Trend
Transport market	[…] […]	●	↗
Fleet structure	[…]	◕	↗
Fleet utilisation	[…]	◕	↗
Technological development/ operational requirements	[…]	◑	→
Investment funds	[…]	◑	→

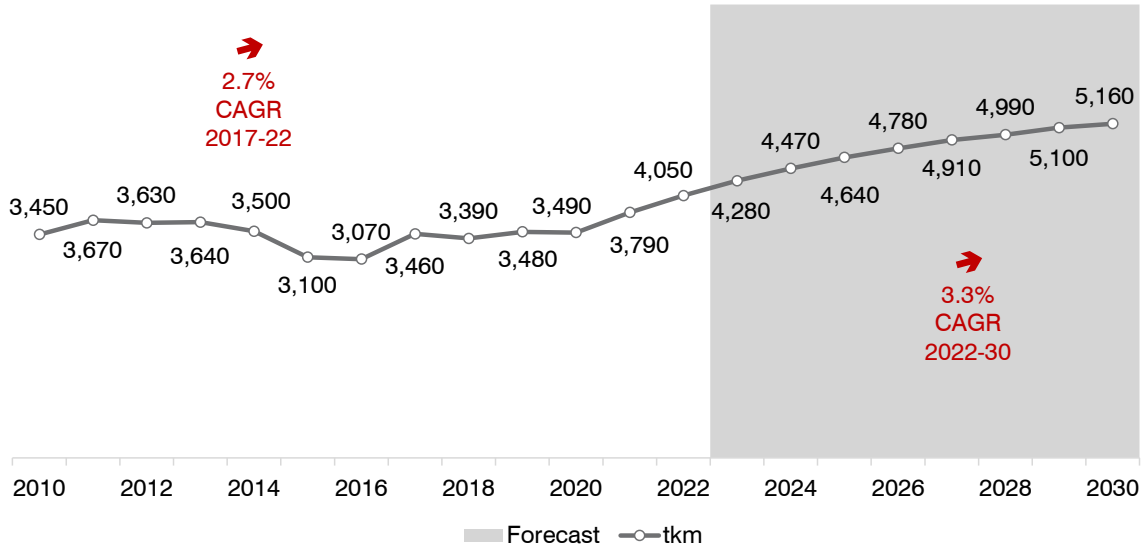
Relevance for the after-sales market: ● = very high, ◕ = high, ◑ = medium, ◔ = low, ○ = none

5-year trend: ↑ = strongly increasing, ↗ = increasing, → = constant, ↘ = decreasing, ↓ = strongly decreasing

2.5.2 Transport market

[…]

Development and forecast of rail freight transport performance in Asia
(bn tkm)



Source: Statistical institutes, SCI Verkehr forecasts

Figure 15: Development and forecast of rail freight transport performance in Asia

[…]

Country	Transport performance (bn tkm)	Share of total region performance	CAGR 2022-2027	Drivers
China	3,160	80%	3.5%	[…]
India	800	20%	5.5%	[…]
Others	90	< 5%	4.0%	[…]
Total	**4,050**	**100%**	**3.9%**	[…]

Figure 16: Freight transport performance by country in Asia

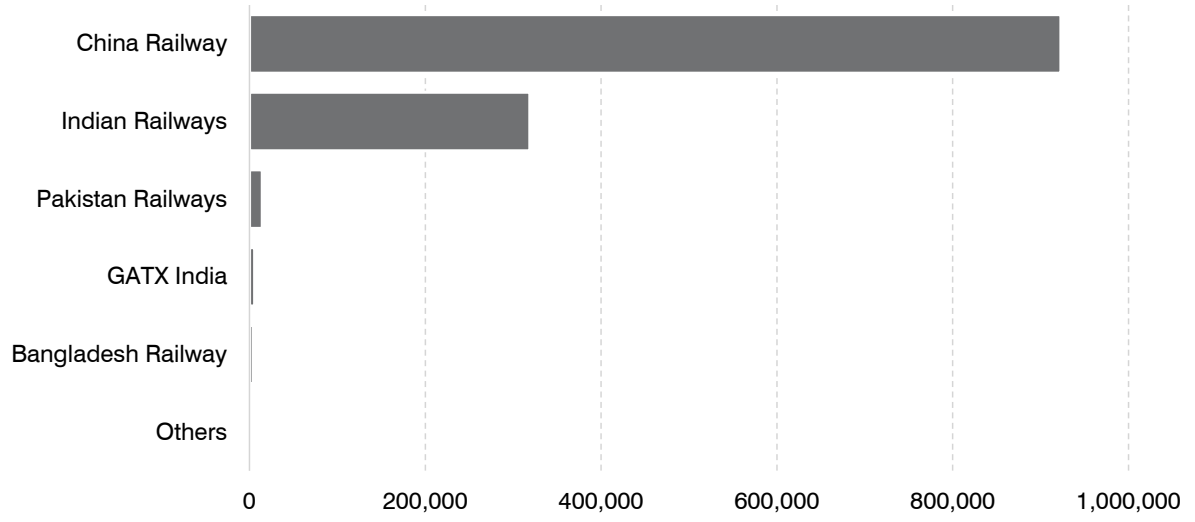
2.5.3 Installed base

[…]

Vehicle segment	Installed base, 2022 (in units; rounded)	Installed base development CAGR 2022–2027 (%)	Average age 2017 (in years; rounded)	Average age 2022 (in years; rounded)	Fleet age trend 2017 vs 2022
FW	XXX	XXX	XXX	XXX	↗
E-Loco	XXX	XXX	XXX	XXX	→
D-Loco	XXX	XXX	XXX	XXX	↗
		5-year trend: ↗ = increasing, → = constant, ↘ = decreasing			
					© SCI Verkehr GmbH

[…]

Freight wagons in Asia in 2022 – installed base by owner* (units)



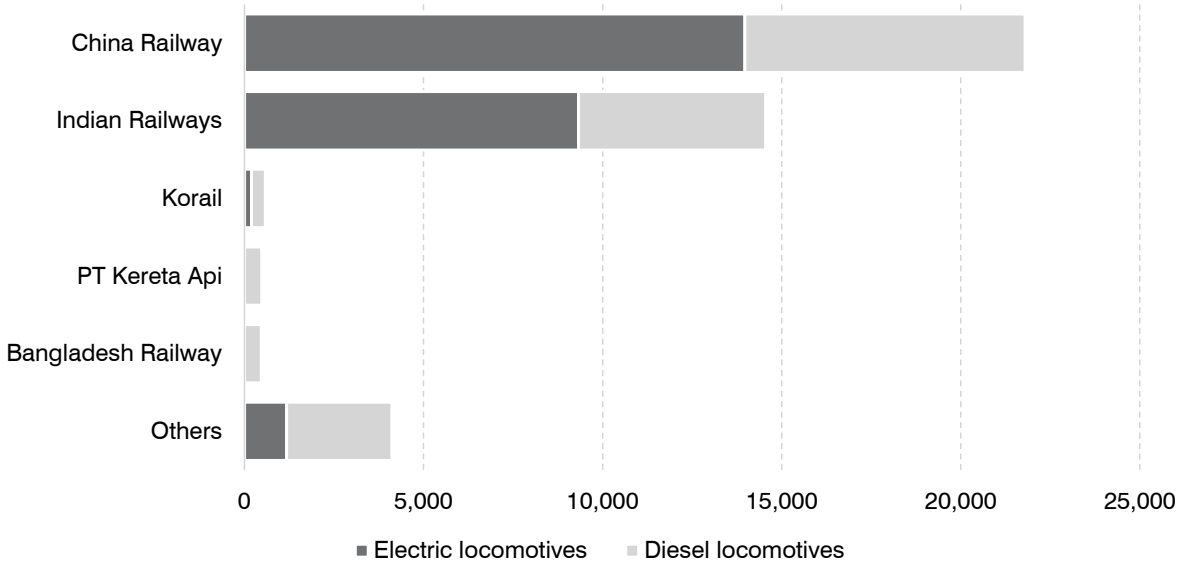
* In freight wagon segment, operators of leased wagons are often not known, therefore the ownership structure is presented
Source: SCI Database

© SCI Verkehr

Figure 17: Freight wagons in Asia in 2022 – installed base by owner

[…]

Locomotives in Asia in 2022 – installed base by operator (units)



Source: SCI Database

Figure 18: Locomotives in Asia in 2022 – installed base by operator

2.5.4 Market shares

[…]
[…]

2.5.5 Projects

[…]

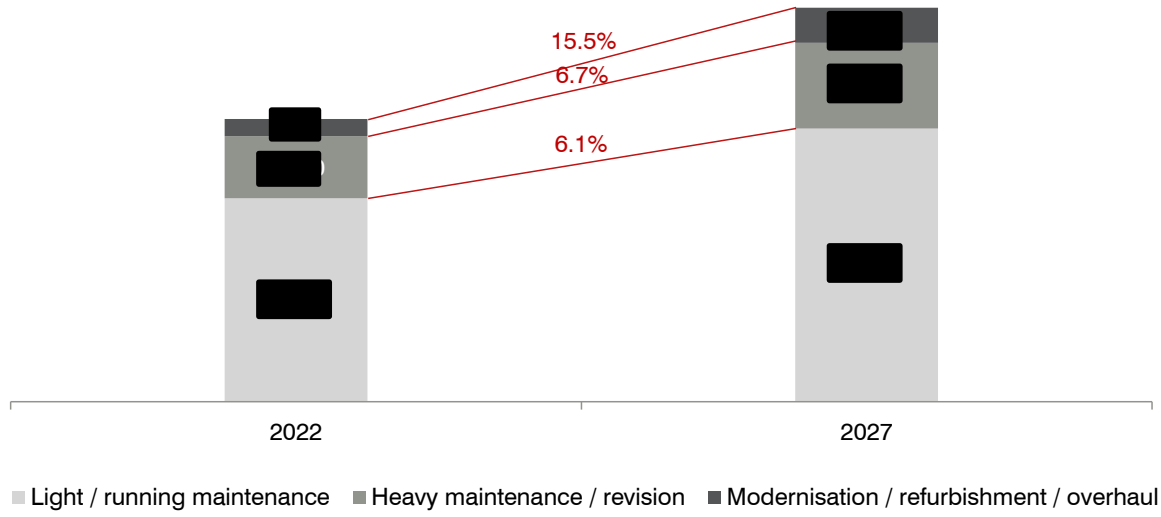
2.6 China

Market development

Segment	New vehicles 2022 (EUR m)	New vehicles CAGR 2022-2027 (%)	After-sales 2022 (EUR m)	After-sales CAGR 2022-2027 (%)
Passenger rail vehicles	XXX	XXX	XXX	XXX
Freight rail vehicles	XXX	XXX	XXX	XXX
Urban rail vehicles	XXX	XXX	XXX	XXX
Total	XXX	XXX	XXX	XXX
				© SCI Verkehr GmbH

[…]

Market volume and 2022-2027 CAGR by maintenance type in China (EUR million)

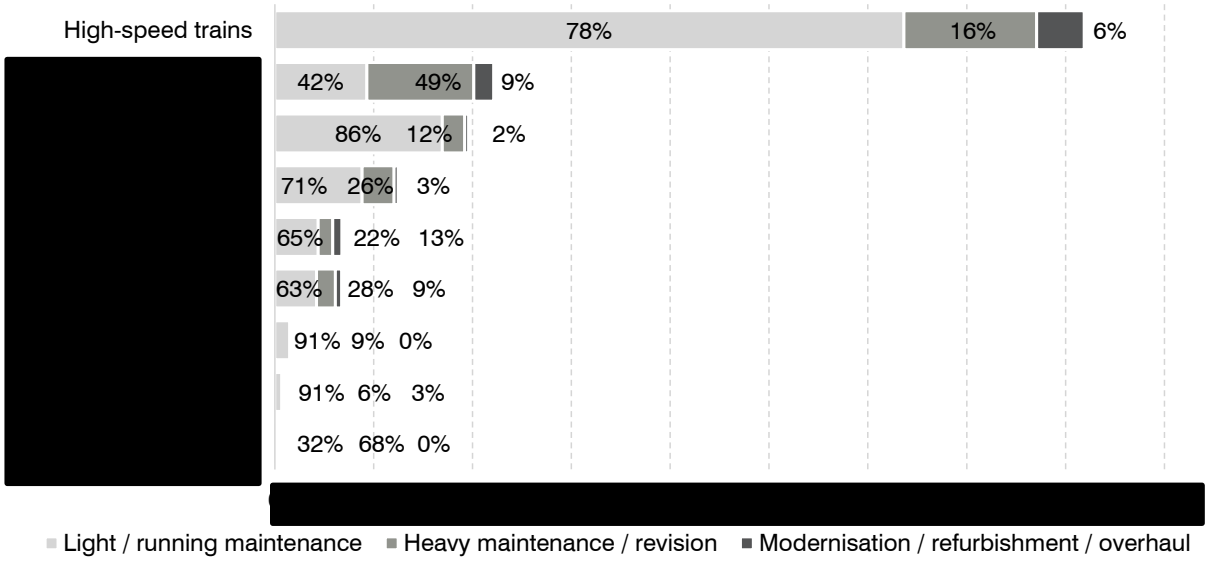


Source: SCI Database © SCI Verkehr

Figure 19: Market volume and 2022-2027 CAGR by maintenance type in China

[…]

Market volume of rolling stock after-sales services in 2022 in China by vehicle segment
(EUR millions)



Source: SCI Database

Figure 20: Market volume of rolling stock after-sales services in 2022 in China by vehicle segment

Market structure and maintenance providers

[…]

Company type	Company	Rolling stock segment				Maintenance strategy and activities
		FW	Locos	Passenger	Urban	
Incumbent	CR Beijing		x	x	x	Responsible for operation and maintenance activities in the northern geographical regions
Incumbent	CR Hohhot		x	x	x	
Incumbent	CR Taiyuan		x	x	x	
Incumbent	CR Harbin		x	x	x	Responsible for operation and maintenance activities in the northeastern geographical regions
Incumbent	CR Shenyang		x	x	x	
Incumbent	CR Shanghai		x	x	x	Responsible for operation and maintenance activities in the eastern geographical regions
Incumbent	CR Jinan		x	x	x	
Incumbent	CR Nanchang		x	x	x	
Incumbent	CR Guangzhou		x	x	x	Responsible for operation and maintenance activities in the southern geographical regions
Incumbent	CR Nanning		x	x	x	
Incumbent	CR Wuhan		x	x	x	Responsible for operation and maintenance activities in the central geographical regions
Incumbent	CR Zhengzhou		x	x	x	
Incumbent	CR Chengdu		x	x	x	Responsible for operation and maintenance activities in the southwestern geographical regions
Incumbent	CR Kunming		x	x	x	
Incumbent	CR Qinghai-Tibet		x	x	x	
Incumbent	CR Lanzhou		x	x	x	
Incumbent	CR Urumqi		x	x	x	

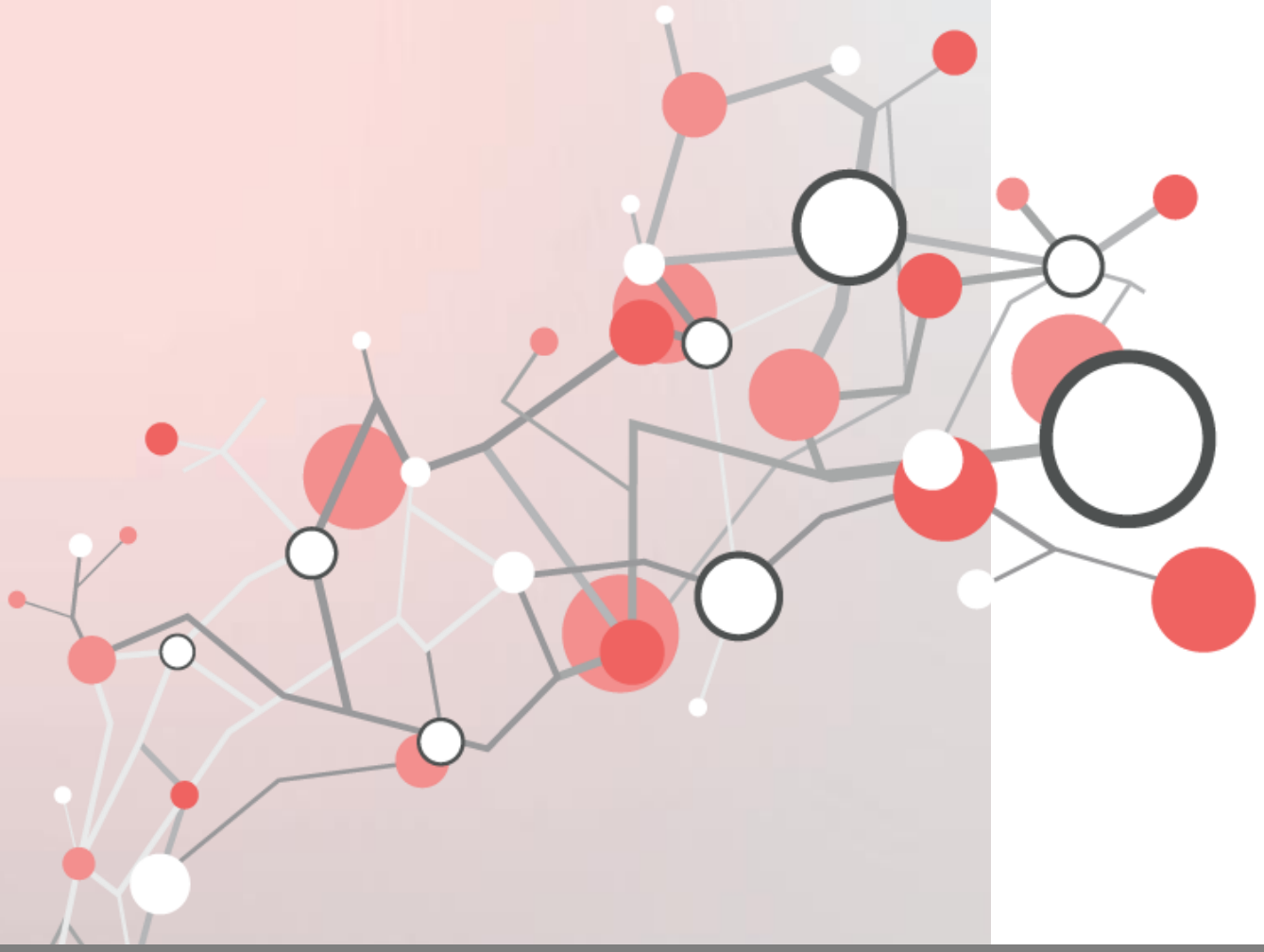
Company type	Company	Rolling stock segment				Maintenance strategy and activities
		FW	Locos	Passenger	Urban	
Incumbent	CR Xi'an		x	x	x	Responsible for operation and maintenance activities in the northwestern geographical regions
Incumbent	China Railway Express Company (CRE)	x	x			Nationwide rail freight transport and maintenance services
Incumbent	China Railway Container Logistics (CRCT)	x	x			
Incumbent					x	As of the end of 2022, a total of 51 cities in China had their own urban rail systems, each with certain maintenance level capabilities
Manufacturer	Alstom Shanghai (JV SHBRT)				x	Metro maintenance services, including preventive and corrective maintenance, overhauls, safety inspections and train cleaning
Manufacturer	Alstom Sifang (Qingdao) Transportation			x		Production and various maintenance levels of high-speed trains

Selection of relevant projects in China – full-service and modernisation:

Rolling stock segment	Maintenance segment	Company	Status	No. (units)	Time period	Contract volume (EUR m)	Brief description
HST	Full-service	Alstom/Bombardier Sifang (Qingdao) Transportation	Completed	various	2021-2022	52	Maintenance of 592 HST cars
Metro	Full-service	Alstom/ Shentong Bombardier Rail Transit (SHBRT)	Ongoing	34	2022-2027	43	Entire lifecycle maintenance of Movia metro trains
E-Loco	Modernisation	Wabtec	Awarded	25	2024-2026	14	Modernisation of Mk3 battery-electric locos
LRV	Full-service	Keolis	Ongoing	30	2019-2024	n/a	Operation and maintenance in the Songjiang district
Metro	Full-service	Shentong Bombardier Rail Transit (SHBRT)	Ongoing	83	2018-2028	n/a	Ten-year overhaul service for 498 metro cars
Metro	Modernisation	Alstom	Completed	318	2020-2021	50	Nanjing metro vehicles equipped with train control and monitoring system
HST	Full-service	Bombardier/CSSR Sifang	Completed	71	2020	321	Maintenance services for a total of 656 HST cars

2.7 India

2.8 Japan



ANNEX

Annex

1 Market delimitation and methodology of the study

1.1 Objective of the market analysis

SCI Verkehr's MultiClient Study "Rail Vehicle Maintenance – Global Trends in the After-Sales Market" offers comprehensive insight into the structure, volumes, drivers and developments in the rolling stock after-sales market.

The after-sales market makes up a good half of the total railway vehicle market and is developing with higher yearly growth rates than the OEM market, with less volatile planning horizons. The after-sales market is therefore very important for the players in the market. Expenditure on the maintenance of rolling stock represents an important cost factor in the lifecycle of railway vehicles. Efficiency increases are therefore often an important factor in the strategic orientation of railway operators. The awarding of maintenance services to external partners is a typical development resulting from this, especially in emerging railway markets. Budget restrictions as a result of the Covid-19 pandemic have also resulted in the postponement of procurement projects and additional investments in old fleets to extend their operational life. The after-sales market therefore offers medium- to long-term growth prospects for manufacturers and independent suppliers of maintenance services in particular.

In view of this, all companies in the rail industry are greatly interested in obtaining reliable market information on the after-sales segment.

With this MultiClient Study, SCI Verkehr addresses this demand and provides core data relevant to competition for market volumes, as well as current and future trends in this segment. This study is a continuous further development of the successful previous study from 2018, including advanced data, new evaluations and assumptions for maintenance costs, and the latest market forecasts. The structure of the study has been improved in order to present the maintenance market even more clearly.

In concrete terms, this market study of rail vehicle maintenance contains:
- An overview of the worldwide rolling stock after-sales market differentiated by region, including an in-depth analysis of the most important country markets
- Analysis of vehicle fleets and operators in all regions
- Detailed presentation of market structures and market organisations
- Identification of key players in the maintenance sector
- Identification and evaluation of drivers in the after-sales market and future trends
- Presentation of important current maintenance and refurbishment projects
- Company factsheets for the top players in the rolling stock after-sales market

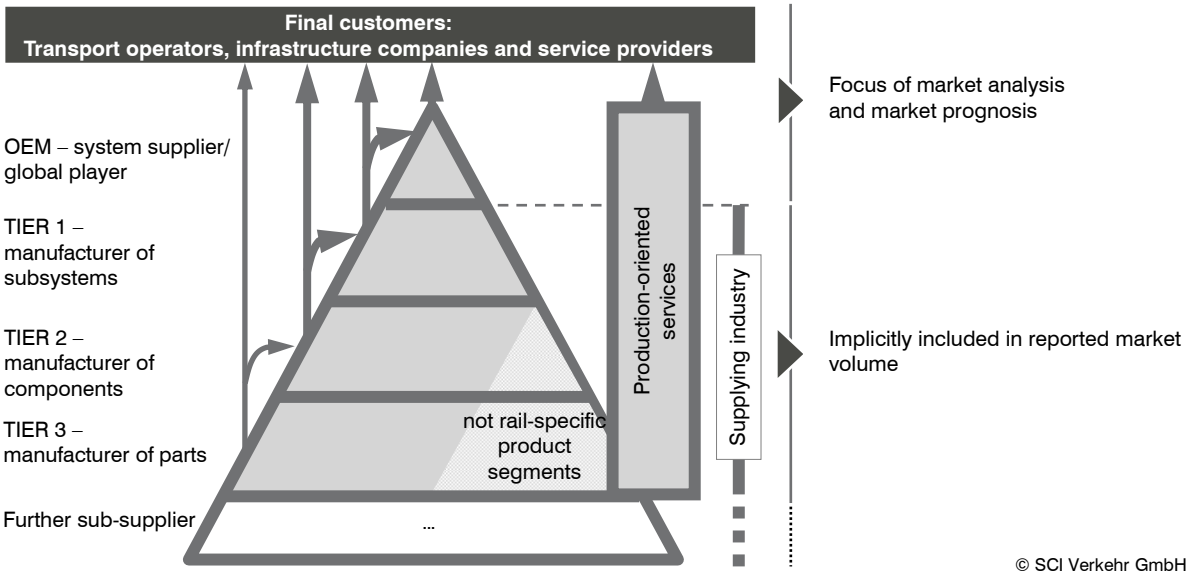
This study thus provides a sound analysis of the global rolling stock after-sales market. It sets out important information for companies established in the railway industry, as well as current and potential future operators of maintenance workshops, who can use this information to shape operational and strategic planning.

1.2 Delimitation of the market analysis

1.2.1 Delimitation of the OEM and after-sales business

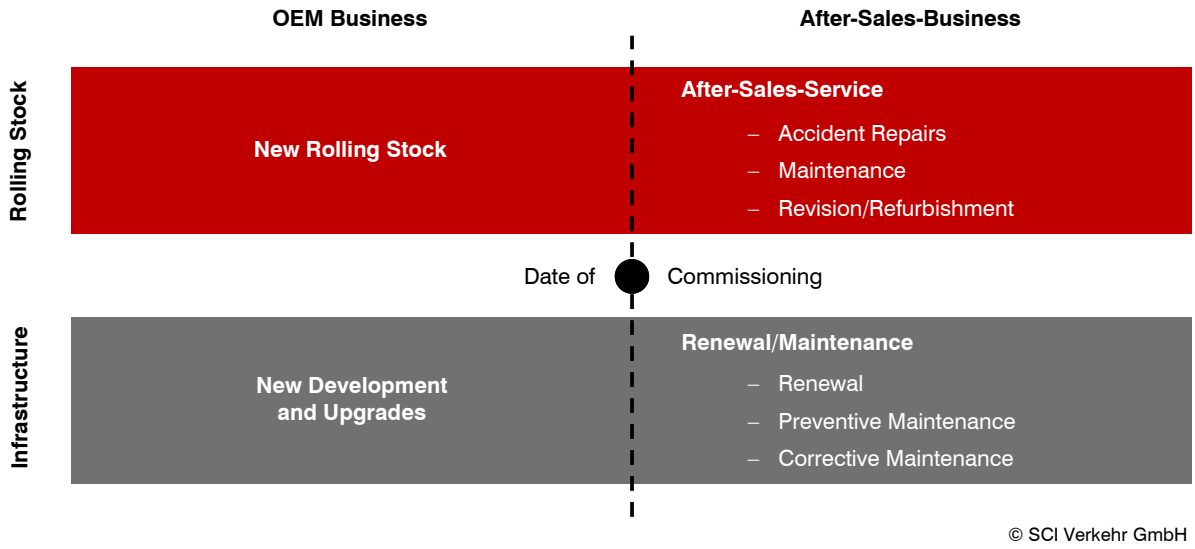
The information on market volumes only refers to the top level of value creation. The components or levels of value creation beneath these are only included implicitly. The top level of value creation in the vehicle maintenance market concerns services offered by companies who carry out the vehicle maintenance. The market volume for component overhaul, as well as the installation of new parts in existing vehicles, is therefore also implicitly included.

Relationships of Value Creation in the Railway Industry



The market involving capital equipment that is to be operated for the first time (OEM market), on the one hand, and that involving maintenance services and spare parts on the other hand (after-sales market), account for very different proportions of the total market for a product segment and are also structured differently. The delimitation is carried out according to the following system:

Delimitation of OEM und After Sales Business

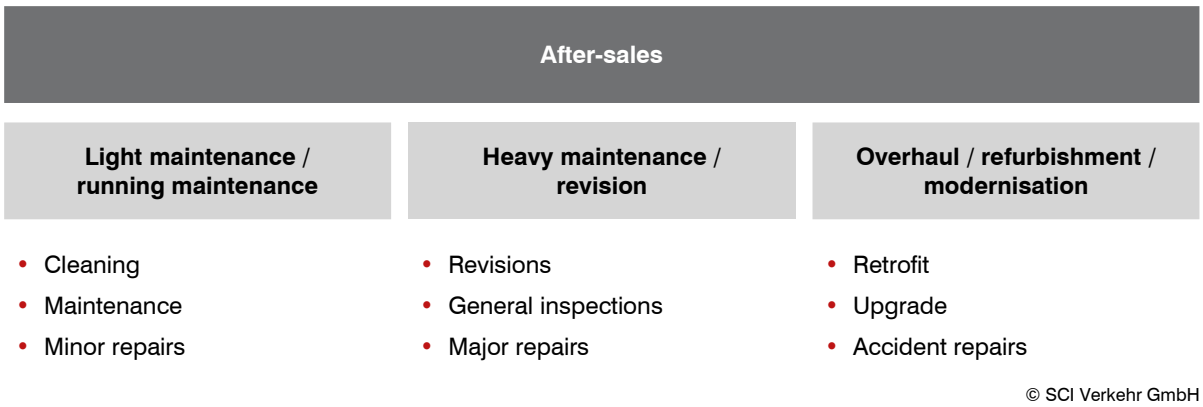


The after-sales market includes all services performed after a vehicle or line has been put into operation.

1.2.2 After-sales market definitions

For rolling stock, all maintenance work (i.e. light/running and heavy maintenance/revisions), as well as accident repairs and refurbishment/modernisation projects, are covered by the term “after-sales”. The after-sales market includes all services performed after a vehicle has been put into operation.

The individual levels of maintenance are delimited according to the following system:



SCI Verkehr uses the following definitions as the basis for the different maintenance levels:

1. **Light/running maintenance:** Includes daily and annual cleaning and regular technical services, as well as light/running repairs. These activities ensure that vehicles are in sound and technically adequate condition for daily operation. The light maintenance can be carried out both in relatively simply equipped workshops and on the track (mobile).
2. **Heavy maintenance/revisions**: Essentially consists of major repairs and statutory inspections, as well as general inspections. These measures investigate the technical condition of vehicles and relevant components and, if required, will rectify any problems. Inspection cycles can be set at fixed time intervals or based on mileage covered. Increasingly, components are also refurbished according to their actual condition, independently of fixed periods (condition-based maintenance).
3. **Overhaul/refurbishment/modernisation**: Overhaul or replacement of important vehicle components. Replacement of defective or worn components is designed to restore vehicles to a technically sound condition. Refurbishment project duration depends on the required scope of work and quantity of vehicles needing refurbishment. Modernisations usually have the aim of preparing the vehicle for further operation over many years and generally take place once in a vehicle’s life.

The following table gives an overview of the work that is usually performed at the different maintenance levels:

Work	Light/running maintenance	Heavy maintenance/ revisions	Overhaul/ refurbishment/ modernisation
Cleaning	x	x	x
Visual and functional tests, some measurements	x		
Refill operating materials	x	x	x
Smaller repairs	x		
Dismounting of the vehicle		x	x
Detailed measurements and functional test		x	x
Systematic replacement of worn parts		x	x
Exchange and overhaul of components (e.g. wheelsets, powerpacks)		x	
Exchange and/or upgrade of components and functionality (e.g. remotorisation, installation of new CCS system, new interior design for passenger vehicles)			x

While light and heavy maintenance usually follows defined deadlines and work, modernisations are one-off events to improve the functionality of a vehicle or to prepare it for use over a further longer period. The scope of a modernisation can vary greatly depending on the specific project. The scope of the work also varies depending on the vehicle segment, and in some cases it also varies in various world market regions.

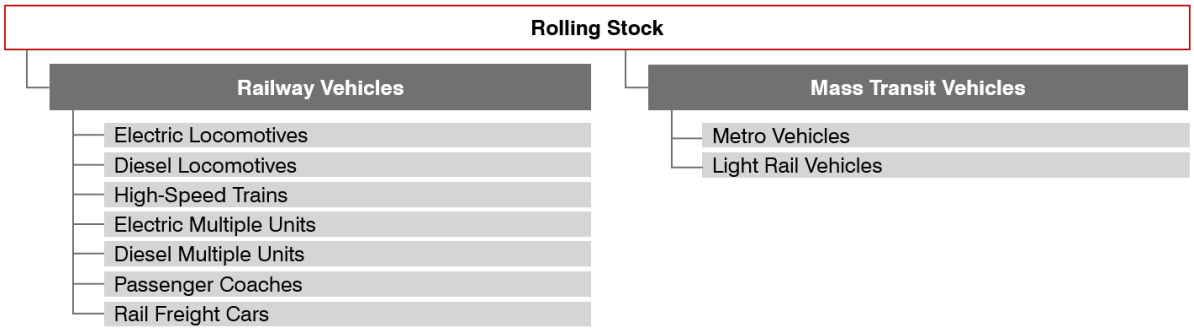
The after-sales market and OEM market are often substitutes for each other: if, despite existing demand, investment projects for new vehicles have to be postponed or abandoned, existing assets will have to be used for a longer time period or more intensively. This often leads to a higher demand for maintenance work, which is reflected in higher after-sales volumes. Conversely, the market volume in the after-sales segment often shrinks when high-maintenance assets are replaced by new products. Nonetheless, this does not necessarily lead to the conclusion that maintenance expenditure can be reduced by new procurements, because the high technical complexity and increased functionality of new products often leads to new maintenance requirements, counteracting the advantage provided by the low-maintenance components installed.

A maintenance site or workshop is defined as a geographical location where a company performs maintenance services (i.e. light/running and heavy maintenance/revisions) as well as accident repairs and refurbishment work.

1.2.3 Railway technology product segments

The structure of the railway market can generally be divided into the sub-sectors of infrastructure, systems technology and vehicles. The following market analysis primarily considers the after-sales market related to rolling stock. Within the rolling stock sub-sector, SCI Verkehr differentiates between railway vehicles and mass transit vehicles (urban rail vehicles).

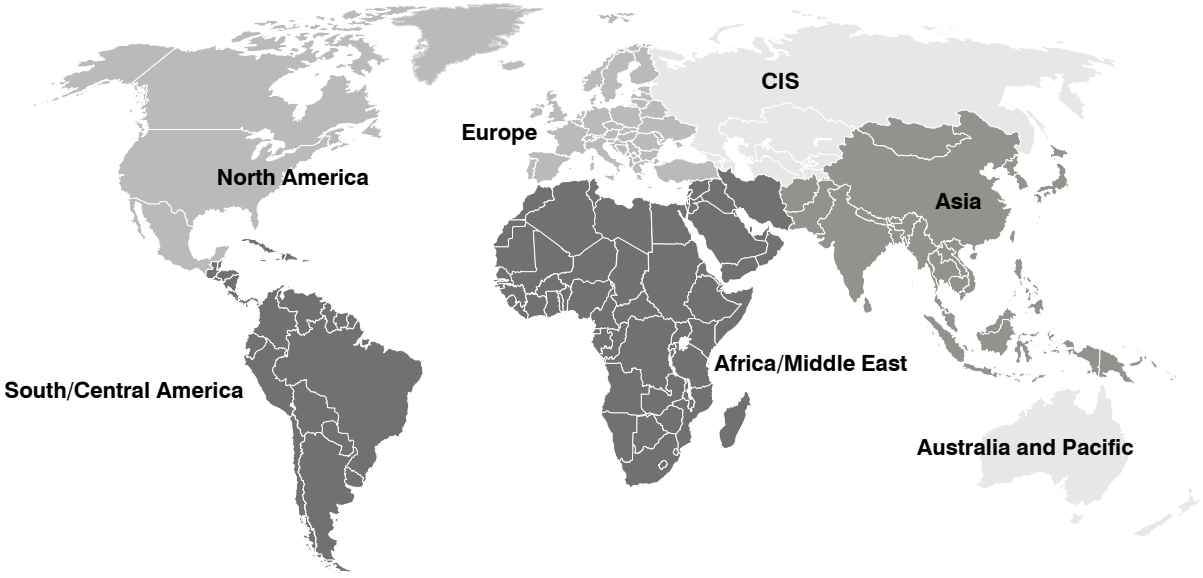
Structure of the Product Segment Rolling Stock



The study covers market trends in passenger rail, urban rail and rail freight transport. All vehicle segments apart from locomotives and freight wagons can be clearly allocated to passenger rail transport, while freight wagons are classified under rail freight transport. Locomotives are used in both passenger and freight transport. However, since locomotives are mainly used in freight transport and are often maintained in specialised workshops, SCI Verkehr allocates them to the freight transport market in this study when determining markets and operators. Urban rail transport is solely carried out by LRVs and metro vehicles.

1.2.4 Geographical focus

The world market has been divided into eight regions. This regional division corresponds with the segmentation in the previous study.



Each individual market region has leading markets that have a significant effect on overall market developments (such as currently China and India in Asia, and Germany and France in Europe). In addition, considerable differences related to market structure and market organisation can become apparent in individual countries. For this reason, this study analyses not only the overall market region, but also individual core countries separately at the end of the chapter covering their respective region.

1.2.5 Temporal focus

In keeping with the system of SCI Verkehr's market studies, the markets have been analysed for the year 2022; the forecast period comprises the years 2023 to 2027. Market volumes and forecasts refer to the time at which maintenance is carried out.

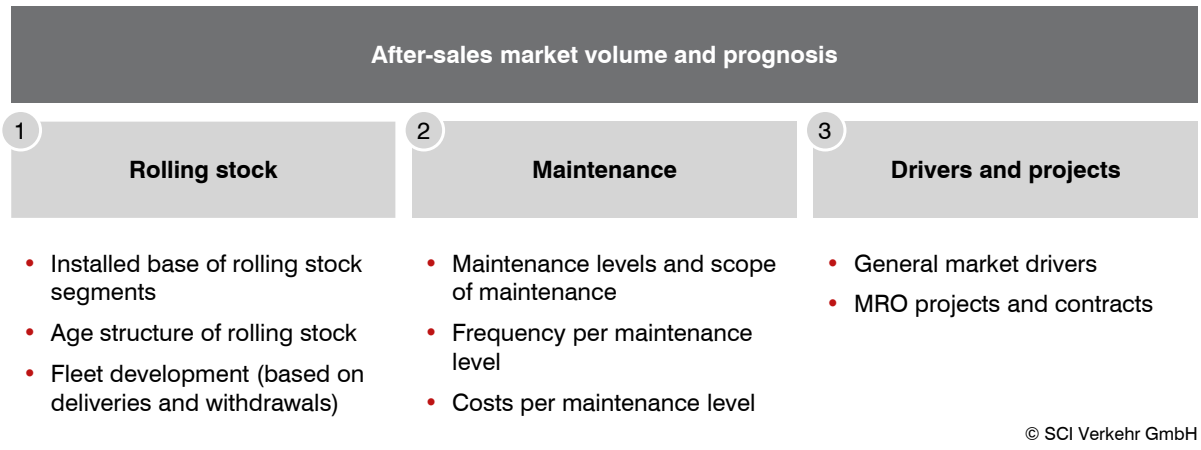
The editorial deadline for this study was 15 November 2023.

All data concerning installed bases is based on 31 December 2022, although up-to-date fleet information can only be an average value due to the large number of changes and the fact that some sources are out of date.

1.3 Market analysis methodology

As an industry insider, SCI Verkehr has taken up the challenge of developing a market forecasting method that provides valid statements about current market volumes and short- to long-term market development in the rolling stock after-sales market.

To calculate the market volume for after-sales services, SCI Verkehr has developed a unique fleet- and driver-based forecast tool. The following figure shows all relevant input parameters of the forecast tool.



1 Rolling stock

The main input for the forecast of after-sales services is the underlying vehicles and fleets for which maintenance is performed. The number of vehicles per segment and market (fleet size), the respective age of the rolling stock or fleets, and the development of the fleets are decisive for the after-sales volume and its development.

SCI Verkehr has comprehensive fleet data available worldwide in its SCI DATABASE. For each vehicle segment and market, a wide range of data is collected, such as vehicle type, delivery, service life, operator and technical details. These data form the basis for the fleet size and age structures of the respective fleets.

In addition, SCI Verkehr forecasts the fleet development per market and segment. For the short and medium-term time horizon, procurement projects and withdrawals from service form the basis for fleet development. The long-term fleet development is based on key drivers like transport market development and infrastructure development. An algorithm creates virtual new deliveries based on the long-term fleet development, which also takes into account replacement purchases for vehicles that reach the end of their service life. This enables SCI Verkehr to forecast the rolling stock after-sales market even in the long term.

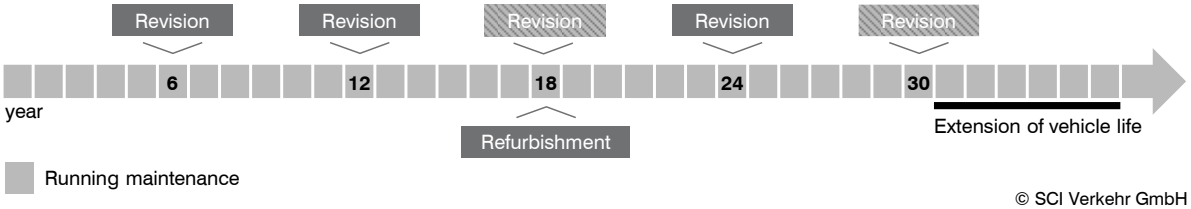
2 Maintenance

The second key factor in calculating the after-sales market volume is the various maintenance levels, their costs and cycles. SCI Verkehr has defined three maintenance levels and the associated maintenance work on the basis of industry guidelines (e.g. VPI), its many years of project experience, and cooperation with manufacturers, operators and maintenance providers (see also the chapter on delimitation of the after-sales market):

– Light/running maintenance
– Heavy maintenance/revisions
– Overhaul/refurbishment/modernisation

For each vehicle segment and market region, SCI Verkehr has determined and defined the intervals of the maintenance levels. The following figure schematically depicts the different maintenance intervals over the lifecycle of a vehicle.

Exemplary scheme of maintenance cycles



Light maintenance usually takes place at intervals of less than one year. SCI Verkehr makes assumptions here for annual maintenance requirements. Heavy maintenance / overhauls often take place at intervals of between six and eight years, but may also vary depending on the field of operation and mileage. In addition, SCI Verkehr has been observing a trend towards condition-based maintenance for years, which is making fixed intervals less rigid. In addition, the reconditioning of individual components, such as wheelsets, is increasingly being carried out independently of the vehicle's maintenance and at its own intervals. However, SCI Verkehr continues to observe that major maintenance work is carried out on vehicles at fixed intervals during inspections.

Overhauls/modernisations usually take place only once, in the second half of a vehicle's lifetime. In order to concentrate work and limit the downtime of vehicles, all the work involved in an overhaul is usually carried out during a refurbishment.

One factor that is currently important for the development of the after-sales market is maintenance measures (revisions or modernisations) to extend the service life of a vehicle. Due to the decline in revenues in the wake of the COVID-19 pandemic, operators worldwide have postponed procurement projects. In the case of replacement purchases, SCI Verkehr assumes longer operating periods for old

fleets, meaning that they will undergo an additional maintenance cycle or major modernisation and drive up after-sales volumes.

Based on the knowledge of delivery times and required maintenance intervals, peaks in the after-sales market – caused by numerous overhauls in a short period, larger modernisations, or refurbishment projects for individual vehicle types – can be forecast more accurately.

In addition to the intervals, SCI Verkehr analyses the costs of the maintenance levels differentiated by market region and vehicle segment. In countries with a strong dependence on refurbished used vehicles, the expenses for refurbishments are correspondingly higher.

In the analysis of the expenditure for after-sales services, SCI Verkehr has taken the following kinds of costs into consideration:
– Costs for operating materials, spare parts and other materials
– Level and development of labour costs
– Costs for workshops
– Margin expectations of companies

3 Drivers and projects

SCI Verkehr enhances the results of the fleet and maintenance-based calculation with evaluations of general market drivers and known maintenance contracts and projects. In this way, additional effects that could not be taken into account in the previous calculation are supplemented by the market experts of SCI Verkehr. For example, a slump in transport performance as a result of crises leads to lower mileage, and thus less wear and tear and maintenance expenditure for vehicles.

For years, SCI Verkehr has concerned itself extensively with current and future drivers of development for the demand for after-sales services. For the first time in this study, these are presented transparently in the regional chapters. In general, SCI Verkehr differentiates between political and socio-economic drivers with a general effect and drivers impacting directly upon demand and supply. In addition, SCI Verkehr takes into consideration the interaction between the key drivers of development.

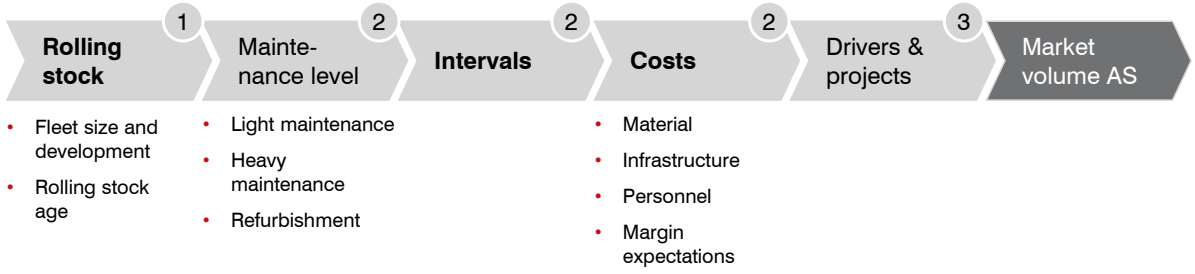
The evaluation of the drivers is based on the following system, which evaluates according to the relevance for procurements, as well as the five-year trend:

Relevance	Characteristics	Trend	Characteristics
4/4	Very high importance	⇑	Significant increase in importance in the future
3/4	High importance	↑	Increasing importance in the future
2/4	Medium importance	→	Constant importance in the future
1/4	Low importance	↓	Decreasing importance in the future
0/4	No importance	⇓	Significant decrease in importance in the future
Purpose: Assesses the importance of driver characteristics for the future procurement of railway industry products		**Purpose:** Assesses how the driver for the procurement volume of products from railway industries will change in the next five years	
			© SCI Verkehr GmbH

In addition, known maintenance contracts and projects are taken into account when determining the after-sales volume. SCI Verkehr systematically analyses these in the SCI DATABASE. Important contracts are listed in this study in tabular form for the world market regions.

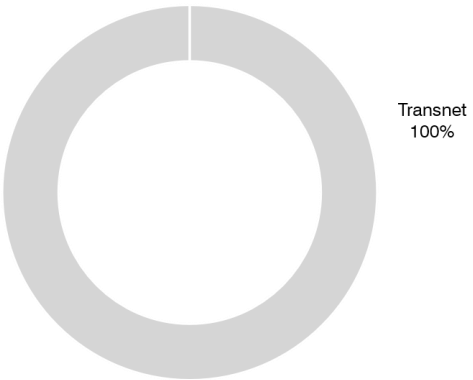
The following figure shows the forecast scheme for the rolling stock after-sales business:

Forecast scheme for the rolling stock after-sales business



2 Factsheets of the most important manufacturers and companies

2.1 Transnet Engineering

Transnet Engineering	
Overview	
Headquarters 160 Lynette Street, Kilner Park, Pretoria, 0186, South Africa www.transnetengineering.net	**Company introduction** Transnet Engineering (TE) is the engineering division of Transnet SOC Ltd and offers the manufacture, upgrading conversion, repair and maintenance of railway rolling stock, as well as spare parts and associated transport equipment. TE is the most important freight wagon manufacturer in South Africa, but also works on locomotives, passenger coaches and components. The company is able to manufacture 4,500 freight wagons and to maintain over 7,000 wagons per year. Moreover, TE produces and maintains all types of railway wheelsets for the Southern Africa region. **Company history** With origins dating back more than a century to the mechanical engineering department of the former South African Railways and Harbours, TE has supported railways in the expansion of the country's economy, developing innovative bogies and wagons. Through the years, the company has become a diversified supplier of customised rolling stock for the coal, iron-ore, intermodal, agricultural, fuel and cement industries. **Current relevant company information** In April 2023, Transnet Engineering announced that it is seeking a partner to establish a leasing company in order to lease rail vehicles, including wagons and locomotives. The establishment of a leasing company is aligned with the policy directive for rail reform, and aims to create a more enabling environment by lowering barriers to entry for new train operating companies, which will be utilising available slots on the network in line with the regime for third-party access.
Management Ralph Mills (CEO)	**Recent business development** Over the past five-year period, Transnet Engineering has been struggling with decreasing revenues and growing losses. For FY 2022/23, Transnet's Engineering division achieved a revenue of EUR 400 million and a net loss of EUR 150 million.
Current shareholders	 Source: Transnet © SCI Verkehr

Year	Employees	Revenue (EUR m)	Net profit (EUR m)
2022/23	**8,126**	**400 (ZAR 8,045 m)**	**-150 (ZAR -3,015 m)**

Breakdown of revenue by activities in FY 2019							
New rolling stock	**Rolling stock after-sales services, spare parts & components**	**Infrastructure**				**Other rail revenue**	**Non-rail revenue**
		Track systems	Electrification	CCS	PIT		
15%[e]	**85%**[e]	-	-	-	-	**-**	**-**

Maintenance business overview
In the after-sales business, Transnet Engineering (TE) offers the manufacture, upgrading conversion, repair, and maintenance of railway rolling stock, as well as spare parts and associated transport equipment. Moreover, TE produces and maintains all types of railway wheelsets for the South African Region.

Sites of final assembly for rolling stock				
Region	**Country**	**Site(s)**	**Products**	**Remarks**
Africa/Middle East	South Africa	Bloemfontein, Durban, Germiston, Koedoespoort, Salt River, Uitenhage	E-Loco, D-Loco, EMU, DMU, PC, FW, components	

3 Definitions and sources

3.1 Definitions

Worldwide railway industries market

Item	Definition
After-sales market	– **For rail vehicles: all services performed after initial operation** – For infrastructure and system technology: all services performed to maintain or create this performance level after a vehicle or line has been put into initial operation
Railway industries	– All products and services specifically used for rail transport
Railway market	– Product markets and transport markets (the following explanations refer exclusively to the product markets for the planning, production, delivery and start-up of railway industry products. The transport markets are only used as indicators for drivers)
Transport markets (for information purposes only)	– Long-distance passenger rail transport – Local rail transport – Urban transport – Rail freight transport
Product markets	– **Rolling stock including services** – Infrastructure including services – System technology including services
Rolling stock	– All rail-bound vehicles in scheduled operation apart from – Construction and maintenance vehicles – Secondary vehicles and special-purpose vehicles (e.g. historical vehicles, cable cars) – Vehicles for special infrastructure and automated operation (e.g. automated guided vehicles, monorails, maglev trains)
Infrastructure	– Track systems – Railway electrification
System technology	– Control command and signalling – Passenger information systems
OEM market	– Initial operation of rolling stock – New development and upgrading of infrastructure and system technology (see also the definition of new development and upgrade)
Site	– A site is defined as a geographical place or location where a company or an operating facility of a company is located

Market volume and forecast

Term	Description
Market volume	– Products and services in the product markets performed internally by end customers (operators) and externally by the railway industry Assumptions: – Created at the time of initial operation/delivery of rolling stock, infrastructure and system technology – Where delivery periods of rail vehicles are spread over several years, the market volume is split equally over the years – In terms of infrastructure and system technology, a typical project sequence is assumed, within which the respective components are allocated to a specific delivery period within the course of the overall project
Market forecast	– Takes into consideration the effects of price and quantity (see methodology for an explanation) – Quantity effect: change to the delivered quantities – Price effect: price development
Quantity effect	– Rolling stock: change in quantity – Infrastructure: change in km and/or quantity – System technology: change in km and/or quantity
Price effect (price development)	– Price increase of railway industry products due to appreciation of the product – Real prices that will be paid in the short to medium term (in the forecast period) for railway industry products – Long-term price development of important supplier products for railway products
Current market volume	– Market volumes of the year 2022 – Balances out the volume fluctuations occurring in some product segments due to the progression of procurement contracts or delivery processes
Time horizons	– For future market developments, three time horizons are normally differentiated: – Short term: 1 to 3 years – Medium term: 3 to 5 years (end of the forecast period 2022–2027) – Long term: more than 5 years
CAGR	– Compound annual growth rate between the current and future market volume – The CAGR enables a comparison of growth in various segments and serves as a simple, recognised evaluation of current market development
Market share of companies	– Products delivered or services performed by railway industry companies in the last five years, 2017–2022 – The volume is assigned to the end customer at the time of delivery – Market share of rolling stock is measured in: Quantity/unit

Market drivers and their key figures

Item	Definition
Driver	– Factors influencing the medium- to long-term development of the market volume
Importance of driver	– Unit: qualitative assessment, five-step scale (none, low, medium, high, very high) – Purpose: assesses the importance of characteristics of the driver for the procurement of railway industry products – Source: SCI Verkehr and discussions with experts
Driver trend	– Unit: qualitative assessment, five-step scale (strongly decreasing, decreasing, constant, increasing, strongly increasing) – Purpose: assesses how the driver for the procurement volume of railway industry products will change in the next five years – Source: SCI Verkehr and discussions with experts
Creditworthiness of a country	– Unit: index number between 1 and 100 – Purpose: assessment of the sustainability of political investment decisions, financing conditions for domestic and foreign investors and the possibility of realising PPP solutions – Source: our own calculations based on an aggregate of credit agency ratings: Standard & Poor's, Fitch, Moody's, DBRS Morningstar, Scope Ratings. The countries where no ratings from these sources were available received the worst, i.e. 0, rating.
GDP (Gross Domestic Product)	– Unit: EUR billions – Purpose: provides information about a region's economic power, i.e. the basic prerequisite for investments in transport infrastructure and transport modes – Source: IMF World Economic Outlook (Apr/2023) + our own estimates
Inflation	– Unit: percentage increase compared to the price of the previous year – Purpose: planning security for companies – Source: IMF World Economic Outlook (Apr/2023)
Degree of urbanisation	– Unit: percentage increase of the urban population as a share of the total population – Purpose: influences the affinity for railway transport – Source: United Nations, Population Division, The 2022 Revision
Economic growth	– Unit: percentage increase in the GDP per year – Purpose: indicator for the development of demand and the budgets available for investments in transport systems – Source: IMF World Economic Outlook (Apr/2023) + our own estimates

3.2 Abbreviations

Item	Definition
ARI	American Railcar Industries
ATC	Automatic Train Control
ATO	Automatic Train Operation
ATP	Automatic Train Protection
CAF	Construcciones y Auxiliar de Ferrocarriles
CAGR	Compound Annual Growth Rate
CCS	Control Command and Signalling
CIS	Commonwealth of Independent States
CR	China Rail
CRRC	China Railway Rolling Stock Corporation
DB	Deutsche Bahn, German state railway company
DMU	Diesel multiple unit
EMU	Electric multiple unit
EPA	U.S. Environmental Protection Agency (EPA)
ERA	European Railway Agency
ERA	Egypt Railway Authority
ERTMS	European Railway Traffic Management System
ETCS	European Train Control System
EU	European Union
FSI	Ferrovie dello Stato Italiane, Italian state railway
GDP	Gross Domestic Product
GE	General Electric
GSM-R	Global Standard for Mobile Communications Rail
HEI	Hindustan Engineering & Industries
HMU	Hydrogen fuel-cell traction
HSR	High-speed rail
HST	(Standard) High-Speed Trains, between 250 and 300 km/h
IC	Intercity train (German high-speed train)
ICE	Intercity-Express (German high-speed train)
IEP	Intercity Express Programme
IMF	International Monetary Fund
LRT	Light-rail transit
LRV	Light-rail vehicles
MEC	Mass Electric Construction Company
MoU	Memorandum of Understanding
MRO	Maintenance Refurbishment and Overhaul
ÖBB	Österreichische Bundesbahn, Austrian state railway
OECD	Organisation for Economic Cooperation and Development
OEM	Original Equipment Manufacturer
p.a.	Per annum, per year
PIT	Passenger Information Technology
pkm	Passenger-kilometres

Item	Definition
PPP	Purchasing power parity
RPS	Rail Power Systems
RZD	JSCo RZD, Russian Railways
S-Bahn	Commuter train
SNCF	Société nationale des chemins de fer français, French National Railway Company
TCDD	Türkiye Cumhuriyeti Devlet Demiryolları
TGV	Train à Grande Vitesse (French high-speed train)
tkm	Tonnes-kilometres
TMH	Transmashholding
TSI	Technical Specifications for Interoperability
UIC	Union Internationale des Chemins de fer (international railway association)
UK	United Kingdom
UN	United Nations
XMU	Alternatively driven multiple unit-train (usually hydrogen- or battery-powered)

3.3 List of sources

Our own sources
- SCI DATABASE: SCI Verkehr's continuously developed basic database, currently comprising more than 250,000 individual entries of relevance for the worldwide railway industry. SCI Verkehr has maintained this comprehensive internal database system for all key segments of the railway industries market since 2004. The articles stored here are updated on a regular basis and reviewed with regard to their applicability for market analyses and forecasts.
- SCI RAILDATA: Market Intelligence Platform with the latest market and business information from the global railway sector. SCI Verkehr analyses global trade publications and the daily press for all information regarding railway systems of relevance for decision-making and archives these online in a data pool with around 200,000 specialist news reports and tenders.
- SCI RAILINDEX: quarterly survey of the important decision-makers in the worldwide railway industry with regard to business climate, future expectations, prospects and trends within the railway sector and their own companies.
- SCI MULTICLIENT STUDIES: analyses of market developments in individual product and service segments of the railway industry. In compiling this world market study, SCI Verkehr has drawn upon more than 25 MC Studies in the railway segment. The studies are updated every two years, with a few exceptions.

Public sources

Economic conditions – data and facts
- Publications from the World Bank, OECD, IMF, Economist Intelligence Unit, Institutional Investor, United Nations (Population Division), Eurostat, IBM Business Consulting Services, national statistical offices, World Resources Institute, Germany Trade & Invest, The World Factbook

Railway industries – data and facts
- Publications from transport and infrastructure companies; annual reports from the railway industry; Eurostat data publications; United Nations; World Bank; Railway Directory; UIC statistics, Progtrans

Other external sources to check plausibility
- Topic-related publications in trade journals
- Specialist articles in trade journals
- Trade fairs and conferences
- Interviews with internal and external experts
- Round-table discussions with industry experts

3.4 Table of Figures

SCI Verkehr GmbH is an independent medium-sized management consultancy focused on strategic issues in the international rail, infrastructure and logistics business. We know our markets worldwide and have been supporting our international clients in the development and realisation of their strategies since 1994.

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