German Regional Rail Transport: Between Hope and Failure

A status quo analysis and 2030 projection

a presentation on the research project ‘Regional Railway Transport in Germany after COVID – reduced, recovering or booming?’

Presenters

TECHNISCHE UNIVERSITÄT DRESDEN

European Investment Bank | Institute

Paavo Brummer
Master Economics

Carmen Wendt
Master Transportation Economics

Timm Kretschmar
Master Transportation Economics

Valeska Lippert
Master Business Administration

Teresa Münzberg
Master International Relations

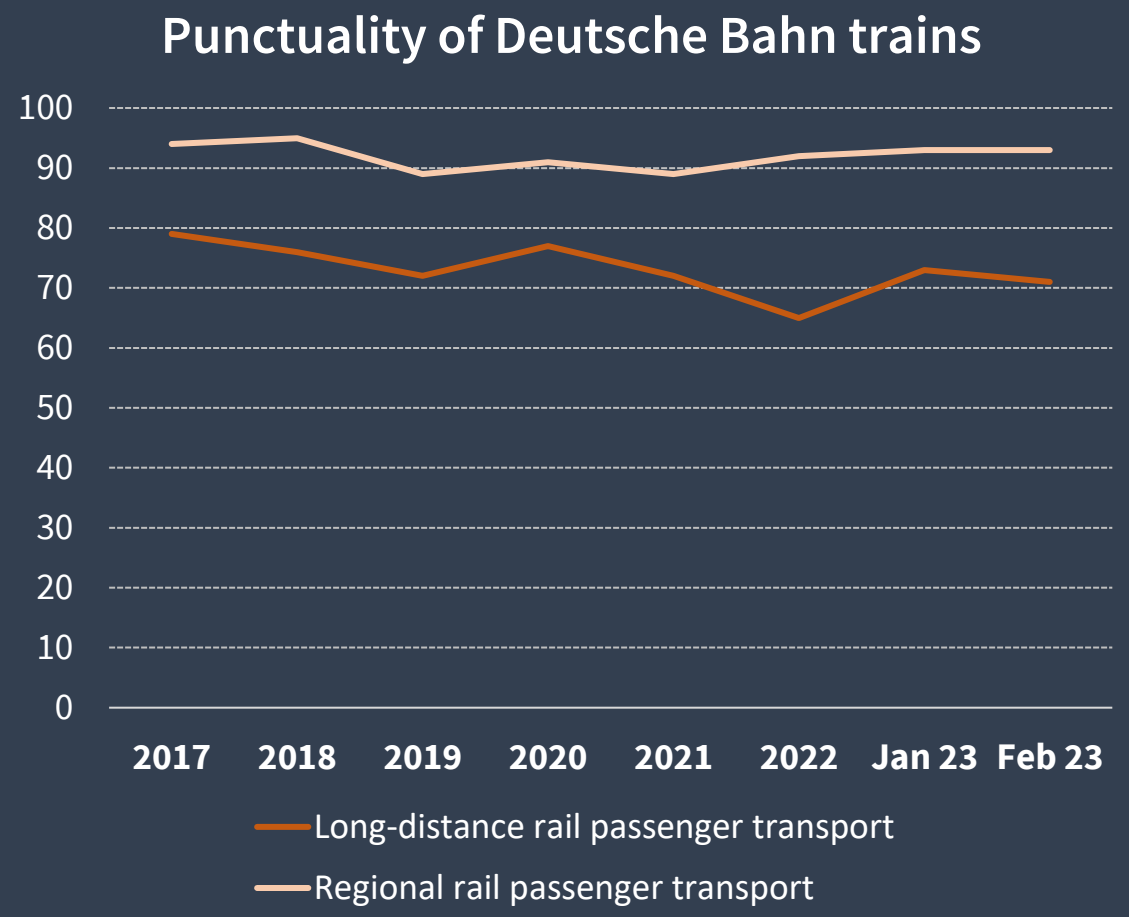
Jonathan Koenning
Master International Relations

Motivation

THE LOCAL de

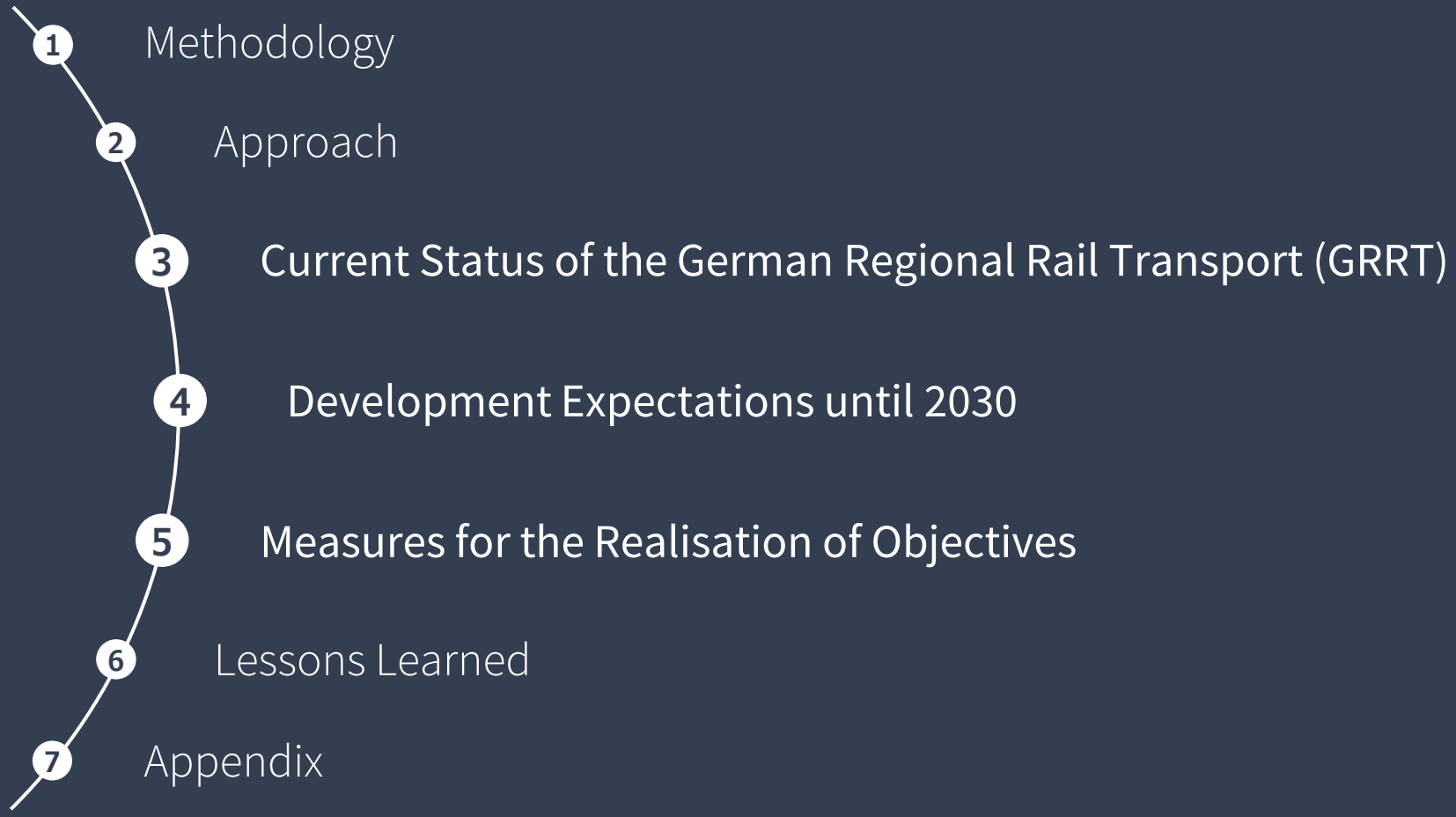
'A disaster': How did train travel in Germany get so bad?

Aaron Burnett - news@thelocal.de
Updated Sat 20 Aug 2022 10:04 CEST



(Bundesnetzagentur, 2022)

Structure


1
Methodology
2
Approach
3
Current Status of the German Regional Rail Transport (GRRT)
4
Development Expectations until 2030
5
Measures for the Realisation of Objectives
6
Lessons Learned
7
Appendix

2. Methodology

2.1 Methods

Scenario Technique

… tool for creating & analysing future scenarios to anticipate demand for action

- Scenarios describe potential future situations as network of inter-connected factors
- Helps exhausting future opportunities and reducing risk

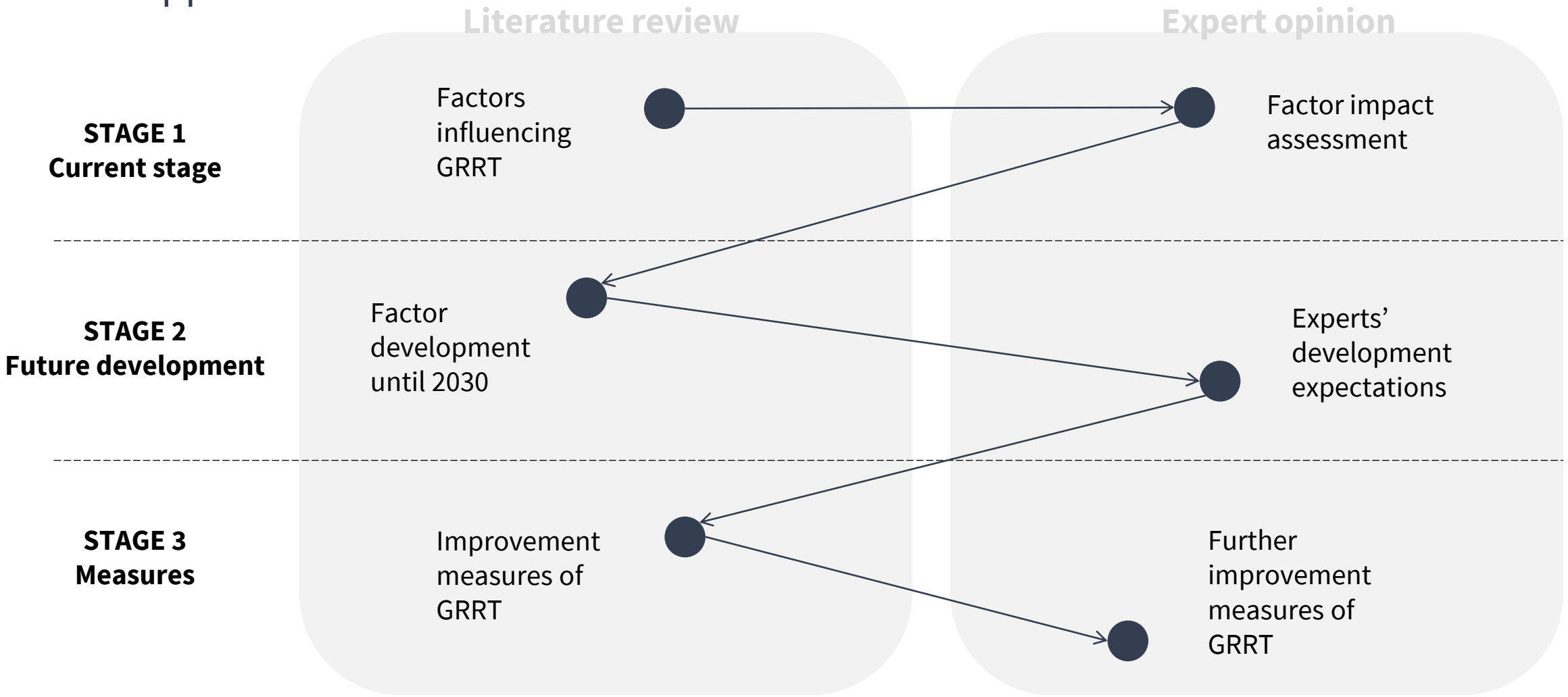
Expert Interviews

… method for gathering information from the factual knowledge & subjective opinion of experts

- Future projections are associated with uncertainty and individual expectations
- Involvement of experts justifies assumptions

2. Methodology

2.2 Approach



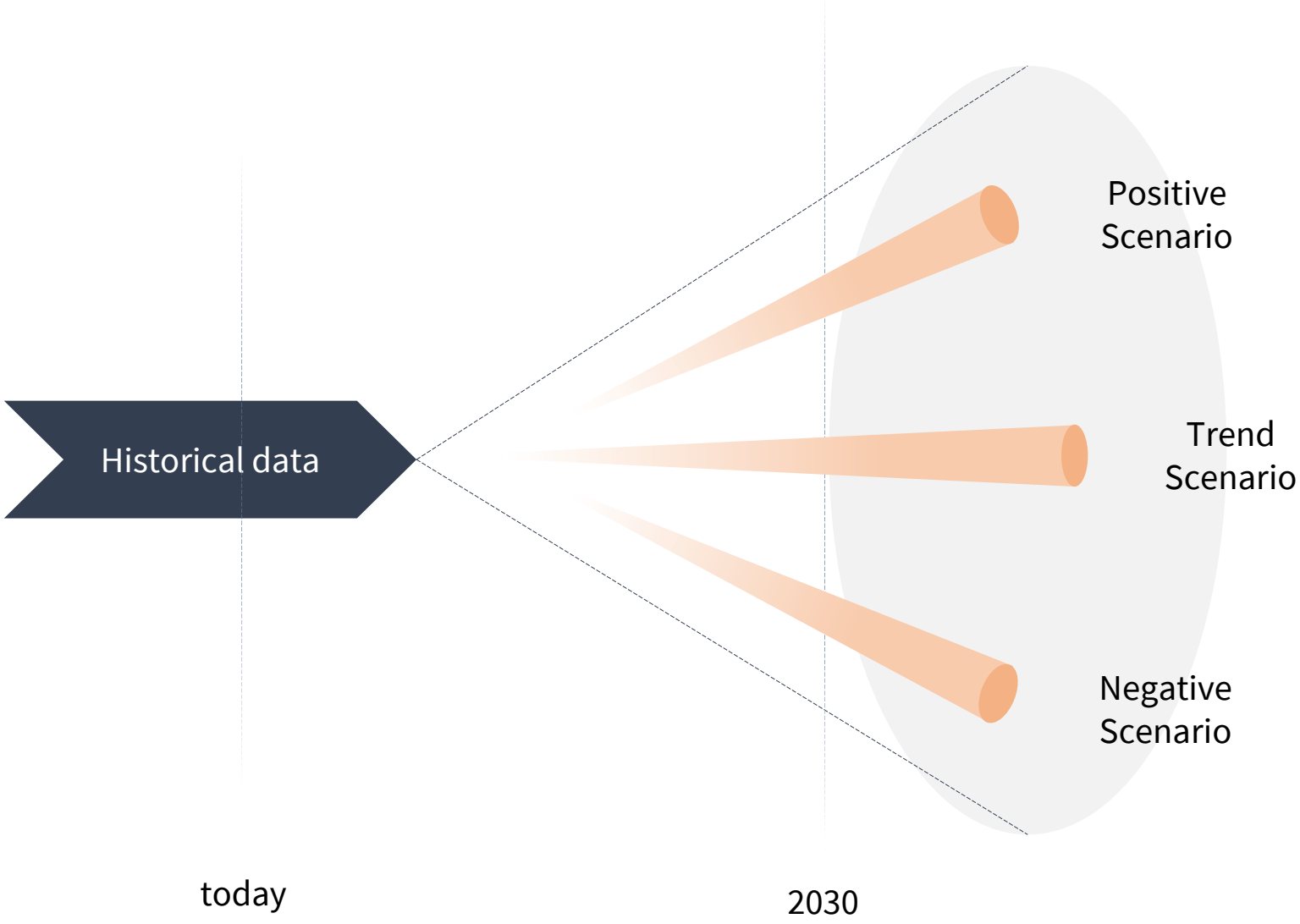
2. Methodology

2.3 Scenario Technique

The current state of factors influencing train sector is known, but their uncertainty and complexity of forecasting increases grows with advancing time.

→ Factors develop into different states, creating multiple scenarios

→ Reasonable combination of manifestations as basis of future strategies



2. Methodology

2.5 Scenario Technique

1. Analysis of scenario field

- Separating scenario fields in spheres of influence and influencing factors
- Influence analysis: interconnectedness of factors with each other and object of observation
- Relevance analysis: determining key factors

2. Look ahead with future projection

- Identifying characteristic developments of each factor with a fixed time horizon
- Based on literature and experts' statements

3. Scenario development

- Evaluation of consistency of future projections (plausibility of occurrence)
- Consistent combination of future projections (projection bundles)

2. Methodology

2.4 Expert Interview

Expert Portrait

Interview 1

- Transport and Environmental Economist
- Researcher at consulting firm focussing on transport planning and traffic-oriented environmental protection)

Interview 2

- Employee at Verkehrsverbund Oberelbe (VVO)
- VVO is a linked transport system of local public transport in the wider area of Dresden

Interview 3

- Employee at DB RegioNetz Verkehrs GmbH / DB RegioNetz Infrastruktur GmbH
- As a subsidiary of Deutsche Bahn, DB RegioNetz offers local rail passenger services in rural areas

2. Methodology

2.5 Interview Guide

1. Current Status of the German Regional Railway Transport

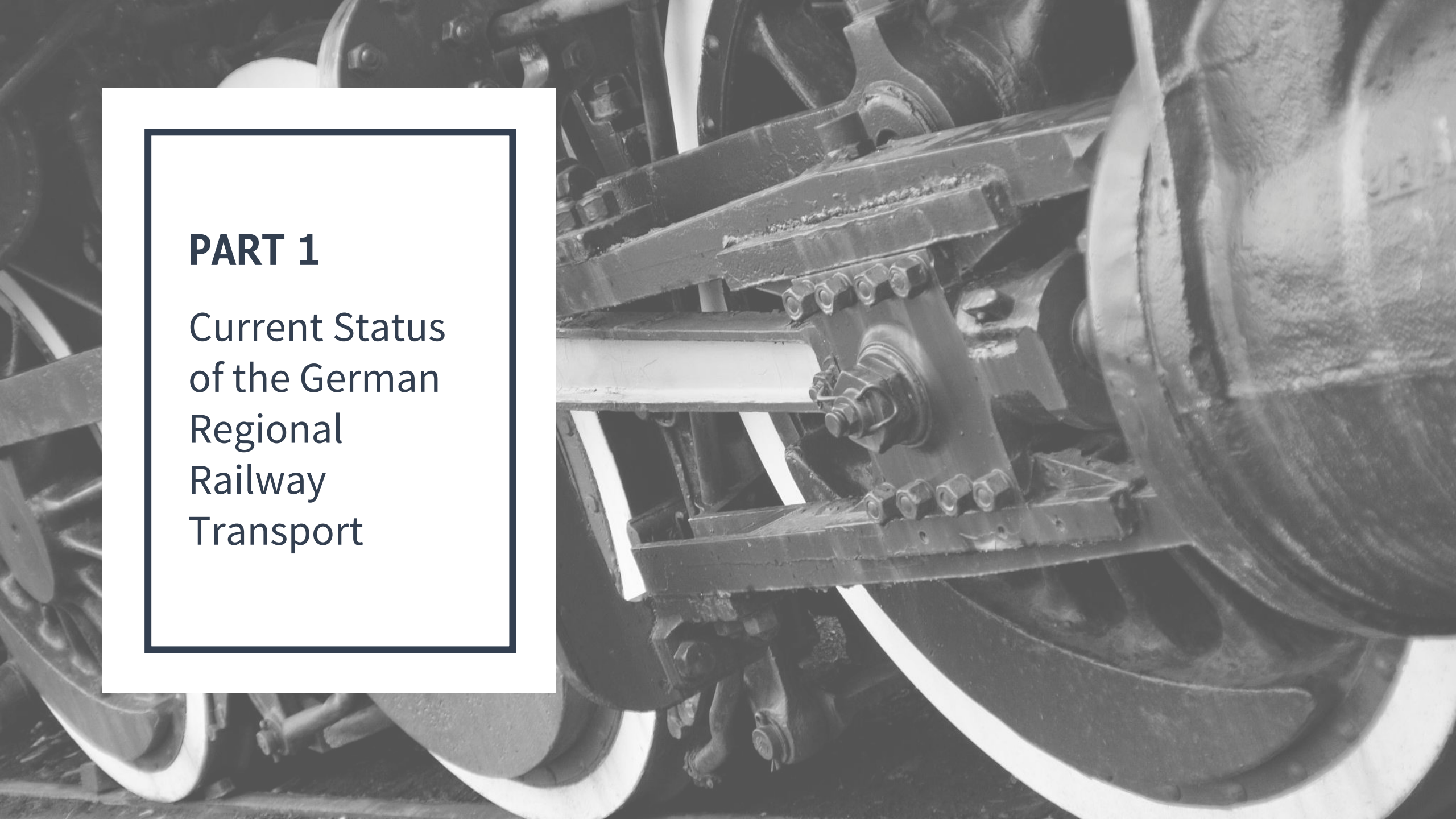
- How would you describe the current demand and supply situation of German regional railway transport?
- How important is the state as a source of funding and as political guide for its development?
- What other influencing factors determine its development (digitisation, prices, environmental awareness etc.)?
- What has changed in the situation of German regional rail passenger transport due to the COVID 19 pandemic?

2. Development Expectations until 2030

- Let's first take an optimistic perspective and think of the best possible version of the year 2030. Ecological develop-ment goals are frequently discussed. How does German regional passenger transport support their realisation?
- What other goals are pursued until 2030? What obstacles stand in the way of realising these goals?
- How do you think demand will actually develop by 2030? And how do you think the situation of the operators will develop by then?
- You have already mentioned influencing factors. What obstacles could lead to differences between goals and reality in the future?

3. Measures for the Realisation of Objectives

- In order to achieve development goals, specific measures are needed. One such measure is the €49 ticket, which is to be available from April 2023. What expectations – and perhaps fears – do you associate with it for the future?
- What other measures are conceivable for you to achieve development goals by 2030? (not only by the state, but also by operators and customers)
- What obstacles could make the implementation of such measures more difficult?



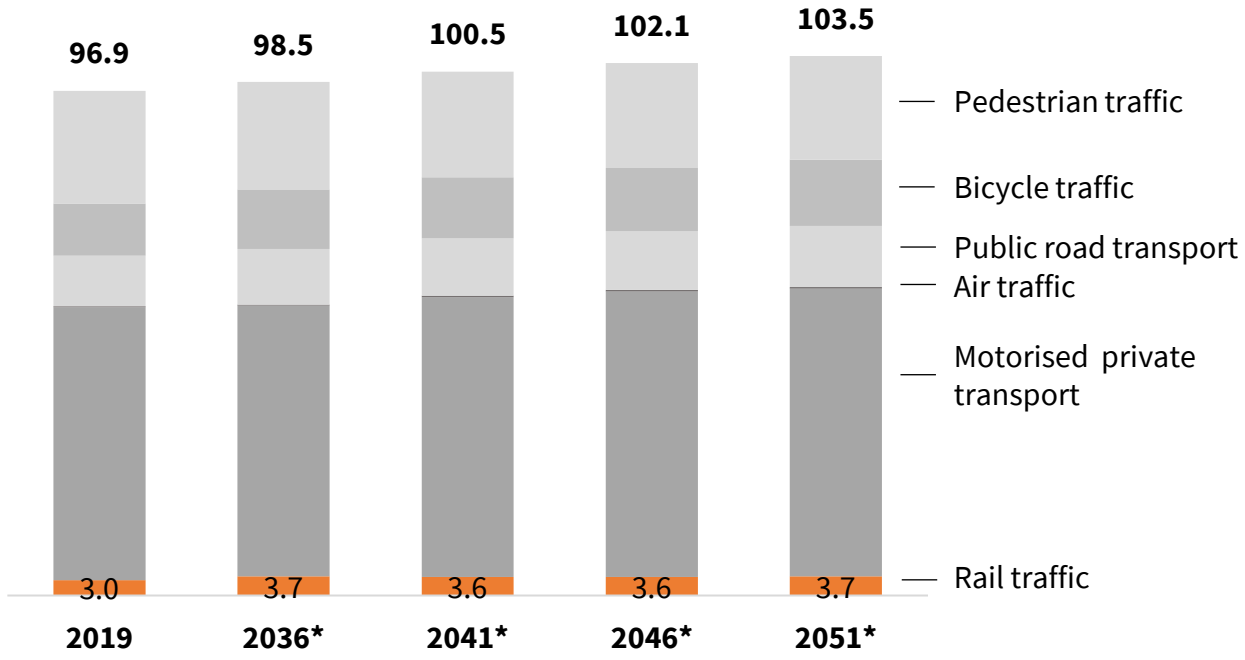
PART 1

Current Status of the German Regional Railway Transport

3. Current Status of the GRRT

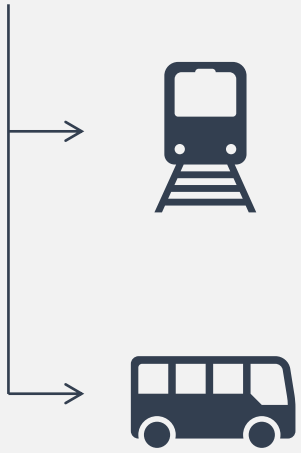
3.1 Introduction

Traffic volume per mode of transport in millions of passenger trips



(Bundesministerium für Digitales und Verkehr, 2020)

In Germany, local public transport is the responsibility of 2 bodies by law:



Regional rail transport: responsibility of federal states

Regional road transport: responsibility of municipalities

3. Current Status of the GRRT

3.3 Factor Weighting

Highly relevant	Relevant	Less relevant
Demographic change	Technological innovation	Market access
COVID-19	Deutschlandticket	Personnel costs
Service availability	Deutschlandtakt	Usage of further investment opportunities
Political Priorities	Market competitiveness	Availability of building materials
Relative attractiveness	Extension of passenger services	
Infrastructure	Economic outlook	

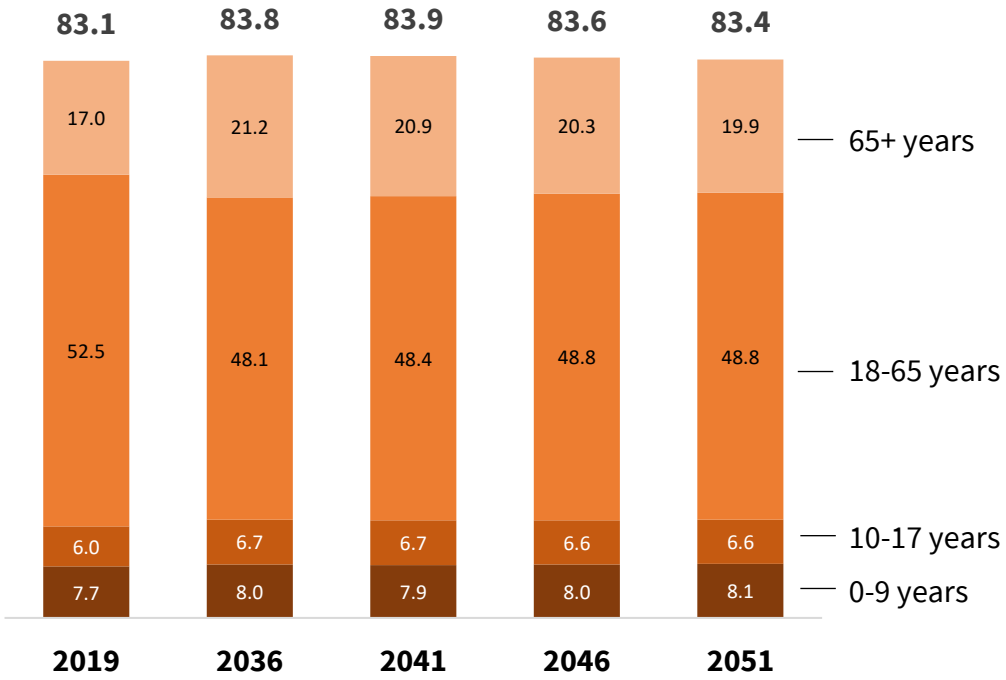
(Own weighting and representation based on remarks from experts & literature)

3. Current Status of the GRRT

3.2 Influencing Factors

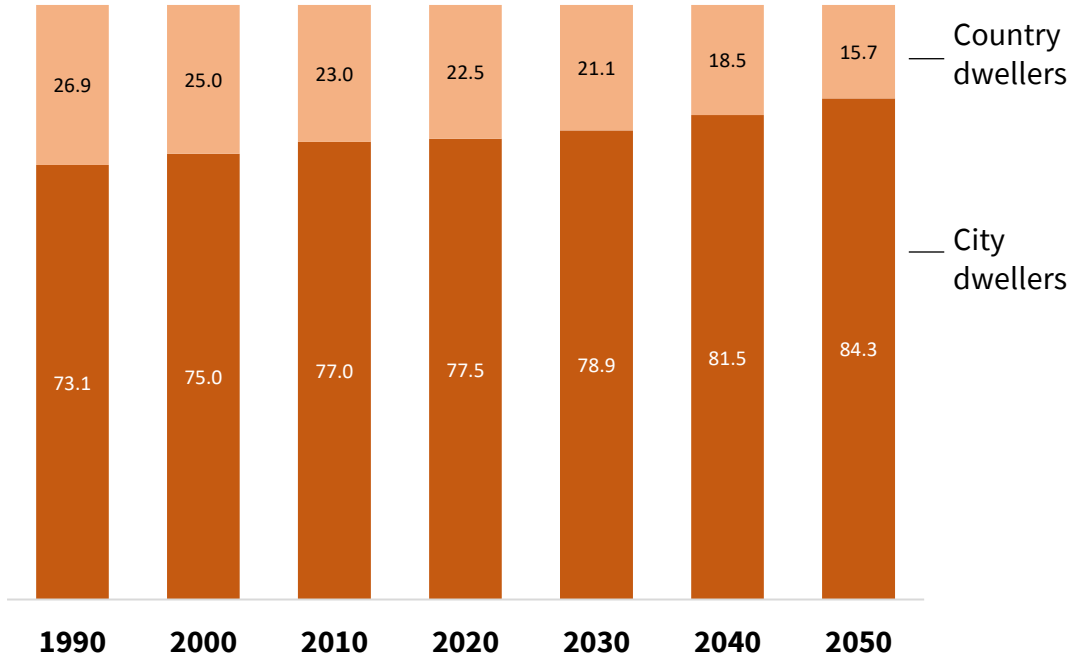
Demographic Change

Population in Germany by age group in million



(Bundesministerium für Digitales und Verkehr, 2020)

Number of urban and rural residents in millions

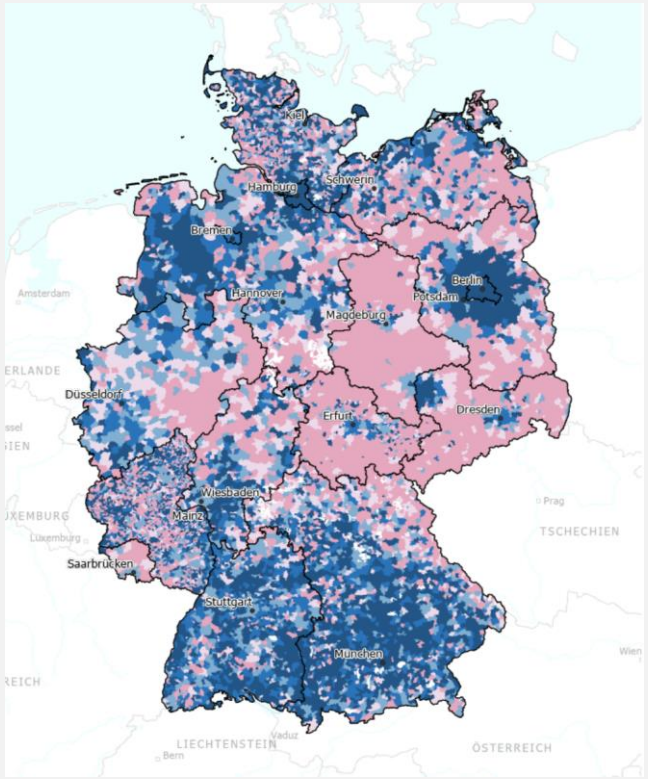


(Bundesministerium für Digitales und Verkehr, 2020)

3. Current Status of the GRRT

3.2 Influencing Factors

Demographic Change



Average development of the population between 2015 & 2020 per year

- < -0.25 %
- -0.25-0 %
- 0-0.25 %
- 0.25-0.5 %
- > 0.5 %

Municipalities in western Germany have predominantly experienced population growth between 2015 and 2020

Municipalities in eastern German states have recorded declining population figures

(Deutschlandatlas, 2020)

3. Current Status of the GRRT

3.1 Introduction

Demographic Change

Society is experiencing sustained demographic change & increasing urbanization

Population figures in rural regions have been declining for years

Regional differences: strong traffic increase in southern Germany; shifts from private to public transport in urban areas

3. Current Status of the GRRT

3.2 Influencing Factors

COVID-19

In 2020, **transport performance** in regional passenger rail transport **fell by 38 %** compared to the previous year.

Due to reduced traffic density and an increase in train-path capacity, **punctuality improved**.

Marked declines were observed among all modes of transport that were directly affected by **lockdown measures**.

- Strong **association** between transport accessibility & the spread of Covid-19
- Transport sector **negatively impacted** by slowdown of economic activities & restrictions on social contacts
- During the pandemic people felt safer using bike or own car
- **Low confidence** in public transit during pandemic due to people perceiving it as a riskier space

3. Current Status of the GRRT

3.2 Influencing Factors

★☆☆

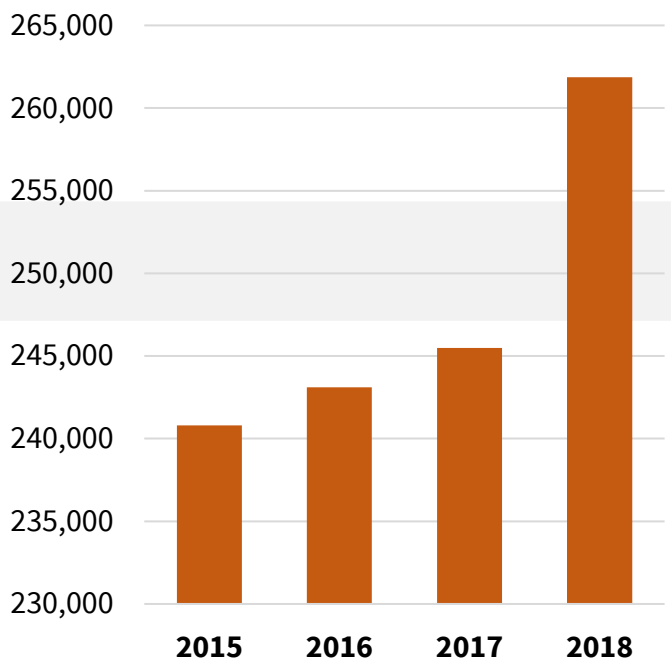
Service availability

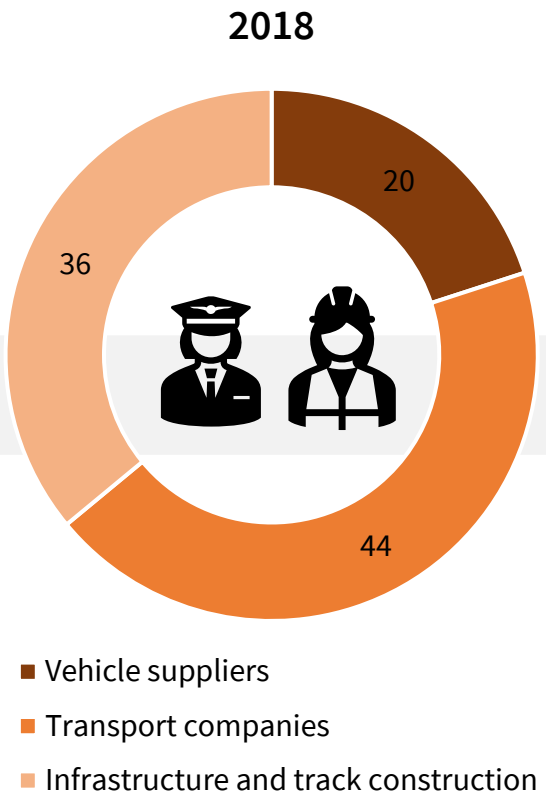
3. Current Status of the GRRT

3.2 Influencing Factors

★☆☆

Personnel availability





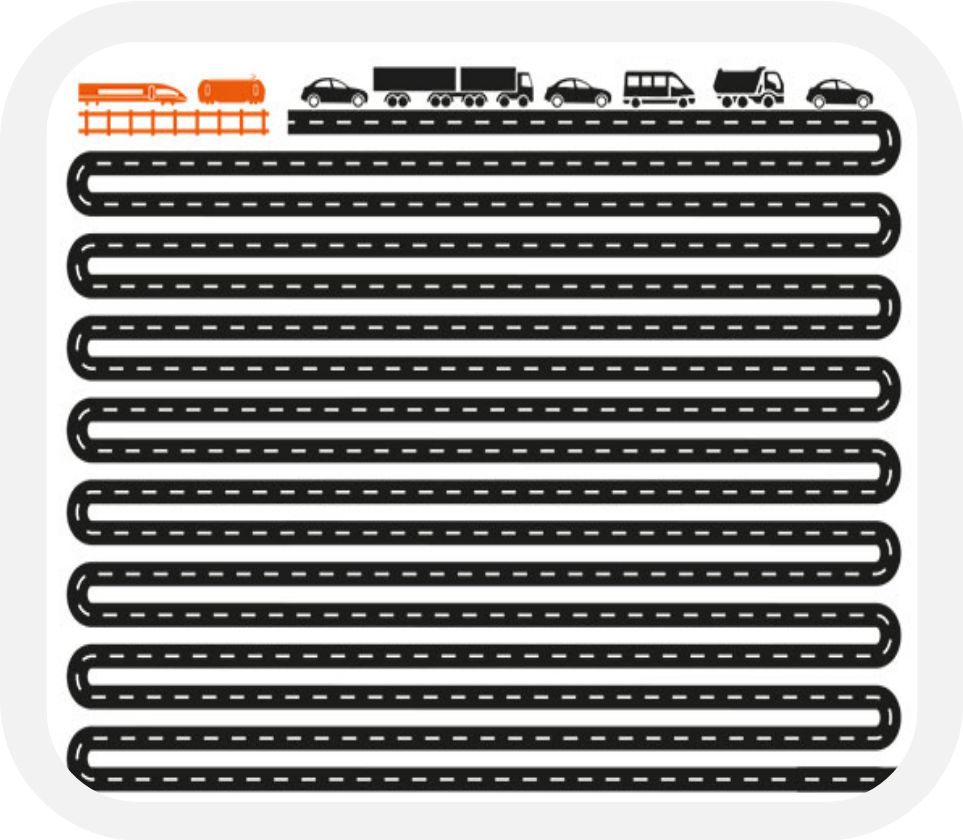
(Allianz pro Schiene, 2018)

- Impact of the COVID-19 pandemic affects **staff availability** → decline in ridership, revenue & employment opportunities
- **Sector needs to become more attractive** to young people, specialists, engineers & IT experts
- Passenger rail **increased market share & jobs**: rail industry provides more than 260,000 full-time jobs, trend is rising

3. Current Status of the GRRT

3.2 Influencing Factors

Political priorities



(Netzwerk europäischer Eisenbahnen, 2019)

Between 1994 & 2010 in Germany, 192 km additional new roads were built per week, compared to only 1,3km of additional railroads per week → factor of 150

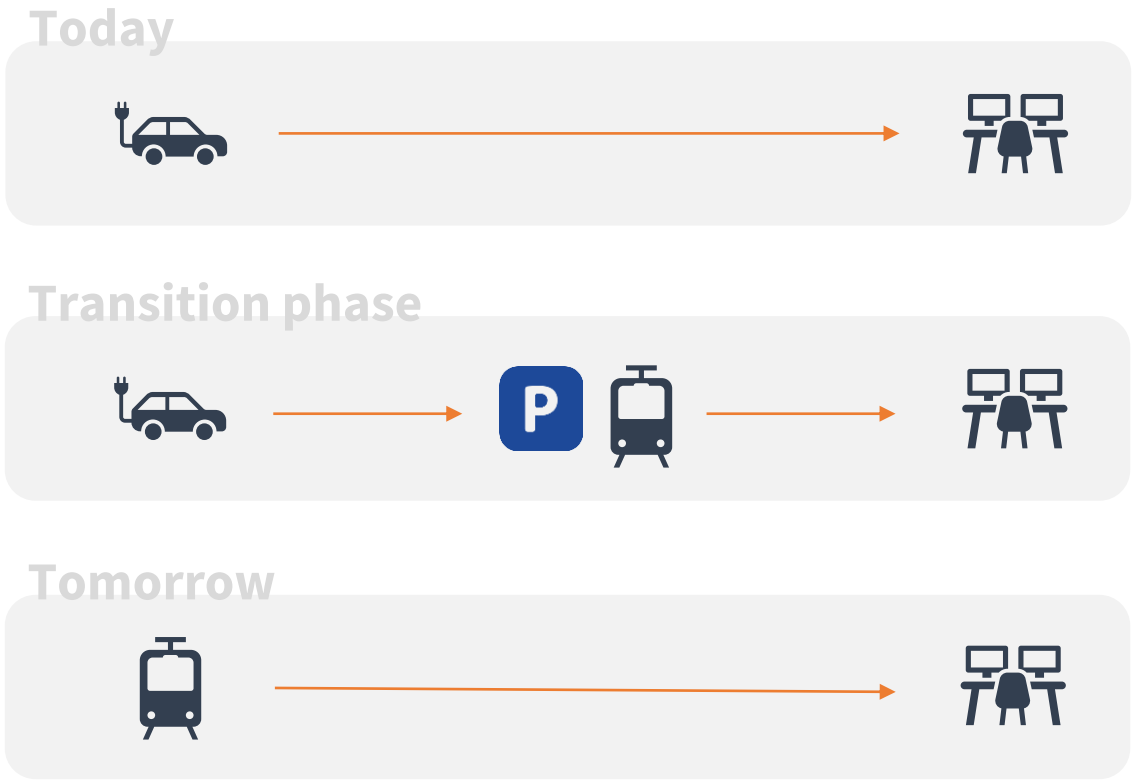
→ All about **political decisions**!

3. Current Status of the GRRT

3.2 Influencing Factors

Relative attractiveness and integration

Are regional railway services and other modes of transport, esp. (electric) cars **substitutes** or **complements**?



3. Current Status of the GRRT

3.2 Influencing Factors

Relative attractiveness and integration

Are regional railway services and other modes of transport, esp. (electric) cars, substitutes or complements?

Substitutes:

- Regional railway services and other modes of transport are substitutes → either take train or car to destination

Complements:

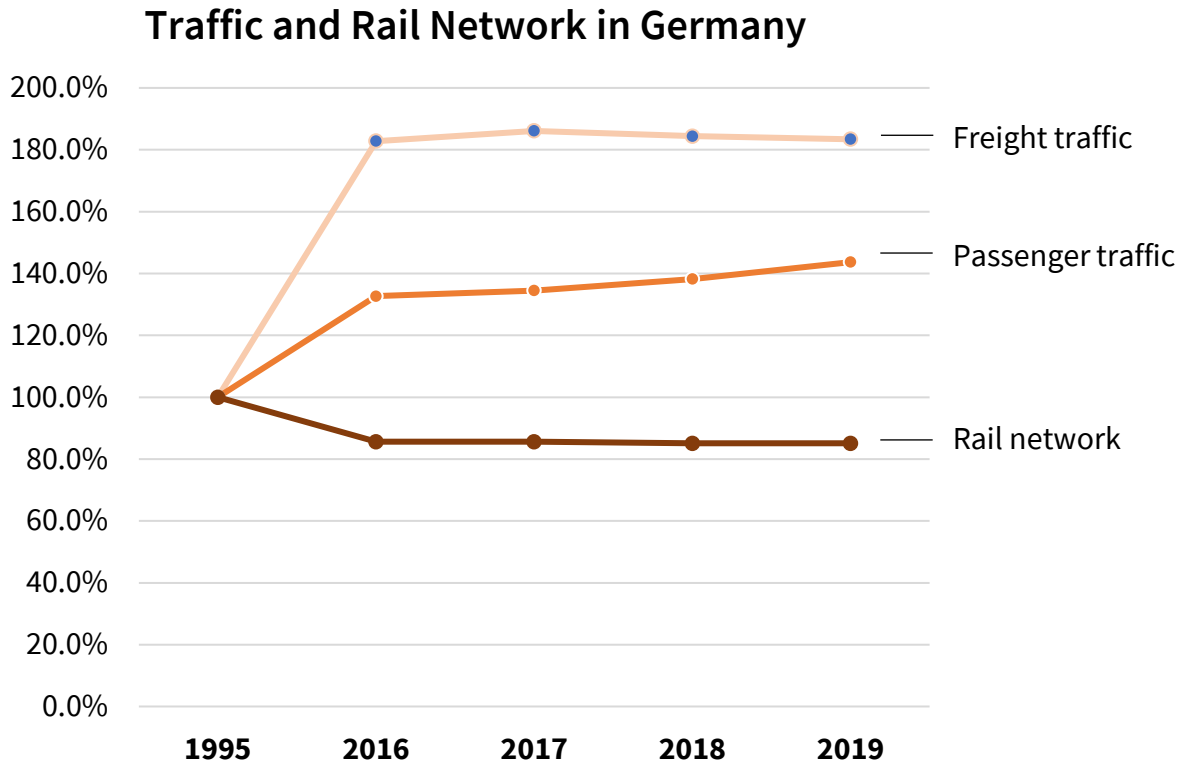
- Park and Ride, esp. in smaller cities and towns: take car to train station, park there, then use train to go to work
- Investment in such infrastructure needed (enough parking spaces)
- More important: Integrability needs to be improved
- Does my train ride regularly? Is my train punctual (punctuality in Germany worse than in other European countries)? If not, what are the alternatives? Can I check in easily via an App?
- Intermediate step in shifting from road transport with high emissions to train transport with lower emissions

This debate again, is politically driven. From our opinion, the discussion needs to move away from E-Fuels, towards making a real impact. This can be achieved by first using railway and street transport as complementary goods, and then as substitutes.

3. Current Status of the GRRT

3.2 Influencing Factors

Infrastructure and electrification



(Allianz pro Schiene, 2022)

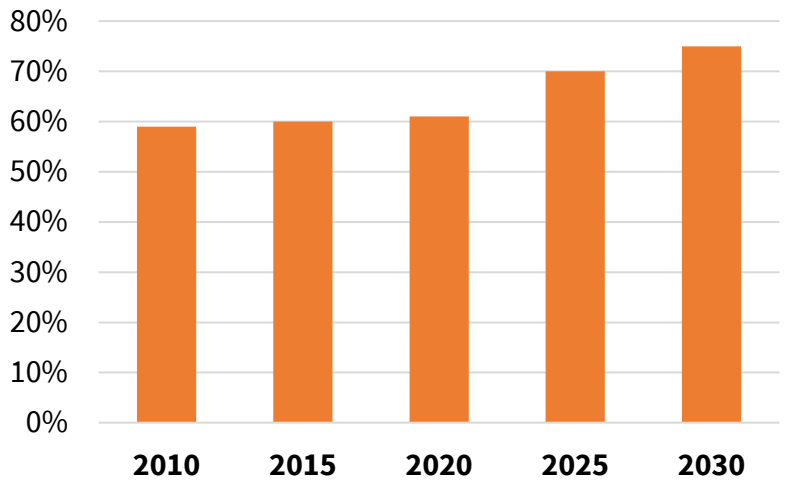
- Traffic increases, but rail network decreases → **scarcities**
- Accessibility: in 2022, ≈ 1.8 billion EUR invested in building new stations or modernising existing ones → yet, every fifth railway station is not yet accessible without steps
  - → Heterogeneity: Saarland 60 %, Schleswig-Holstein 98 %
  - → Federal government significantly increased budget for attractive & barrier-free railway stations for 2023 → > 262 million EUR available for coming year

3. Current Status of the GRRT

3.2 Influencing Factors

Infrastructure and electrification

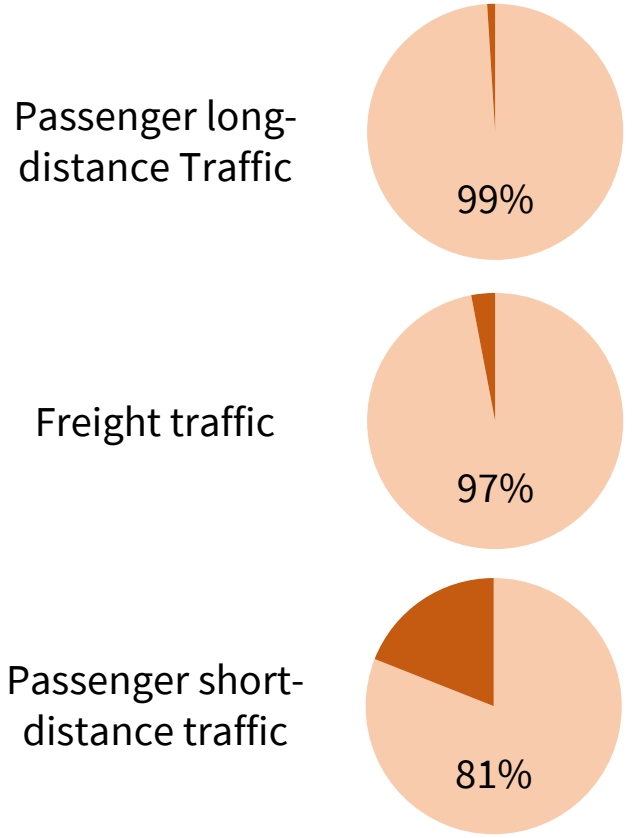
Share of electrified lines in the state rail network in Germany in %



(Allianz pro Schiene, 2022)

Koalitionsvertrag:
75 % in 2030
→ more investment & further expansion needed

Share of electrically powered transport traffic in Germany, 2020



(Allianz pro Schiene, 2022)

3. Current Status of the GRRT

3.2 Influencing Factors

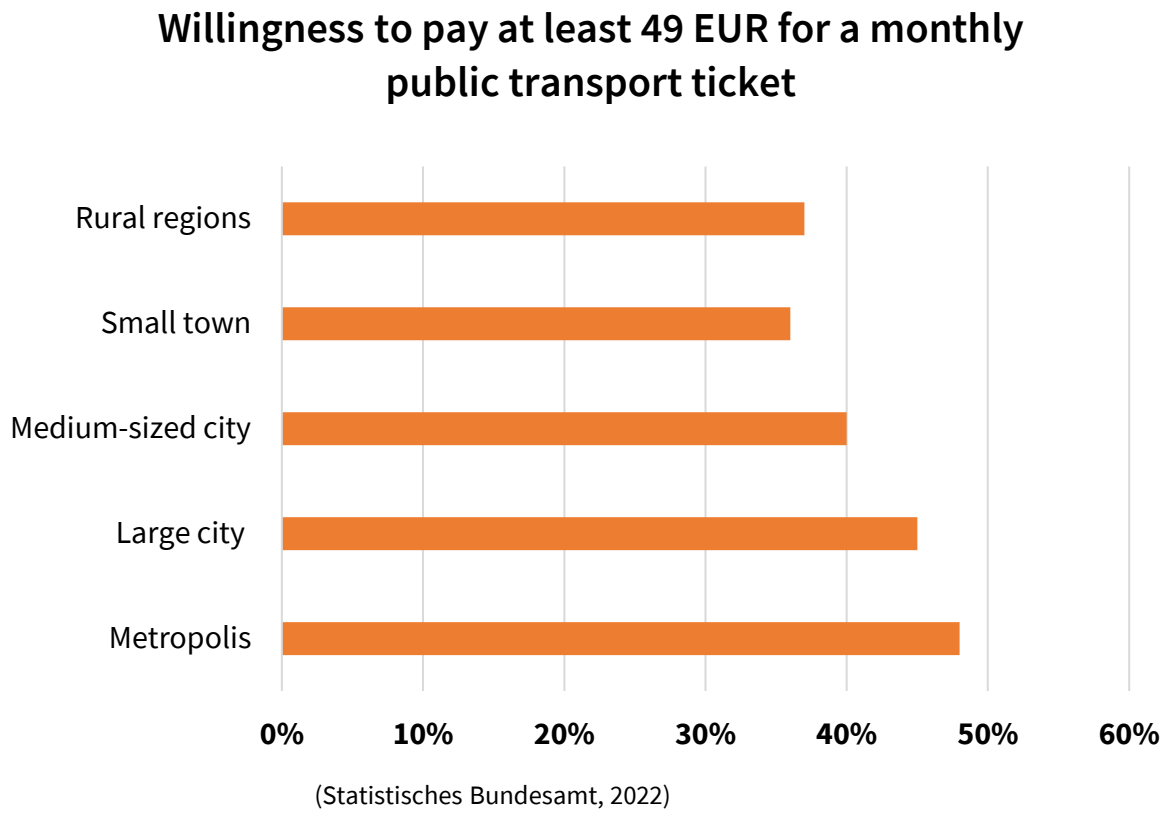
Technological innovation

- Besides Electrification:
  - → **Hydrogen Railcar** (fuel cell generates electricity from hydrogen)
  - → **Battery Multiple-Unit Train** (draws traction current from the overhead line on electrified sections, uses batteries for traction current where no external power supply is available)
    - Advantage: Battery-powered multiple units can use the existing overhead line infrastructure for driving & "refuelling"
    - Disadvantage: Low range when using batteries (only about 100km)
  - → **Hybrid Locomotives** (At partial load, locomotive runs on battery power → only when more power is needed, a diesel engine helps out → engine also serves as a power generator to recharge battery)
  - → **Dual-mode locomotives** (combine two fully-fledged locomotives in one vehicle → vehicle is a real electric locomotive that runs on electricity from overhead line, but also has a low-emission diesel engine on board)
  - → **Last-mile locomotives** (same as Dual-mode, diesel engine is smaller, hence the name)
- More funding needed (between 40-60 % of additional costs for alternate drives are subsidised, compared to 80 % for busses)
- Innovation in battery density needed to extend range of full-battery drive

3. Current Status of the GRRT

3.2 Influencing Factors

Deutschlandticket



(Statistisches Bundesamt, 2022)

- Results from 9 EUR-ticket, which was offered in summer months of 2022
- New permanent offer for public transport in Germany
- Price is 49 EUR per month and is to be valid from May 1, 2023

3. Current Status of the GRRT

3.2 Influencing Factors

Deutschlandtakt

Project to make rail transport in Germany **better coordinated**, **faster**, **more frequent** and **more accessible**

Trains will arrive at the same time & depart again shortly afterwards → optimum transfer opportunities & easy-to-remember timetables

Increase in **flexibility** of travelers

Overall travel time is to be shortened

3. Current Status of the GRRT

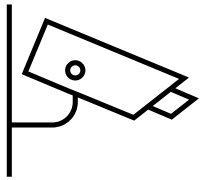
3.2 Influencing Factors

Extension of transport services

Expansion of the range of services needed to stay on top:

Comfort

Food & Drink

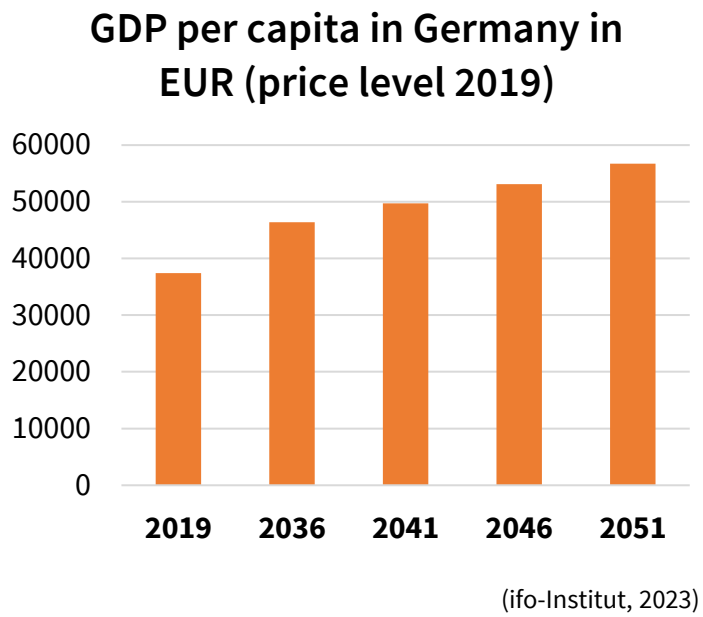


Security

3. Current Status of the GRRT

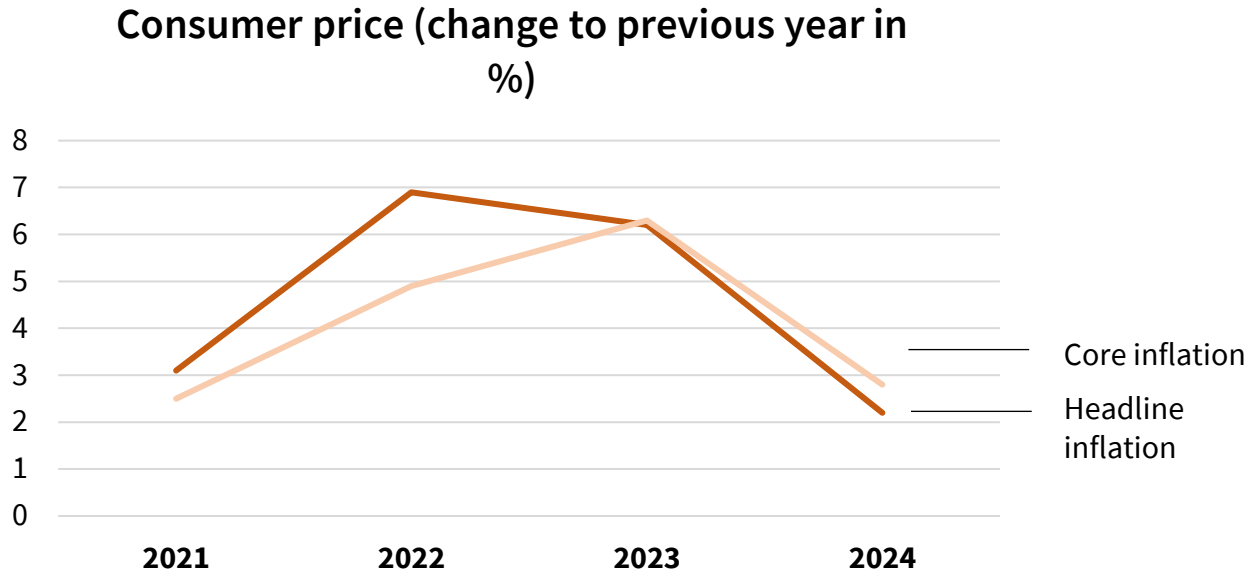
3.2 Influencing Factors

Economic growth and inflation



(ifo-Institut, 2023)

GDP expected to grow by 1.35 % p.a. in real terms until 2040, thereafter 1.26 % p.a.



(ifo-Institut, 2023)

- Overall inflation: fall from 6.9% (2022) to 2.2% (2024)
- Core inflation likely to rise from 4.9% (2022) to 6.3% (2023), decline then to 2.8% (2024)
- Inflation share of energy price will decline strongly
- Assumptions:
  - → Commodities & energy don't become significantly more expensive (current market expectations)
  - → ECB continues to raise its key interest rates

3. Current Status of the GRRT

3.2 Influencing Factors

Market competitiveness

Price
Making train cheaper (e.g. via 49€-Ticket) is only half of the story

It needs to be cheaper in relative terms (compared to other transport modes), taking all variables into account (duration, full train/empty train, working AC/heating, cleanliness, etc)

Digitisation
(“Digitale Schiene”)

Influencing capacity, punctuality, reliability

3. Current Status of the GRRT

3.2 Influencing Factors

Market access

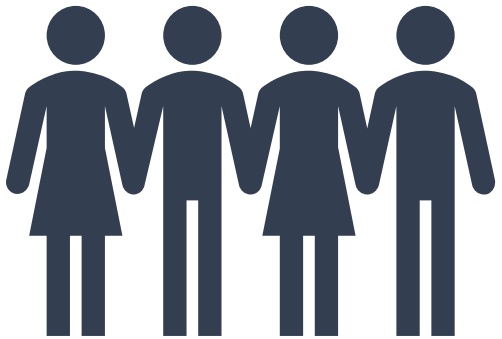
- 446 rail transport companies held a license for the provision of public rail transport services (2020)
- German rail market thus has the highest number of competitors in an international comparison
- Non-federally owned rail transport companies increased their market share
- State railroads from other European countries are active in Germany, which shows that the German rail market is attractive for foreign companies

3. Current Status of the GRRT

3.2 Influencing Factors

Personnel costs

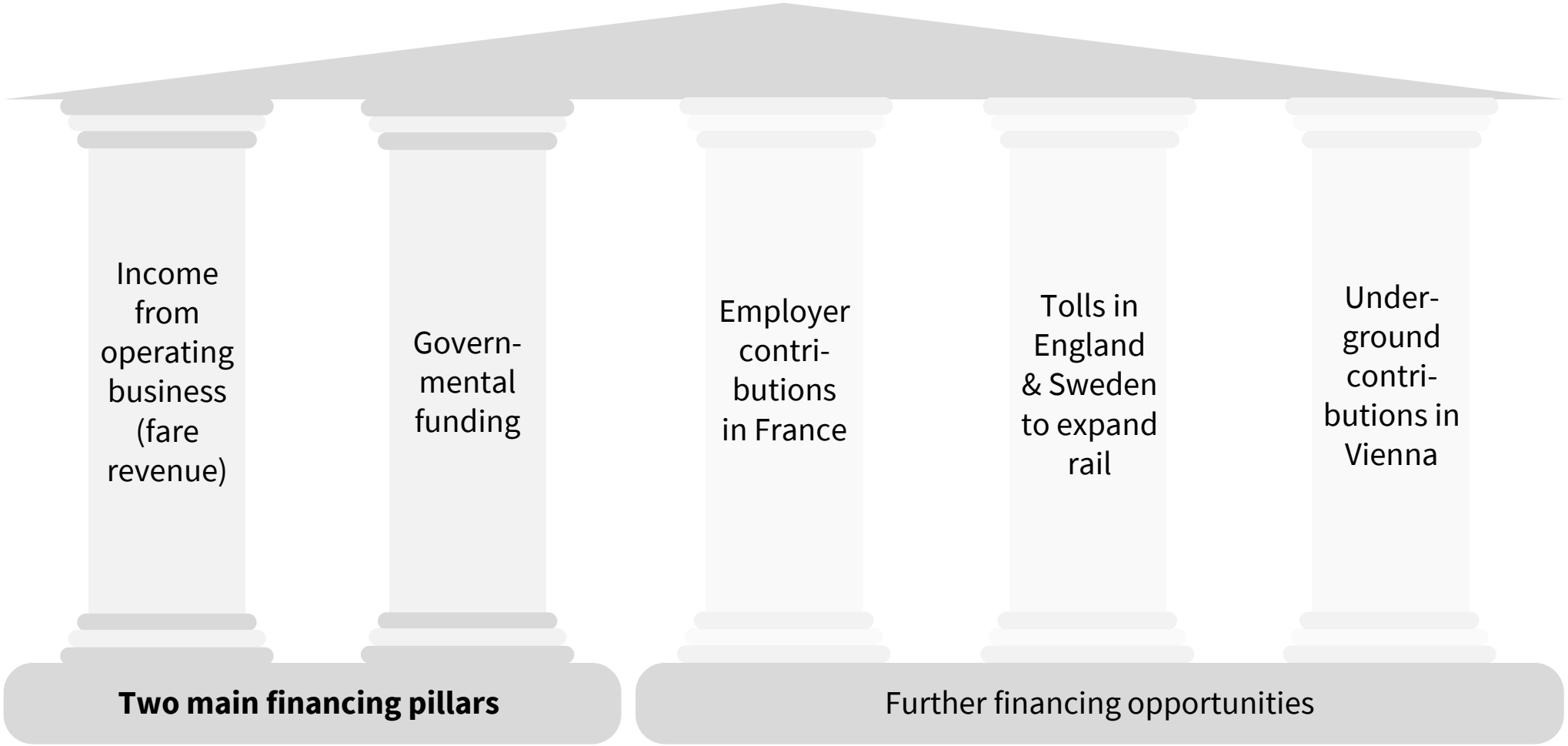
- Costs for driving personnel usually account for about a quarter of the total train transportation costs (i.e. excluding infrastructure usage charges)
- Regional rail passenger transport is a public means of transport and the collective bargaining agreement for the public sector (TVöD) applies to personnel, costs can be higher than in other industries



3. Current Status of the GRRT

3.2 Influencing Factors

Exploiting further investment opportunities



3. Current Status of the GRRT

3.2 Influencing Factors

Availability of building material

- Materials such as rails, sleepers, switches, fastening elements and signals are required for the construction and maintenance of rail tracks in regional passenger rail transport
- Costs may vary depending on availability, supply chain and due to unforeseen events, such as the war of aggression in Ukraine
- Not only the rail industry is affected by these fluctuations, but other industries as well

3. Current Status of the GRRT

3.3 Factor Weighting

Highly relevant	Relevant	Less relevant
Demographic change	Technological innovation	Market access
COVID-19	Deutschlandticket	Personnel costs
Service availability	Deutschlandtakt	Usage of further investment opportunities
Political Priorities	Market competitiveness	Availability of building materials
Relative attractiveness	Extension of passenger services	
Infrastructure	Economic outlook	

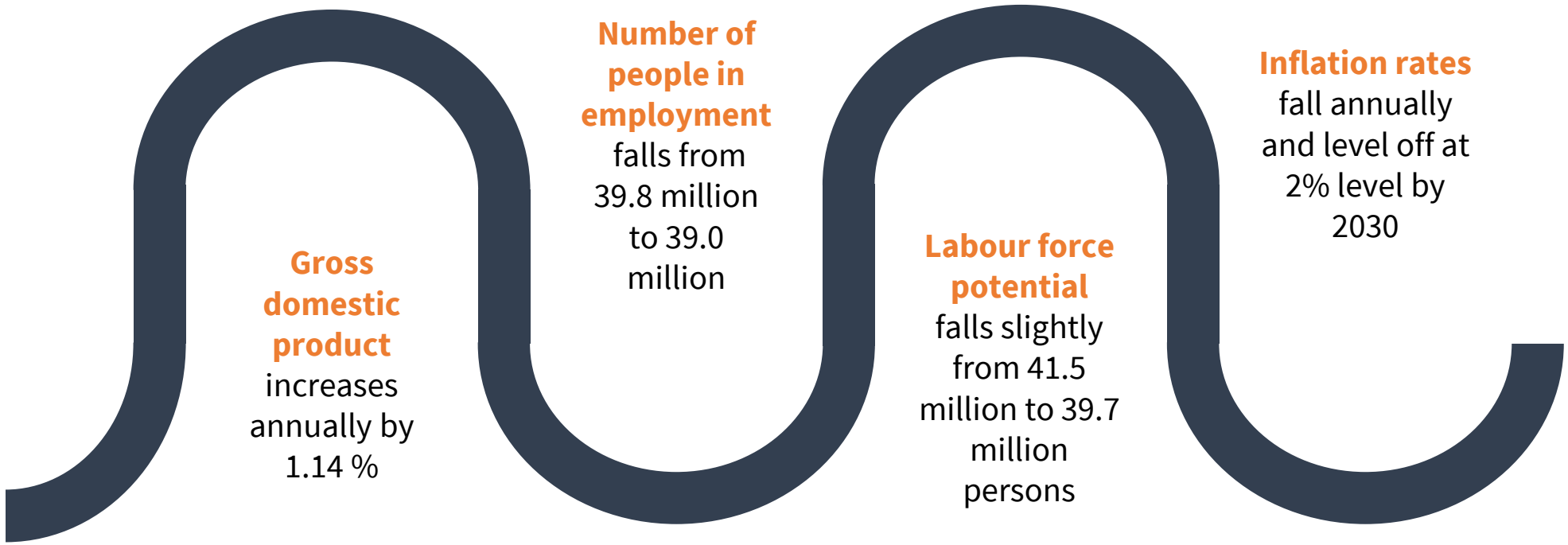
(Own weighting and representation based on remarks from experts & literature)

PART 2

Development Expectations until 2030

4. Development Expectations until 2030

4.0 Economic Assumptions for 2030



(Strukturdatenprognose 2030, 2022)

4. Development Expectations until 2030

4.1 Political Objectives for 2030

New dawn in mobility policy

Enable sustainable, innovative, intelligent, barrier-free and accessible mobility for all

Climate protection targets

Faster decarbonisation of the mobility sector

Doubling of passenger transport services

Corresponding adjustment of timetable and infrastructure capacity

Increase infrastructure investments & secure them in the long term

Invest considerably more in rail than in street

Innovation

Electrify 75% of the rail network and promote innovative drive technologies

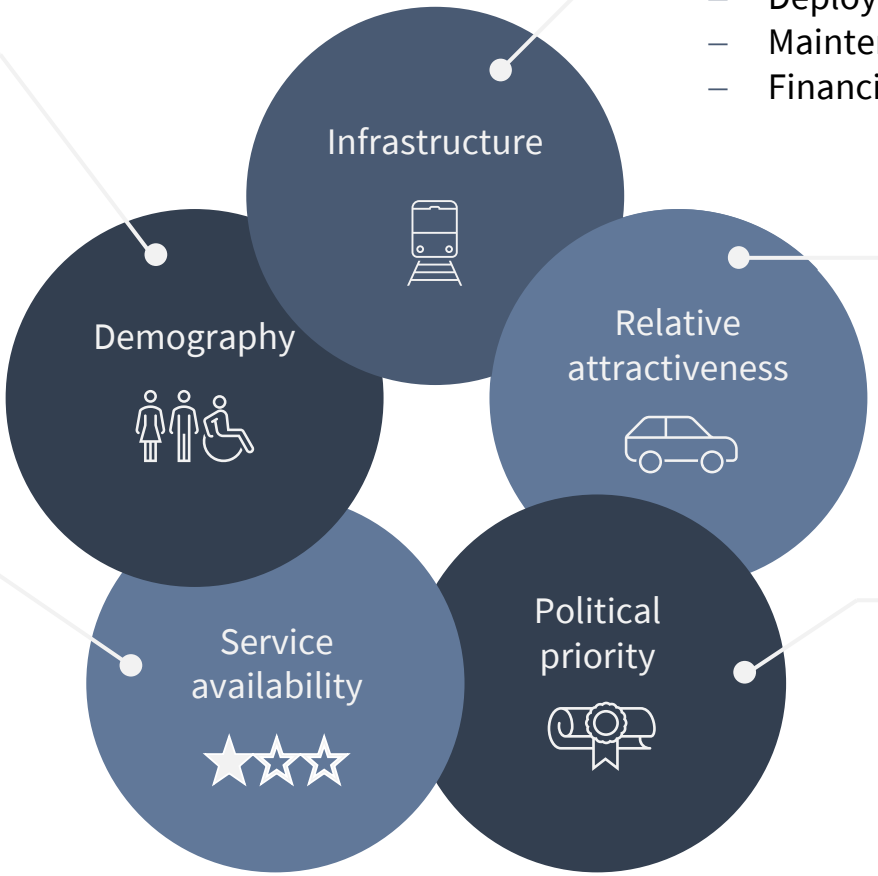
(SPD, BÜNDNIS 90 / DIE GRÜNEN & FDP, 2021)

4. Development Expectations until 2030

4.2 Factor Development

- Deployment of rolling stock
- Maintenance & extension of rail network
- Financing

- (Sub)urbanisation
- Changes in mobility behaviours
- Shortage of staff & qualified personnel



- Sensitivity about environmental issues
- Price
- Quality of transport services
- Digitisation

- Tendering framework
- Interconnection with other transport modes
- Automated train vehicles
- Price-equilibrium

- Overall prioritising of transport modes
- Rail as tool in fight against climate change
- Industry structure
- Research & Development

4. Development Expectations until 2030

4.2 Factor Development

Political Priority

Factor	Specification
Overall political prioritising of transport modes	– Role state attributes to railways in fulfilling its responsibility to provide services of public interest – Differs across regions with different mobility attributes and needs
Rail as a tool in the fight against climate change	– Reduce CO_2 emissions and forward climate goals: new regulations – Direction and extent of political engagement in climate protection
Industry structure	– Driven by availability of public funds, standardisation mechanisms (vehicles, infrastructure), legal complexity, price policy
Research & Development	– Publicly financed promotion of innovations in technology, production and processes shaping train sector

Infrastructure

Factor	Specification
Deployment of rolling stock	– Availability/appropriateness of vehicles (incl. anti-discriminatory accessibility) – Information and communication technology making train sector more efficient and attractive but requiring political intervention
Maintenance & extension of rail network	– New and reconstruction measures required for increase in traffic volume – Bundesverkehrswegeplan: complete implementation improbable – Eliminate bottlenecks: high investments – Supplier industry; residents' resistance
Financing	– Subsidisation gets more important – Basis of measurements has to be reliable long-term financing – Investments take time to make impact

4. Development Expectations until 2030

4.2 Factor Development

Relative Attractiveness

Factor	Specification
Passengers' sensitivity about environmental issues	– Awareness and problematisation of climate change, noise, fine dust drives transport mode choice – Comparatively low decision-making relevance
Price	– Appropriateness and relative expensiveness – Driven by energy costs (which make only 10 % of operating costs of train, but 30 % of car) and Deutschlandticket
Quality of transport services	– Reliability (punctuality, effect of delays) – Travel time (duration) – Accessibility: flexibility (spontaneity & frequency of commencement), land exploitation (connection between starting point & end) – Simplicity (journey planning, ticketing) – Integration of journey chain (changes, waiting time, separateness) – Comfortability, (perceived) security
Digitisation	– Innovation changes mobility and transport mode attractiveness – Digital distribution channels (multimodal platforms, all-in-one offers) – Autonomous driving

4. Development Expectations until 2030

4.2 Factor Development

Demography

Factor	Specification
Mobility behaviour of passengers	– Will be influenced by societal change: elderly people get more mobile – Increasing single households: increasing spatial interactions and broader social contacts' diffusion
Population aging	– Elderly people need anti-discriminatory access and simplification of digital ticket supply
Development of income per capita	– Net income p.c. must keep up with ticket prices or outpace them
(Sub)Urbanisation	– Decreasing rural population, increasing agglomeration
Decreasing overall workforce	– Migration needs to be upheld – Better and more recruitment of trainees

Availability & quality of train services

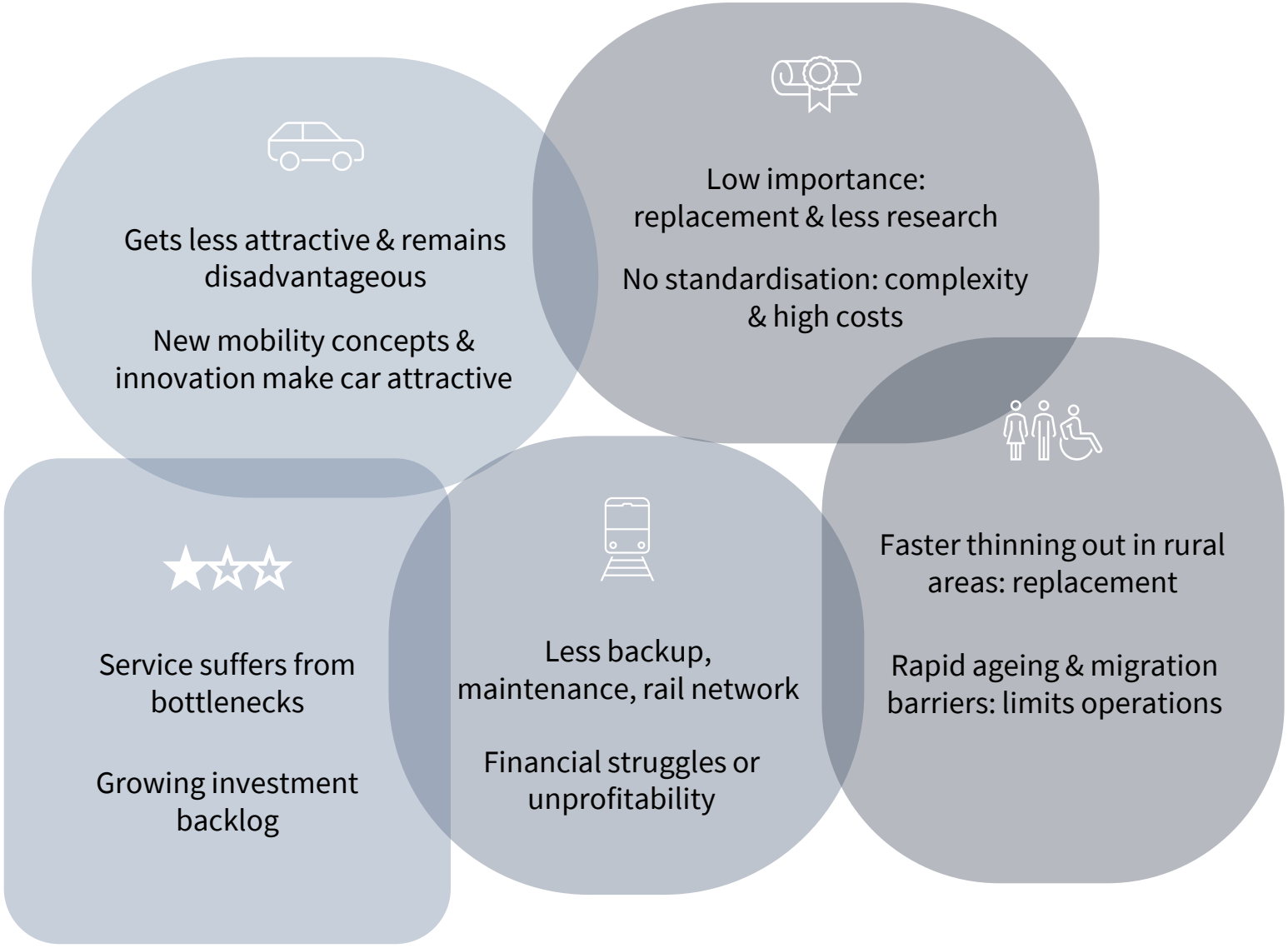
Factor	Specification
Automated train vehicles	– Rail development organisation is too short dated: lack of planning security
EU-wide border-crossing mobility	– More supranational train connectivity helps to increase passenger figures
Technical innovations of service	– Responding to passenger preferences, environmental awareness and simplicity to access train services
Public tendering	– Dogma of "low-cost supplier wins": loss of service quality: ticket classification could be implemented
Price-quality ratio	– Price-equilibrium between high passengers' numbers & cost coverage – 49 EUR will be in place for two years, costing 1.5 bn EUR per year – By 2025, "Deutschlandticket" is supposed to cost at least 69 EUR

4. Development Expectations until 2030

4.3 Negative Scenarios

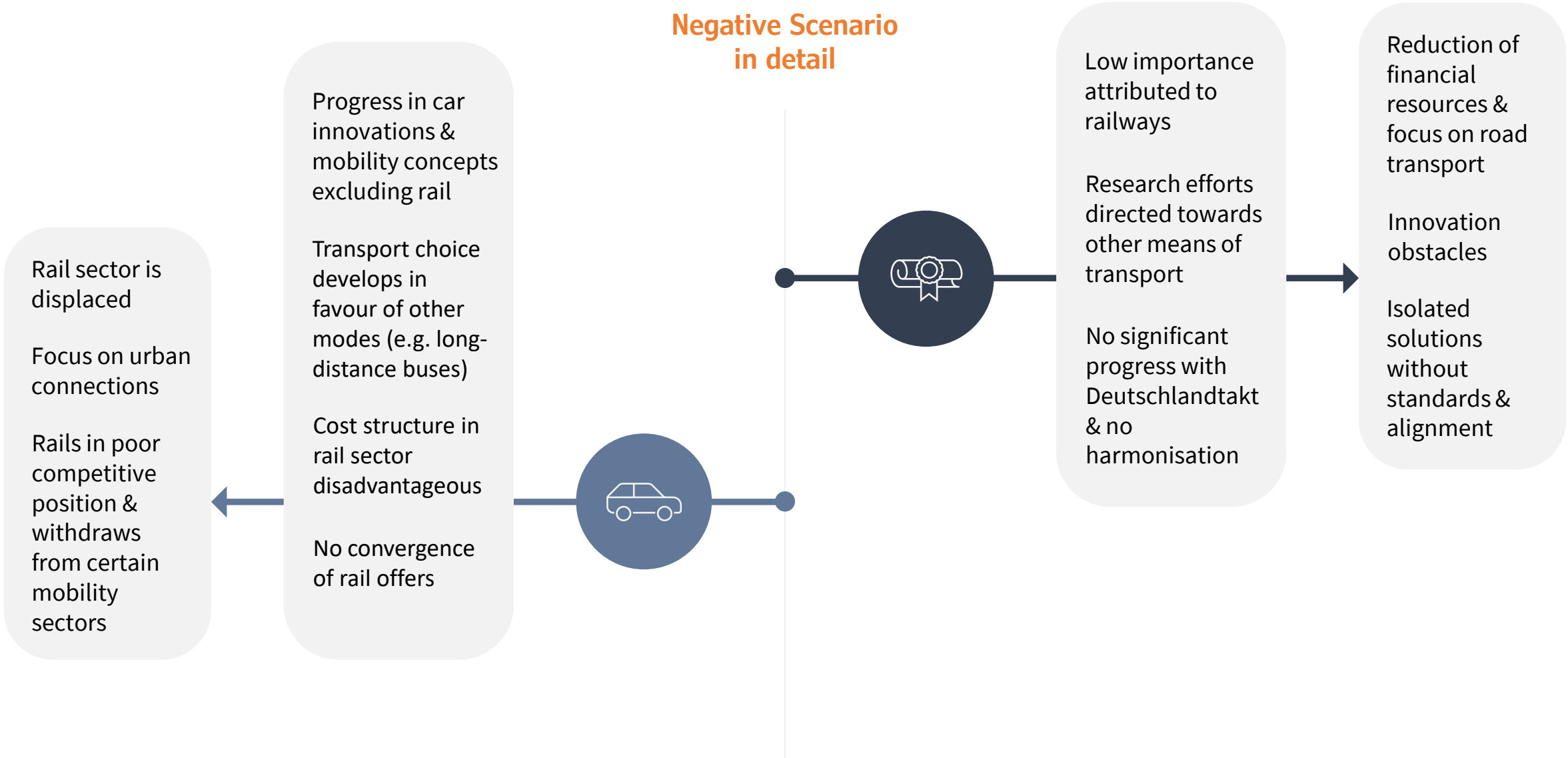
Negative Scenario

- Frequent errors in operations
- Desolate state of infrastructure & transport service
- Hopeless skill shortage
- Growing investment backlog
- Focus on street mobility
- Rail falls behind (limited operations)



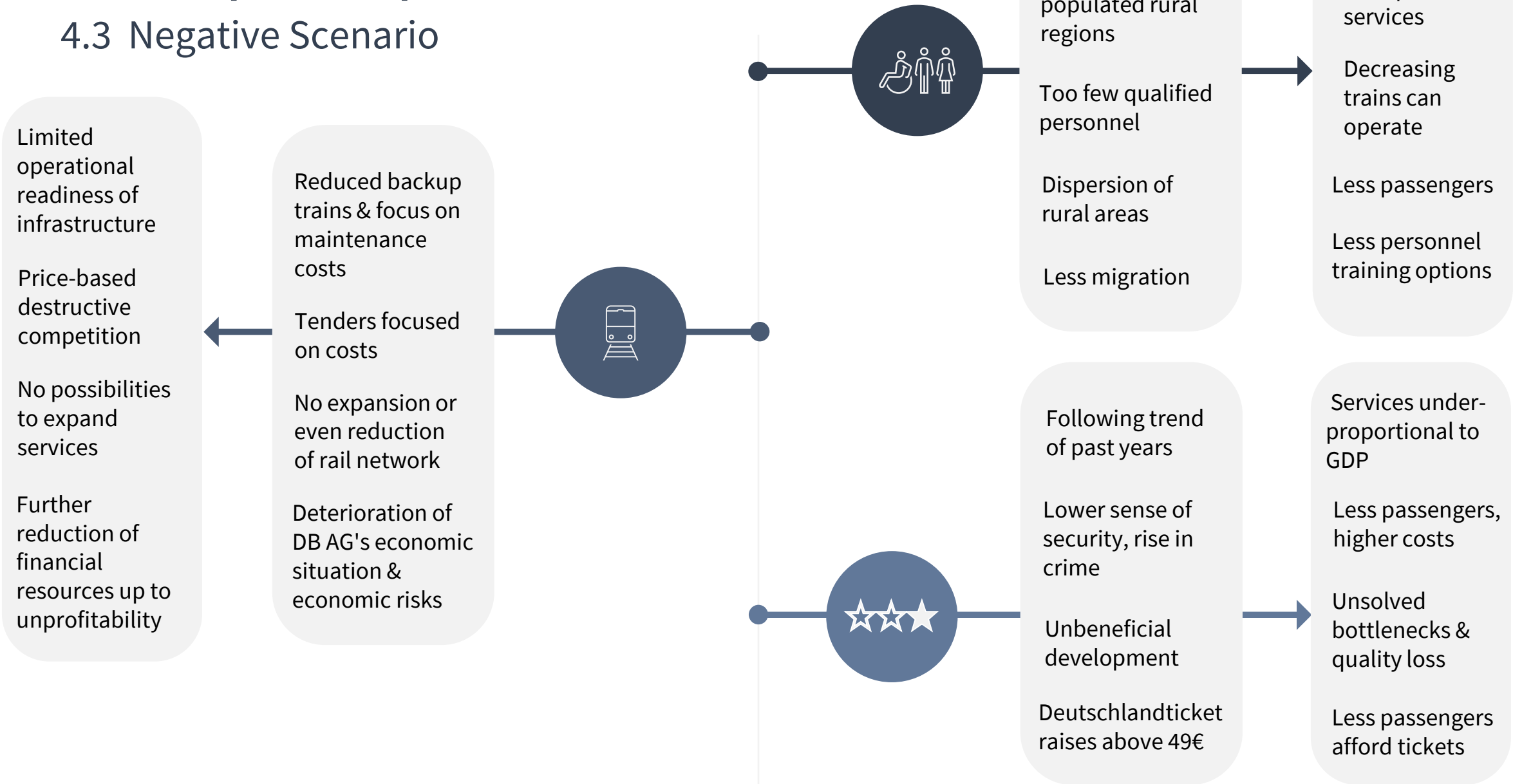
4. Development Expectations until 2030

4.3 Negative Scenario



4. Development Expectations until 2030

4.3 Negative Scenario

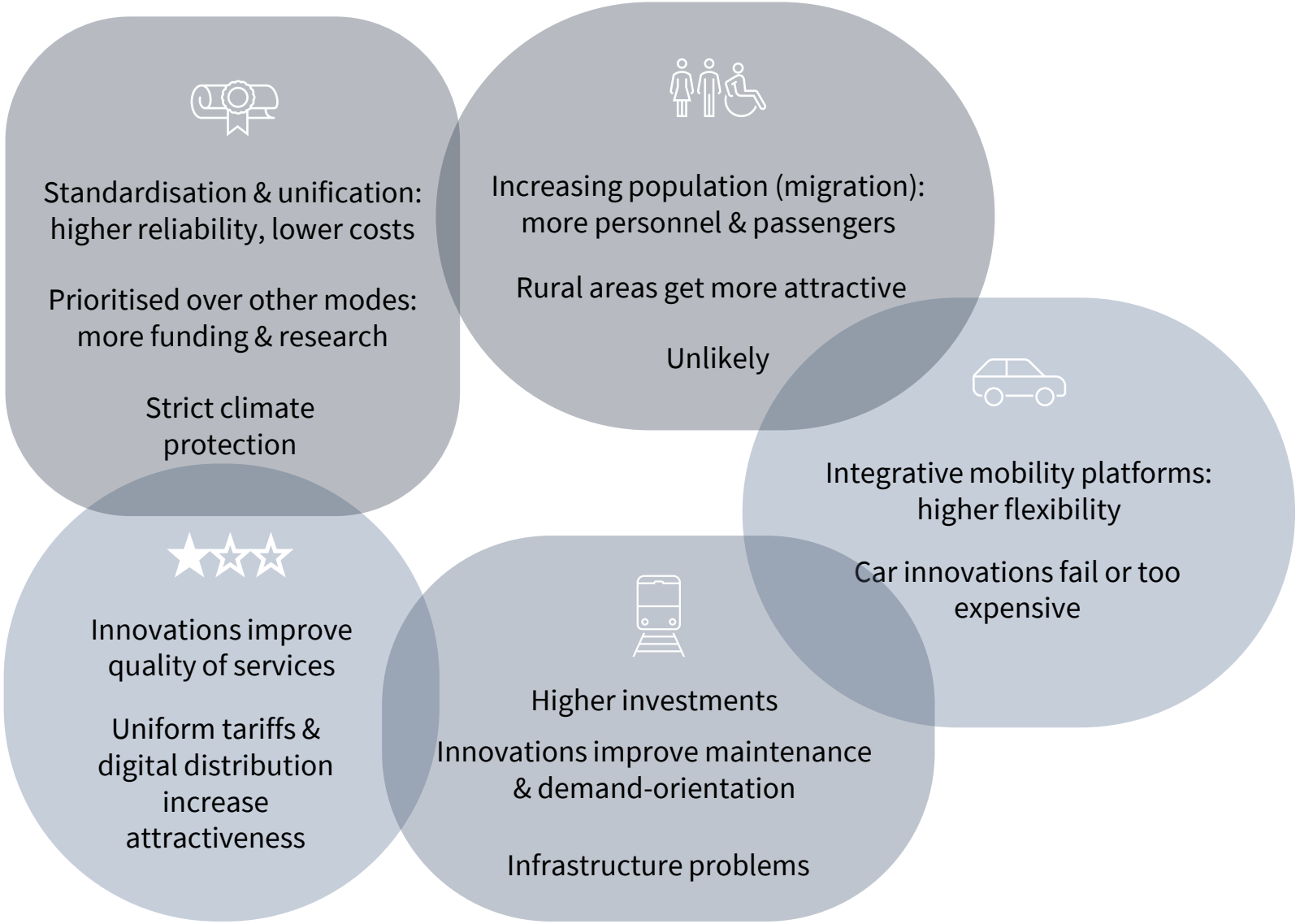


4. Development Expectations until 2030

4.3 Positive Scenario

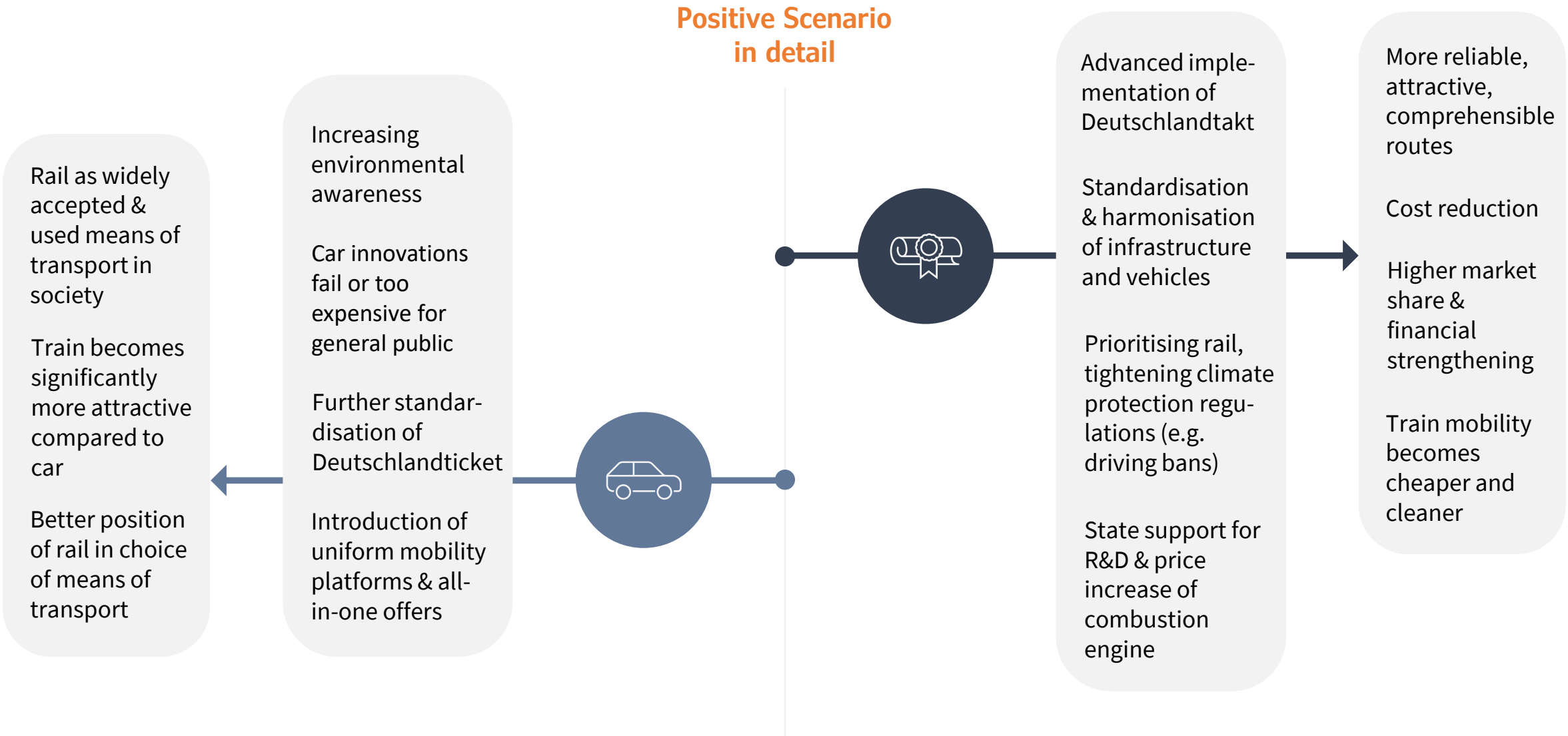
Positive Scenario

- Fixed political tool in providing services of general interest
- Increased attractiveness: standardisation, innovation, mobility platforms, tariff unification
- Increasing profitability
- Infrastructure bottlenecks from past



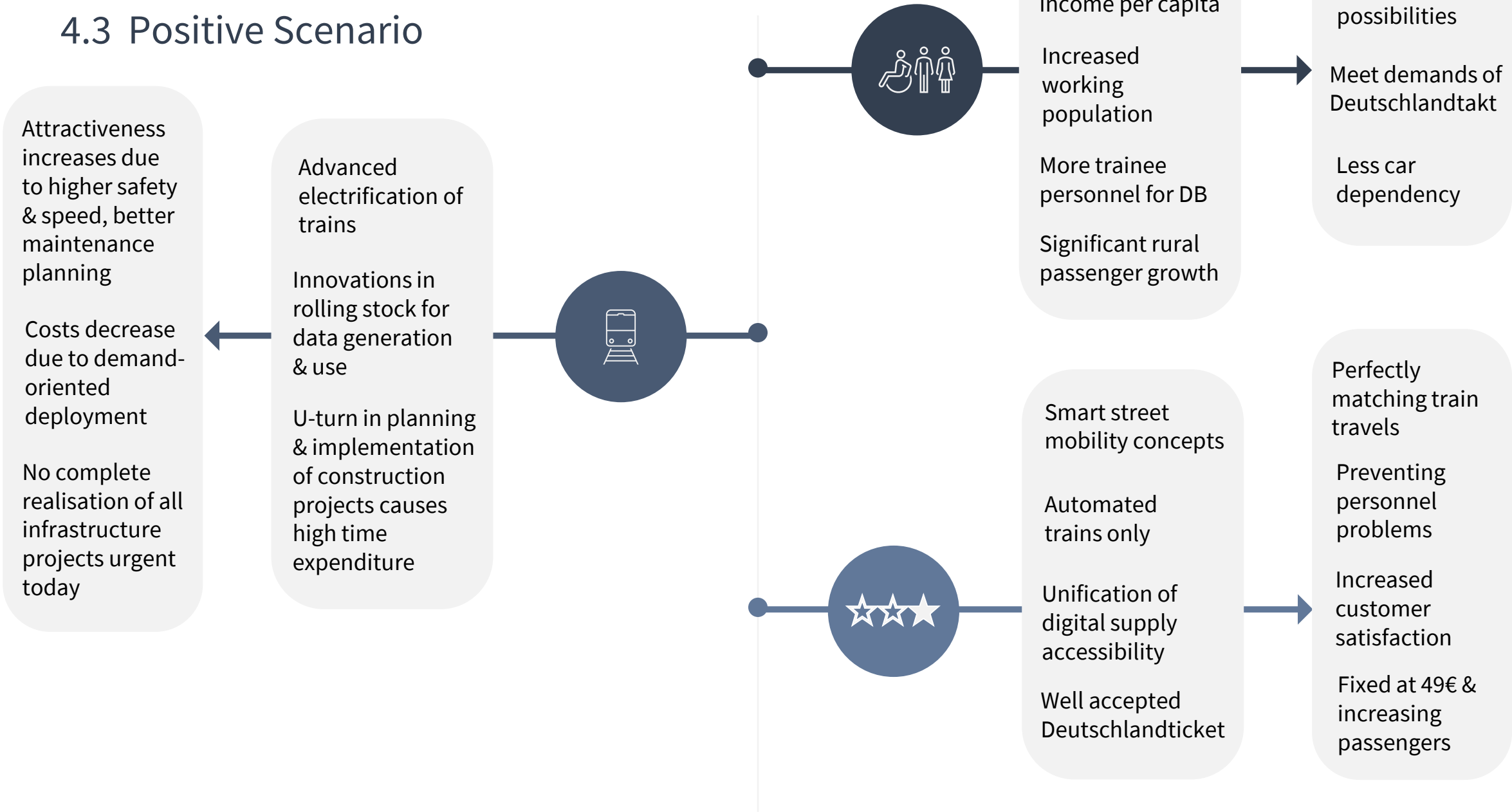
4. Development Expectations until 2030

4.3 Positive Scenario



4. Development Expectations until 2030

4.3 Positive Scenario

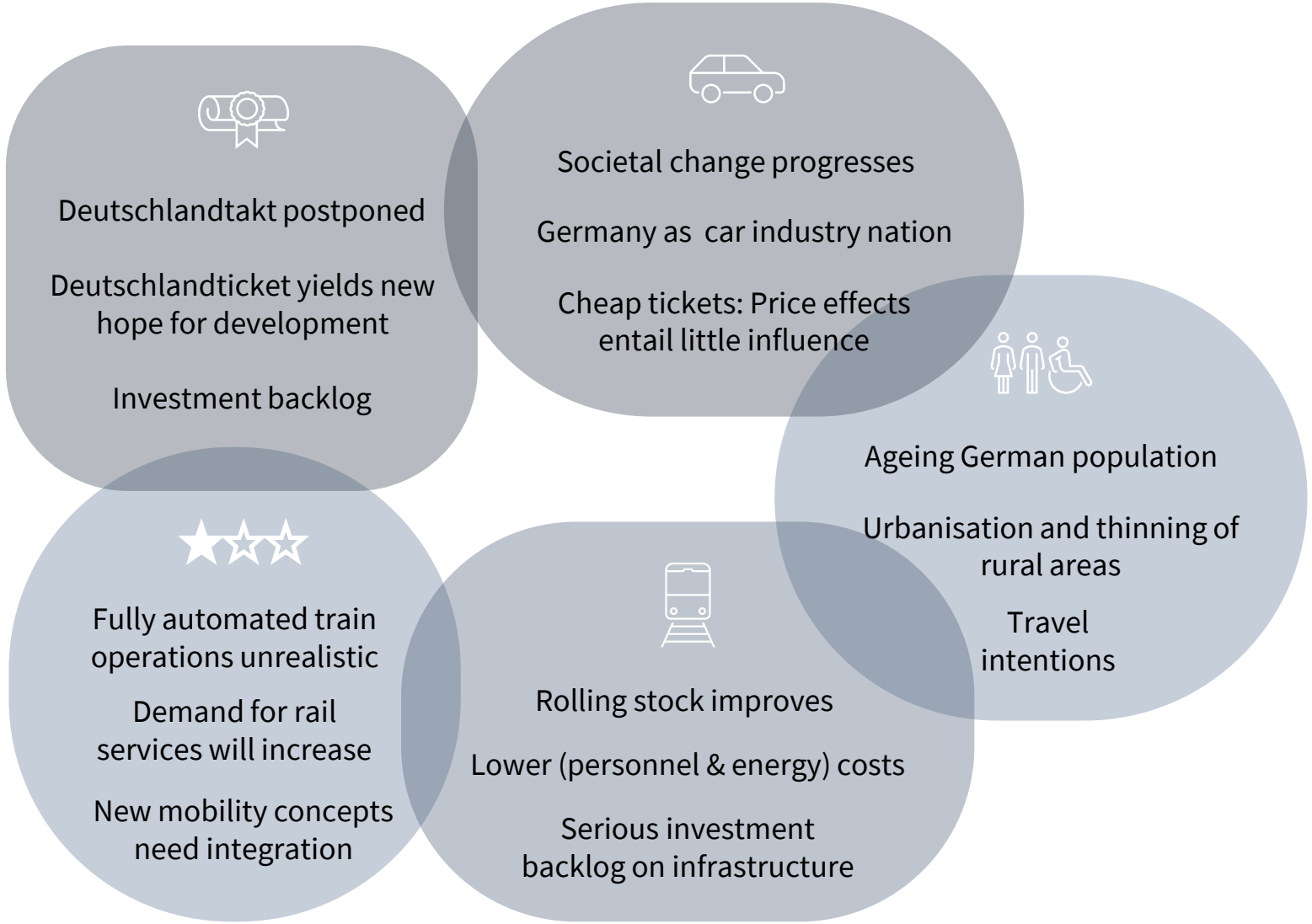


4. Development Expectations until 2030

4.3 Trend Scenario

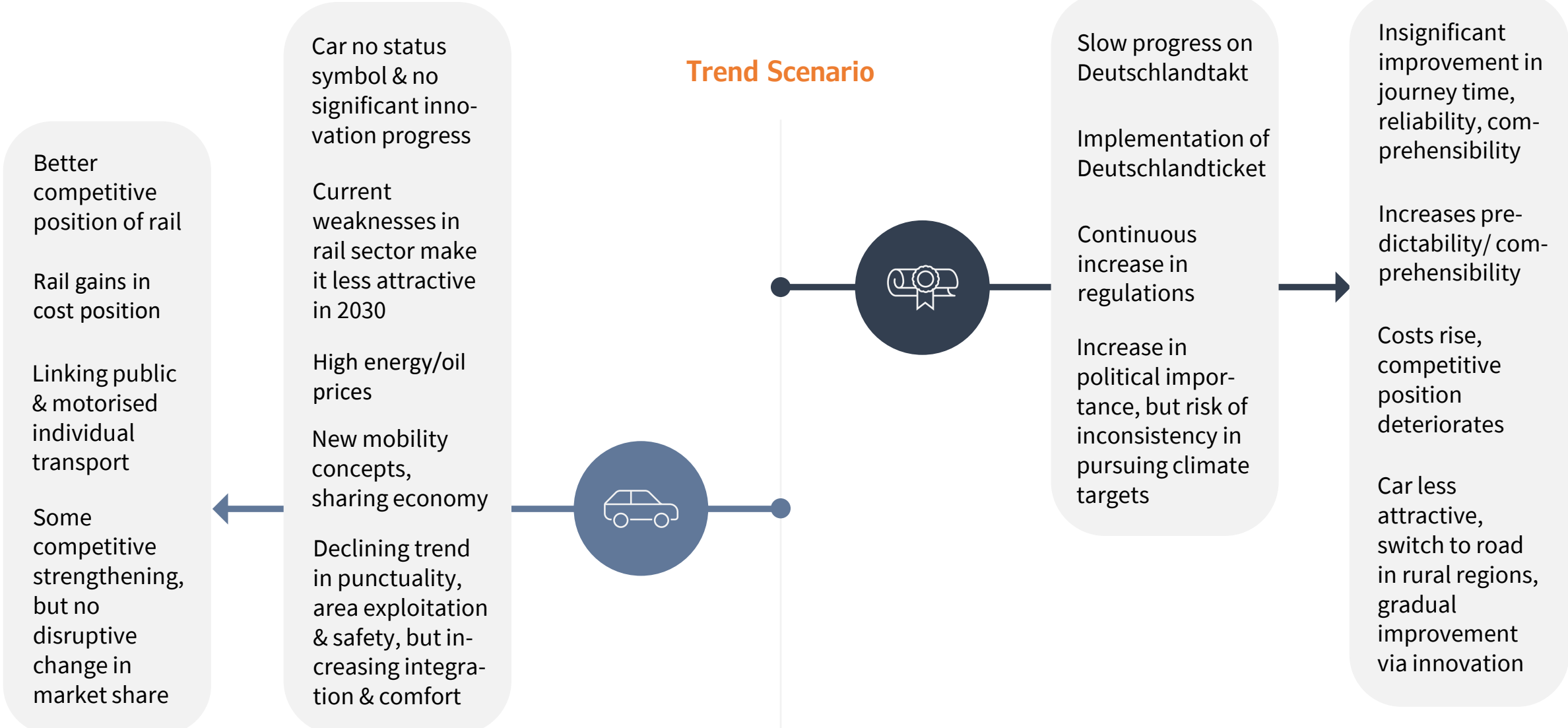
Trend Scenario

- Deutschlandtakt & -ticket present ambitious goals
- Societal attitude towards car changes
- Accelerated aging of population
- Germany will remain a car industry nation
- Increasing demand for rail services
- 60 billion investment backlog



4. Development Expectations until 2030

4.3 Trend Scenario



4. Development Expectations until 2030

4.3 Trend Scenario

More urban & suburban population

Thinning of rural areas

More uneven traffic volume

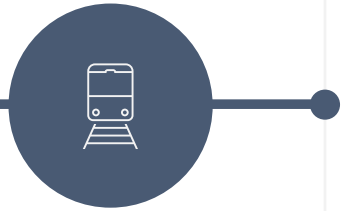
Changes in travelling reasons

Higher efficiency of trains

Lower public transport demand

Increase of stressed paths

More private – less business trips



Innovation on rolling stock (e.g. driver assistance

Ageing of rail network & increasing funding backlog; urgent building projects are postponed

Lack of resources & staff, residents' resistance grows

Funding insufficient & current projects are implemented slowly, so project list grows

Increasing performance, cost reduction, but requiring extensive modernisation

Infrastructure situation doesn't improve → considerably limits operation & service opportunities

No turnaround in funding trend until 2030 → not sufficient for development progress

Hands-off train operations

Home office and virtual meetings

Increasing investments in infrastructure

Trend in higher service qualities

Visionary, but advanced assistance

Less travel necessities

Reduced performance & delays

Increasing personnel costs

4. Development Expectations until 2030

4.4 Target-Performance-Analysis

Innovative and accessible mobility for all

Standardisation of tariffs

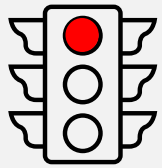
Political prioritising and electrification keep prices constant

Faster decarboni-sation of mobility sector

Increased rail demand, loss of relative attractiveness of car

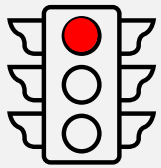
Increased sustainability of rail

Doubling passenger transport



Financial and infrastructure hurdles continue to limit service capacity

Increase invest-ments & invest more in rail than in street



Car will continue to dominate mobility sector in 2030

Inconsistent political prioritisation

Electrify 75% of rail network & promote technologies

Funds made available are needed to reduce the huge critical investment backlog

4. Development Expectations until 2030

4.4 Target-Performance-Analysis

The German Regional Rail Transport is highly likely to **grow by 2030** and its modal split will increase, as well. However, **disruptive mobility** changes in favour of the railway are **not expected**. There is a continuously tense financing situation and infrastructure bottlenecks remain unresolved.

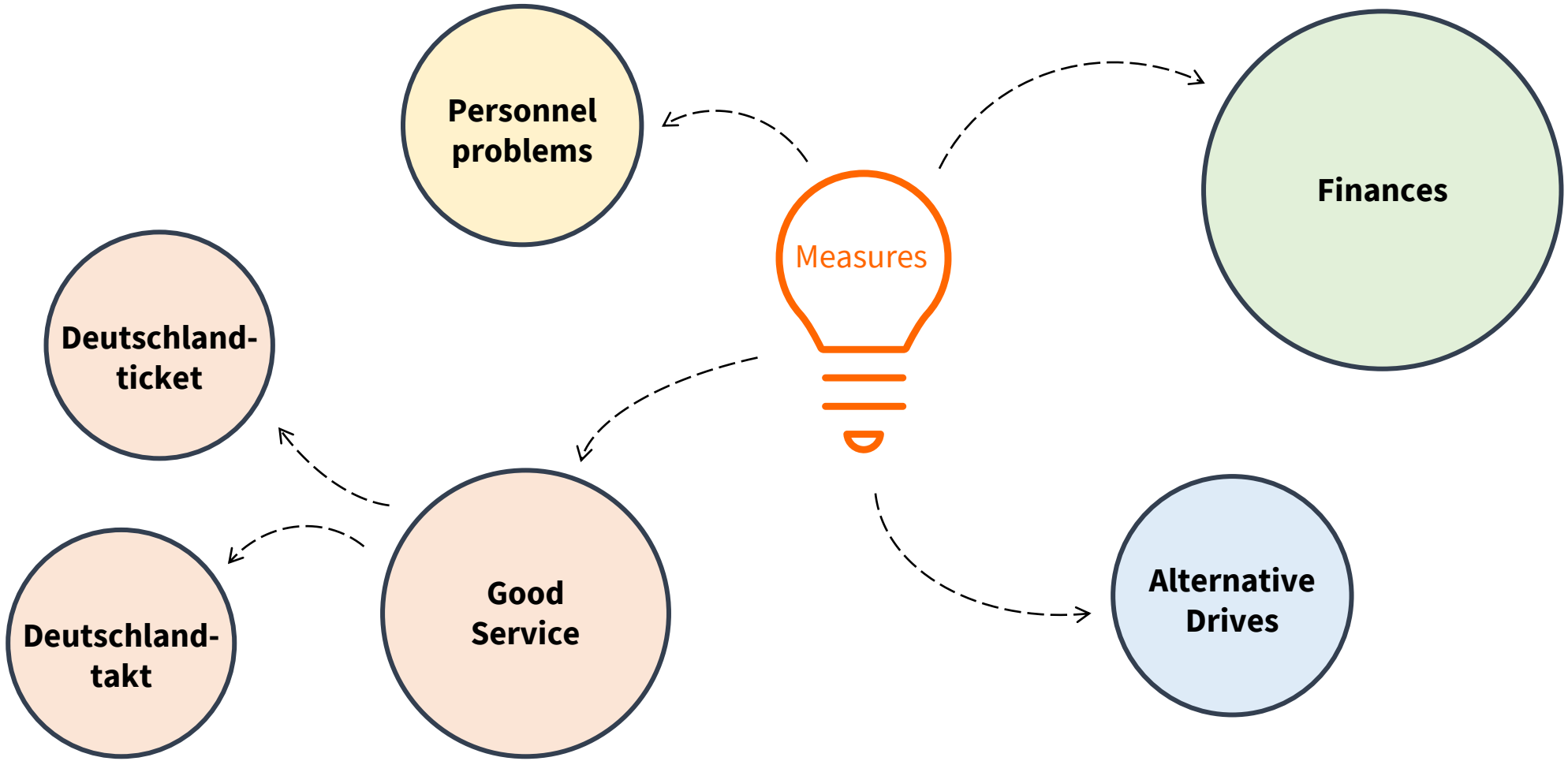
Measures addressing both of these problems **need a long time**. What matters, when it comes to the development of the GRRT until 2030 is how **demographic change** is **reacted** to and how **innovation** is going to change the **competitive environment**.

PART 3

Measures for the Realisation of Objectives

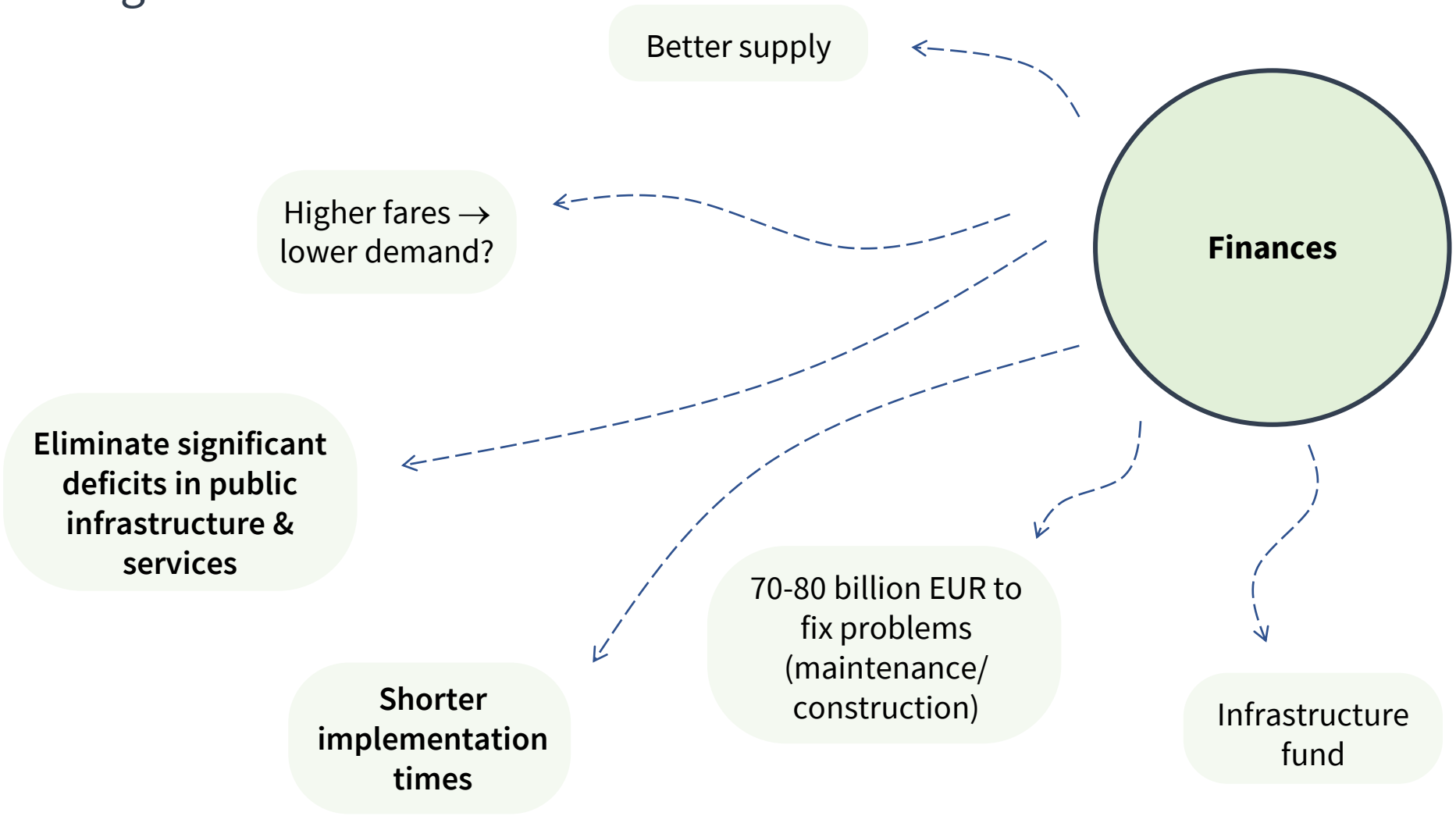
5. Measures for the Realisation of Objectives

5.1 Overview



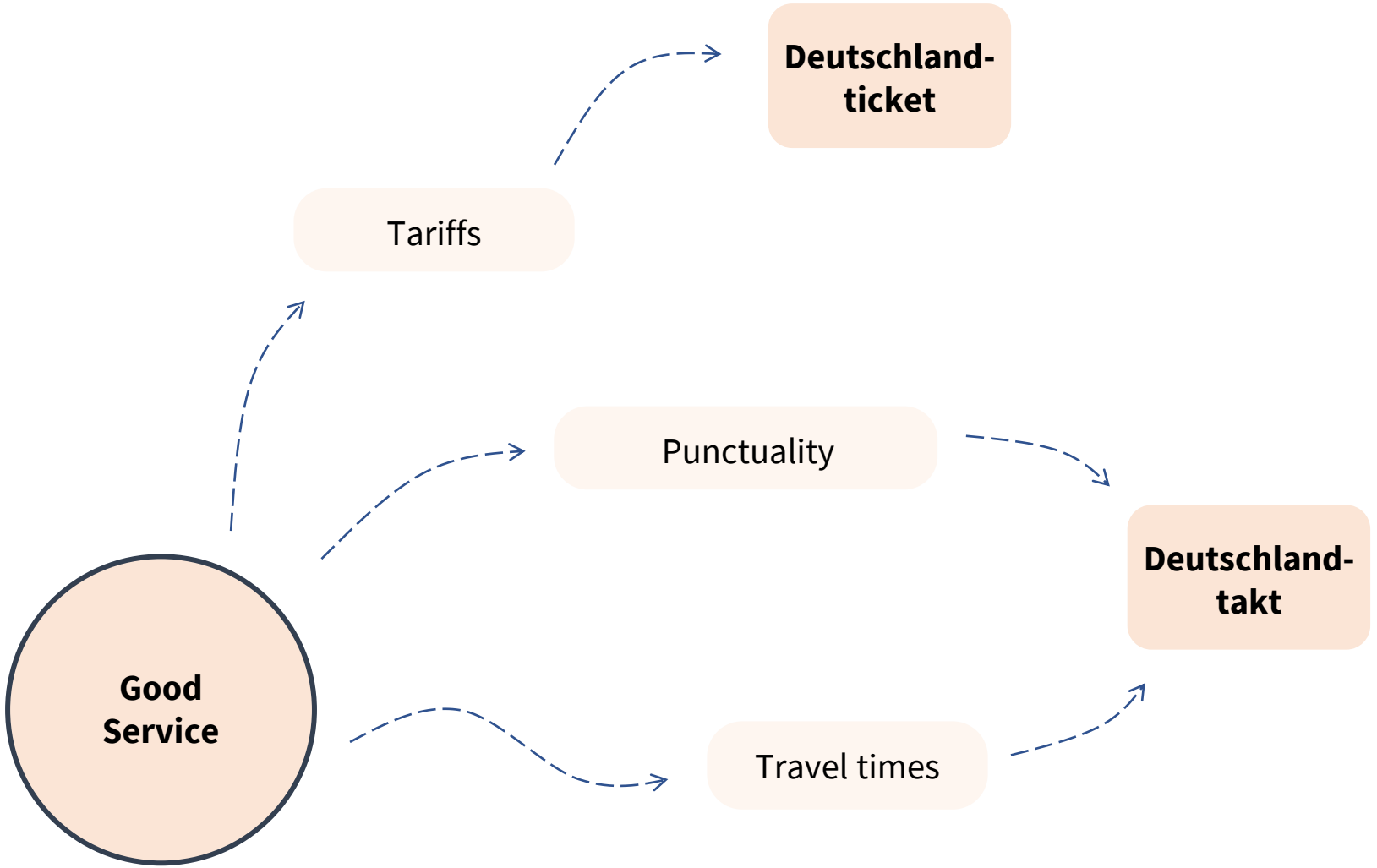
5. Measures for the Realisation of Objectives

5.2 Financing Measures



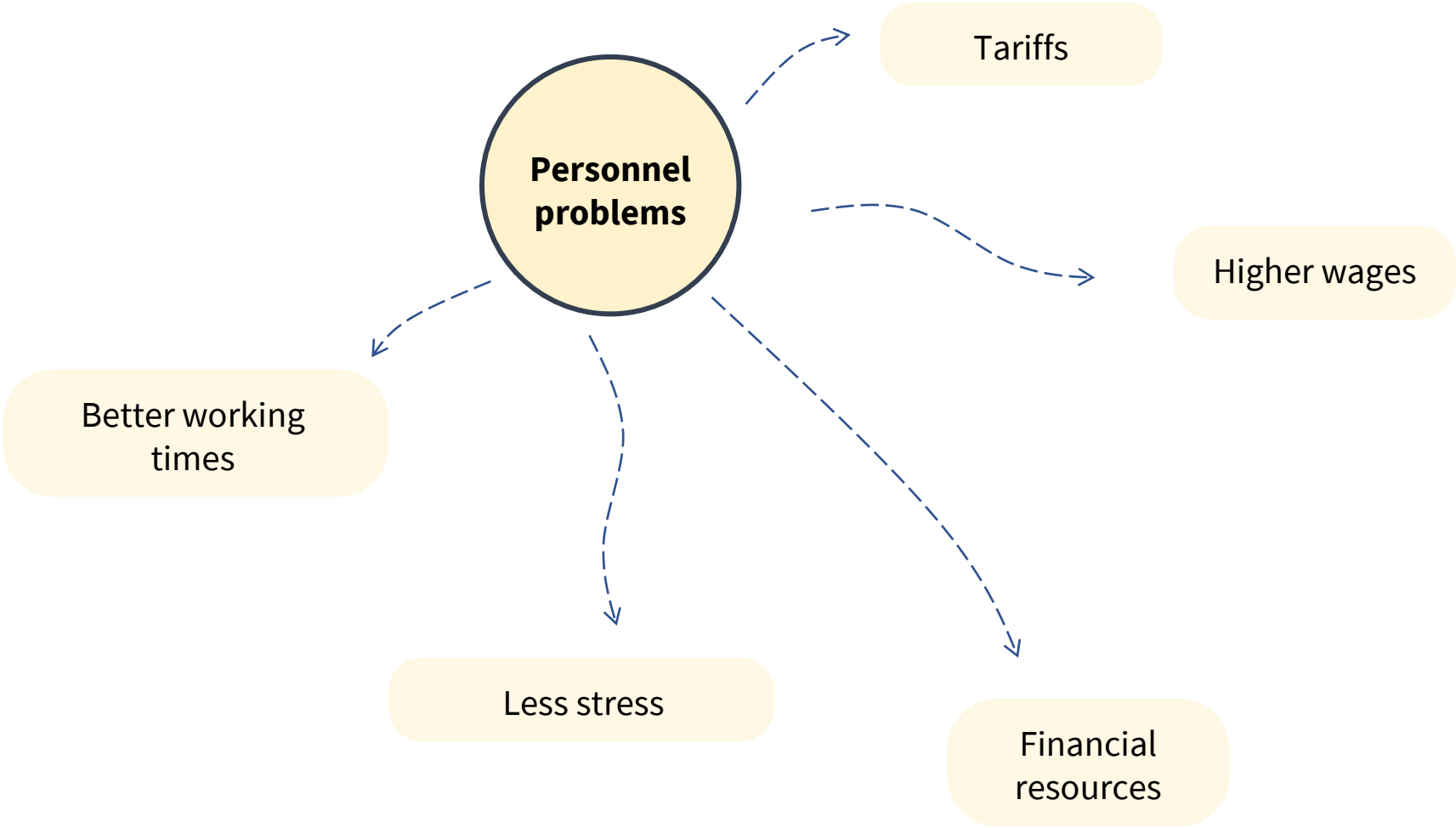
5. Measures for the Realisation of Objectives

5.3 Service Measures



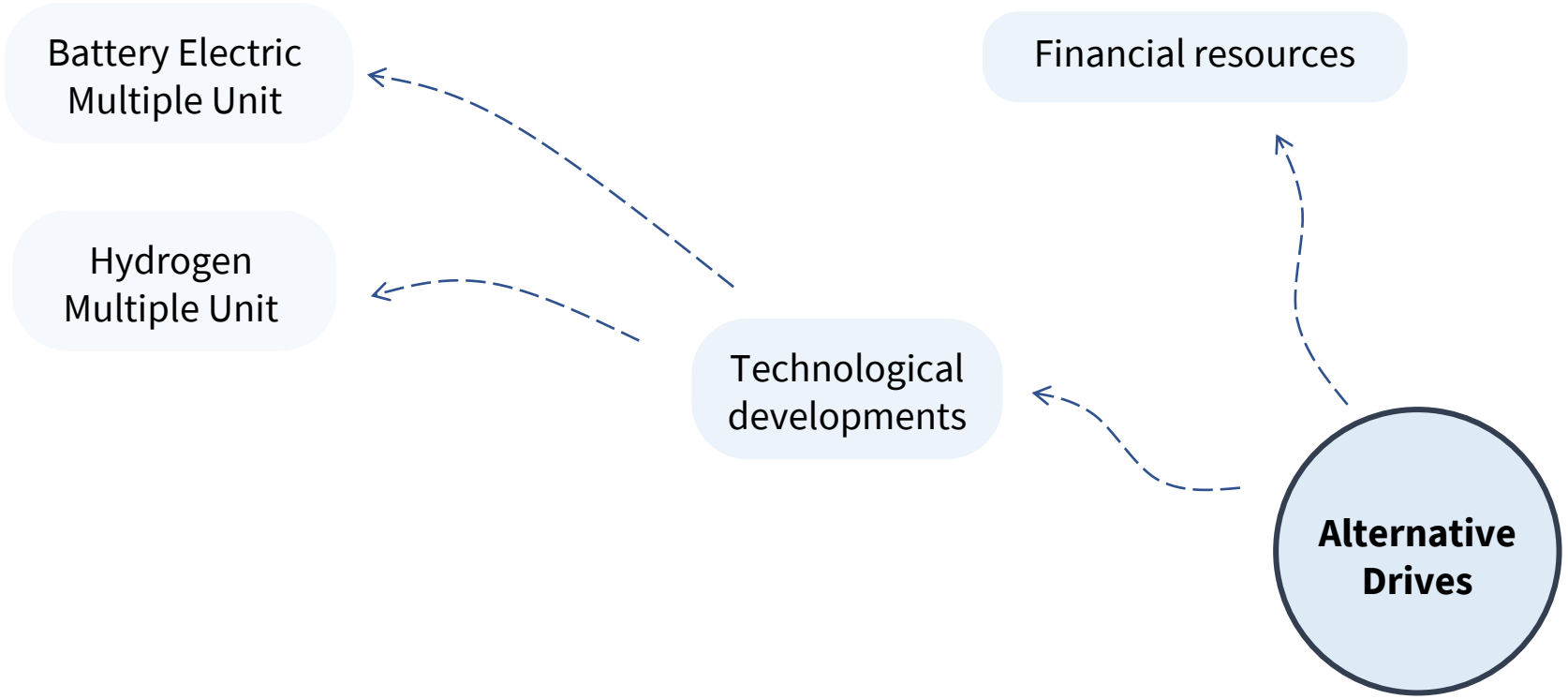
5. Measures for the Realisation of Objectives

5.4 Personnel Measures



5. Measures for the Realisation of Objectives

5.5 Alternative Drives



Lessons learned

01

Overall condition of the GRRT assessed as **good,** although some influencing factors pose serious **challenges**

02

Problems today: demographic change, COVID-19 impact, staff availability, competition from other transport modes, policy priority, infrastructure

03

GRRT will **grow until 2030**, but **disruptive breakthroughs** are **missing**, so that specific targets will be missed

04

Financial barriers and the current state of the **infrastructure** remain problematic

05

Financing conditions must be improved, since other problems are based on this

06

Working conditions and **wages** have to be improved


Thank you for your interest!

Sources

Allianz pro Schiene (2022) *E-Mobilität bei der Eisenbahn.* Allianz pro Schiene, available at https://www.allianz-pro-schiene.de/wp-content/uploads/2022/12/220818_Anteil-Elektrische-Verkehrsleistung_web.png.

Allianz pro Schiene (2022) *Es wird immer enger auf Deutschlands Schienen*. Allianz pro Schiene, available at https://www.allianz-pro-schiene.de/wp-content/uploads/2022/12/221110_Streckenlaenge-Verkehrsleistung-Vergleich-web.png.

Allianz pro Schiene (2022) *75 Prozent Streckenelektrifizierung bis 2030 – deutliche Beschleunigung nötig.* Allianz pro Schiene, available at https://www.allianz-pro-schiene.de/wp-content/uploads/2022/03/220301_Anteil-Elektrifizierte-Strecken-1.png.

BMDV (2022) *Infrastrukturdialog: Prognoseinstrument des BMDV und prognostischer Blick in die Zukunft*, Berlin, BMDV.

Böttger, C. (2022) Umbruch bei der Eisenbahn in Deutschland?, *Wirtschaftsdienst*, vol. 102, no. 8, pp. 618–623.

Böttger, C., & Pörner, R. (2006). Der SPNV in Deutschland-Eine Erfolgsstory mit Potenzialen?. *Jahrbuch des Bahnwesens*, *2007*, 132-140.

Bundesministerium für Digitales und Verkehr (2020) *Masterplan Schienenverkehr*.

Bundesministerium für Verkehr und digitale Infrastruktur (2016) *Bundesverkehrswegeplan 2030* (BVWP 2030).

Bundesnetzagentur (2021). Market developments in 2020 under the constraints arising from the COVID-19 pandemic, in Bundesnetzagentur (ed) *Railway Market Analysis*. Bonn, Bundesnetzagentur.

Bundesnetzagentur (2023) *Marktuntersuchung Eisenbahnen 2022*, Bonn, Bundesnetzagentur.

Sources

Burnett, A. (2022) Deutsche Bahn. A disaster: How did train travel in Germany get so bad?. *The Local Europe AB,* Available at https://www.thelocal.de/20220818/a-disaster-how-did-train-travel-in-germany-get-so-bad.

Gausemeier, J., Pfänder, T. & Lehner, A. (2017) Strategische Unternehmensführung mit Szenario-Management, in Spath, D., Westkämper, E. & Warnecke, H. (eds) *Neue Entwicklungen in der Unternehmensorganisation: Strategien, Planung, Umsetzung,* Berlin, Heidelberg, Springer Vieweg, pp. 97–109.

Gräßler, I., Scholle, P. & Thiele, H. (2020) Scenario Technique, in Vajna, S. (ed) *Integrated Design Engineering: Interdisciplinary and Holistic Product Development,* Cham, Springer International Publishing; Imprint Springer, pp. 615–645.

Hofmann, S. & Olnhausen, T. von (2017) Die Zukunft der Eisenbahn in Deutschland: Szenarien für das Jahr 2040, *IVP-Discussion Paper*, vol. 1, pp. 1–37.

Ifo-Institut (2023) *ifo Konjunkturprognose Frühjahr 2023: Deutsche Wirtschaft stagniert.* ifo Institut für Wirtschaftsforschung, available at https://www.ifo.de/fakten/2023-03-15/ifo-konjunkturprognose-fruehjahr-2023-deutsche-wirtschaft-stagniert.

Kasper, B. & Scheiner, J. (2003) Nahverkehrsplanung für ältere Menschen. Arbeitspapiere des Fachgebiets Verkehrswesen und Verkehrsplanung, Dortmund.

KCW GmbH (2019) *Railmap 2030. Bahnpolitische Weichenstellungen für die Verkehrswende*. Agora Verkehrswende, Berlin.

Neumann, L. & Krippendorf, W. (2016) *Branchenanalyse Bahnindustrie: Industrielle und betriebliche Herausforderungen und Entwicklungskorridore,* 331, Düsseldorf, Studie der Hans-Böckler-Stiftung.

Sources

Netzwerk Europäischer Eisenbahnen (2019) *Auf jeden Kilometer Eisenbahnneubau kommen 150 Kilometer mehr neue Straßen als Schienen seit 1994 – Investitionsprioritäten müssen verändert warden.* Pressemeldung (30. April 2019), available at https://die-gueterbahnen.com/news/auf-jeden-kilometer-eisenbahnneubau-kommen-150-kilometer-neue-strassen.html#:~:text=Auf%20jeden%20Kilometer%20Eisenbahnneubau%20kommen%20150%20Kilometer%20neue%20Stra%C3%9Fen,-Die%20Politik%20hat.

Popp, R. & Zweck, A. (eds) (2013) *Zukunftsforschung im Praxistest*, Wiesbaden, Springer VS.

Reinhold, T. & Kasperkovitz, G. (2013) Eisenbahn in Deutschaln 2025 - Zukunfstperspektiven für Mobilität und Logistik, in Popp, R. and Zweck, A. (eds) *Zukunftsforschung im Praxistest,* Wiesbaden, Springer VS, pp. 299–319.

Resch, H. (2015) *Branchenanalyse: Zukunft des ÖPNV: Entwicklungstendenzen und Chancen*, Düsseldorf, Hans-Böckler-Stiftung. Available at http://hdl.handle.net/10419/125789.

Riener, A., Appel, A., Dorner, W., Huber, T., Kolb, J. C., & Wagner, H. (2020) *Autonome Shuttlebusse im ÖPNV: Analysen und Bewertungen zum Fallbeispiel Bad Birnbach aus technischer, gesellschaftlicher und planerischer Sicht* (p. 206). Berlin, Springer Nature.

Ross, S. (2001) *Strategische Infrastrukturplanung von Schienenverkehrsunternehmen: Entwicklung eines Planungs- und Entscheidungsmodells für die Deutsche Bahn AG*, Wiesbaden, Deutscher Universitäts-Verlag.

Rothengatter, W., Zhang, J., Hayashi, Y., Nosach, A., Wang, K., & Oum, T. H. (2021) Pandemic waves and the time after Covid-19–Consequences for the transport sector. *Transport Policy*, vol. 110, pp. 225-237.

Sources

Sozialdemokratische Partei Deutschlands (SPD), BÜNDNIS 90 / DIE GRÜNEN and Freie Demokraten (FDP) (2021) *Mehr Fortschritt wagen. Bündnis für Freiheit, Gerechtigkeit und Nachhaltigkeit: Koalitionsvertrag 2021 - 2025 zwischen SPD, BÜNDNIS 90 / DIE GRÜNEN und FDP*.

Spath, D., Westkämper, E. & Warnecke, H. (eds) (2017) *Neue Entwicklungen in der Unternehmensorganisation: Strategien, Planung, Umsetzung*, Berlin, Heidelberg, Springer Vieweg.

Tardivo, A., Carrillo Zanuy, A., & Sánchez Martín, C. (2021) COVID-19 impact on transport: A paper from the railways' systems research perspective. *Transportation Research Record*, 2675(5), 367-378.

Vajna, S. (2020) *Integrated Design Engineering: Interdisciplinary and Holistic Product Development*, Cham, Springer International Publishing, Imprint Springer.

VDV & Deutsche Bahn AG (2022) *Deutschland steigt ein. Abschlussbericht zur bundesweiten Marktforschung.* Verband Deutscher Verkehrsunternehmen e. V., Deutsche Bahn AG.