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Chapter 1

Issues and Challenges in Transportation



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Abstract Dynamics of society directly influence the demands for transportation. This paper elaborates this subject for the rail industry in the Netherlands. The paper explains how the market needs to continuously change the rail industry in the Netherlands and describes the current challenges for delivering world-class services for the rail operation.

Keywords Railways · Systems integration · Operations

1.1 Introduction

Society is evolving more rapidly all the time. In the Netherlands, the densely populated Randstad is increasingly encroaching into large surrounding cities. In addition, the economy is growing. Demands for mobility are therefore growing as well. Large cities are expanding, face a significant housing challenge and require good public transport connections.

Sustainability, including that of international transportation, is becoming more and more of an issue in terms of energy consumption, CO₂ emissions, re-use of materials and noise. Autonomous self-driving (electric) cars are on the way that will undoubtedly have an impact on rail transport. On the other hand, trains still have the advantage of transporting many people to and from city centres simultaneously via high capacity corridors. Many modes of mobility will eventually become interconnected as we move to “mobility as a service”.

Technological developments in the field of digitisation, automation and robotisation are more and more far-reaching and reinforce one another. For example, the

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exponential increase in mobile networks, cheap internet, big data, smart devices and artificial intelligence. Passengers expect more and more in respect of travel information, service, ease of paying and “experience”. To an increasing extent, these new systems produce data that can be converted into useful information for analyses, process improvements and product and service development. These technical developments make it easy for a growing number of parties to enter the mobility market.

Whereas the rail network was split up in the nineties, there is now a specific need for horizontal chain cooperation between user, operator, suppliers and sub-contractors. With the ever-increasing demand for transport, vertical, technical and operational system integration of infrastructure, rolling stock, people and processes is important for the introduction of new systems such as European Rail Traffic Management System and Automatic Train Operations, for example.

1.2 The Organisational Development of NS (Netherlands Railways) and the Rail Sector

Following European Directive 91/440/EEC to separate the organisation of railway infrastructure management and maintenance from the commercial exploitation of transport, the public limited company Nederlandse Spoorwegen (Netherlands Railways) in the nineties split into a commercial NS Group and three executive bodies, namely Railinfrabeheer, Railned and Verkeersleiding, which later merged into ProRail. ProRail is commissioned by the government to bear responsibility for construction works, management and maintenance of the rail network. The supervisory role for the Dutch railway industry was removed and housed independently within the Human Environment and Transport Inspectorate.

NS Group was allocated the broad portfolio of commercial activities and divested itself of non-core business activities (railway infrastructure, goods transport and telecoms). The core tasks of passenger transportation (including maintenance of rolling stock), station operations, interchange and real estate development at railway junctions complement one another to support the mobility agenda. Transport on regional networks is publicly tendered by local authorities and awarded to private parties such as Keolis, Qbuzz and Arriva.

Because of this reorganisation within the rail sector, the future of the company was uncertain due to political debate about award of the concession, which revolved primarily around the optimal balance between public and private interests. The NS operating companies devoted too much attention to pursuing their own objectives and there was insufficient focus on integral cooperation in the chain. By focusing on Return on Investment, management lacked sufficient focus on operational processes, quality of service delivery declined and punctuality fell to below the 80 percent standard. The president, the director of Internal and External Affairs and the entire supervisory board resigned at the start of the century.

Subsequently, a new NS management focused on five key objectives in order to improve basic quality: punctuality, service delivery and information provision, working on social safety, provision of adequate transport capacity, and ensuring clean trains and stations.

In addition, there was insufficient focus on cooperation in the chain and system integration by the so-called institutional trilateral consisting of the Ministry of Infrastructure and Water Management (framework and supervision), the railway infrastructure manager (ProRail) and transport providers (NS and others) (van Dongen 2015a, b).

The government conceded that maintenance of the rail network was overdue and now invests robustly in maintenance and renewal of the railway infrastructure by ProRail (Concession and Transport Plan for the Main Rail Network 2015–2025). NS was awarded the concession for the primary rail network and over three billion euros are being invested in new stock. The introduction of new stock did not go smoothly because of insufficient focus on system integration and cooperation with suppliers in chain. For a long time, there were teething problems with the introduction of the Sprinter Light Train and the Fyra project with SNCB (Belgian railways) on the high-speed line failed. It is impossible to specify everything in detail in advance in the development and design of a complex installation and it is inadvisable to place full responsibility with the supplier. The supplier must be held accountable for the technical quality of the design, but the extent to which the installation fits into processes is the shared responsibility of the client and contractor. For that reason, now there is close collaboration on current orders of rolling stock with suppliers such as Flirt (Stadler), Sprinter Nieuwe Generatie (CAF) and Inter City Nieuwe Generatie (Alstom) to ensure quality and reliable deployment of stock in transport operations.

Partly influenced by the results of the Parliamentary Committee that investigated the failure of the Fyra project, the Inspectorate changed its task from purely assessing compliance with legislation and regulations to risk and information-driven methodology with consideration for social interests. The focus is shifting to monitoring the social impact of technological and other developments in the context of the legal basis. This is leading to a change in the relationship with the supervised rail infrastructure manager and transport provider(s), aimed at improved cooperation in the chain and system integration while retaining the purity of the role of the supervisory body. Nowadays this development within the institutional trilateral is in full swing.

There is more and more focus on system integration and parties work together more intensively than during the period of autonomisation and splitting up of the NS corporation. Implementation of operational improvements in recent years means that frequency of trains along the large corridors has doubled and punctuality has increased to over 93% percent. Putting customers first, door-to-door travel and sustainability are important themes within the national scope of NS activities.

With the increased density of trains on the rail network (an intercity train every 10 min), management of transport and maintenance operations have been “merged”: transport and maintenance logistics are so closely interwoven that a single model of operational management, planning and (re)scheduling is appropriate. The statutory

Table 1.1 Data for Netherlands Railways main rail network

Key figures HRN	Unit	Intercity	Sprinter	2017
Costs HRN	Million			2.400
Costs per train kilometre	Euro			18
Passenger kilometres	Billion	14	4	17.9
Train kilometres	Billion	78	50	128
Passengers per train		180	80	40
Speed	Km/h	83	58	71
Full-time employees				17.071

board responsible for day-to-day operational management of NS now consists of a Commercial and Development Directorate and an Operations Directorate.

NS develops an annual transport plan within the concession with the following current policy objectives:

- Continuous commitment to reliable operational management;
- Further disclosure of data and transparency about performance;
- Strengthening of regional cooperation (Table 1.1).

1.3 NS and ProRail's Investment Programmes

There are currently 2.2 million passenger trains in the Netherlands per annum. Together, they cover 165 million train-kilometres per annum. Fifteen years ago, that was just 129 million train-kilometres per annum (NS Annual Report 2017).

NS is investing in new Sprinters. 58 Flirt type trains from Stadler were taken into service in the 2017 timetable. 206 Sprinters have been ordered from CAF and will be deployed from 2019 to 2022. These trains comply with the latest strict technical criteria, are energy efficient, have low floors for level platform-train access, and are equipped with wide doors and sliding steps for easy accessibility. This expansion of the fleet means 45,000 additional seats for NS.

NS ordered 79 new single-decker Intercity trains from Alstom, which will be taken into service in the 2021 schedule. These trains have a total capacity of 25,000 seats and will be deployed on both the regular rail network and the high-speed line (200 km/h). The trains are equipped with electrical sockets, Wi-Fi, air-conditioning and wheelchair-accessible toilets. In terms of safety, the trains are equipped with ERTMS and ATBvv. A cross-border variant to Belgium is being investigated (Pro Rail Annual Report 2017).

NS is modernising 80 double-decker trains with 415 coaches under own management. The design of the trains is being adapted to the changing needs of passengers, for example, "comfortable" seats and a sofa, and led lighting that adapts to daylight.

An energy-efficient air-conditioning system and closed toilet systems with bioreactor have also been installed. Preparation is underway for modernisation of the next sub-series (another 45 units with 244 carriages).

NS has committed at least three billion euros to the abovementioned investments in rolling stock. The new generation of NS trains has low floors for level access to the platforms and therefore have many installations on the roof. That means platforms have to be used in the workshops so that engineers can work at the correct height ergonomically and safely. Hydraulic platforms will be required and train washing systems will have to be adapted at the service locations. Specific tools will have to be purchased where necessary. This is how maintenance hardware for new trains is being organised. NS invests 275 million euros in maintenance equipment.

The innovation and expansion of stations and the railway infrastructure is a response to the growing and changing demand for mobility: greater transfer capacity at stations and capacity on the lines. The state budget for management, maintenance and renewal of the railway infrastructure amounts to 1.3 billion euros annually, and 700 million euros for expansion and newbuild.

By order of the Ministry of Infrastructure and Water Management, ProRail has invested robustly in “world class stations”: Rotterdam, Delft, Den Haag Centraal Station, Amsterdam Centraal, Utrecht, Arnhem, Breda and Eindhoven, with excellent provisions and connections to other modes of transport.

With the 2018 timetable going into effect, there are Intercity trains running between Amsterdam and Eindhoven every 10 min. The same frequency of trains is also planned for the Schiphol–Nijmegen and Breda–Eindhoven lines in future. Expansion of infrastructure capacity is being achieved not only with quadruple-tracks and flyovers, the “flow capacity” of large stations is also being increased with fewer cross-linked approach and departure routes. Utrecht, the ultimate railway junction of the Netherlands, connects millions of train passengers on their journey through the country. Thanks to new straight railway tracks around the station, there is space for more trains and reliable rail transport. There are now fewer railway switches around Utrecht Centraal: only 60 of 186 remain. Trains thus have a fixed arrival and departure track and can arrive and depart more quickly. An additional benefit is that problems on one track do not affect other lines. This benefits the robustness of the time table. Similar improvements are underway in Amsterdam.

With the larger fleet of rolling stock in the Netherlands, there is a shortage of stabling capacity in several places and expansion is being achieved by building physical rail capacity on one hand, and making more efficient and effective use of available capacity on the other.

NS and ProRail plan to invest in new technology, such as ERTMS and 3 kV, together.

1.4 Future Concession and Product Development

The government awarded NS the concession for the main rail network for 2015–2025. The primary rail network roughly comprises the railways to and from large Dutch cities that are connected by intercity services and local train services.

Product agreements have been made in this concession in terms of door-to-door transport, passenger comfort and travel information, safety, punctuality, sustainability, capacity and growth. NS is required to report on this integral performance transparently. Cooperation with infrastructure manager ProRail has also been agreed, not just in terms of the abovementioned objectives, but also in respect of investments, developments and innovation, such as the introduction of ERTMS and upgrading of energy provision to 3 kV, for example. Consumer advocacy organisations also play an important role in this concession: active and constructive input, involvement in product development and transparent insight into the development of Key Performance Indicators. Effective cooperation with decentralised authorities is important. That concerns the transport product and related activities related to door-to-door travel, including for example, night-time demand for services, new stations, enhancement of the station environment, bicycle facilities and parking spaces. Not only does it concern local needs in large cities, but effective cooperation with the regions and coordination of the wider transport offering with regional transport providers, with or without converging lines: development of (integral) timetables, pricing agreements, public transport payment system and validity of tickets.

Concession agreements about product developments have also been made in respect of longer term developments: bicycle facilities at stations and on trains, accessibility for passengers with disabilities, toilet facilities on trains and at stations, development of the fleet, such as newbuild and modernisation. Long-term agreements also include capacity on the railways, such as increasing the frequency of trains along the most important corridors (Eindhoven–Amsterdam, Schiphol–Nijmegen and Breda–Eindhoven), integration of train services on the high-speed line and primary rail network, installation and servicing of new stations, night-time services, short cross-border journeys and long distance international connections.

Every year, NS prepares a transport plan with up to date objectives and KPIs (see Table 1.2).

NS is led by three core passenger needs in terms of day-to-day operations and product development:

- Control: “I have power/control over my own time and journey”. Punctuality in terms of a reliable schedule and good train, bus, tram and metro connections. An acceptable and predictable chance of finding a seat during peak and off-peak times. Reliable door-to-door travel information and passenger information with a view to informing action in the event of disruptions.
- Value: “I feel valued by NS”. Hospitality provided by approachable, friendly, professional employees on trains and at stations. A clean and pleasant travel environment. Positive interaction with readily available personal service provision: service, shops, and customer services, in person or online.

Table 1.2 NS concession KPIs for 2019

Performance indicators	Base value (%)	Achieved 2018 (%)	2019 goal (%)
General customer rating for the main rail network	74	85.6	80
General customer rating for the high-speed line	68	83.4	73
Punctuality of the main rail network within a 5-minute margin	88.9	92.6	91.1
Passenger punctuality on the high-speed line within a 5-minute margin	82.1	82.5	84.1
Information about disruptions on trains and at stations	75	85.2	80
Travel information about the rail network	81.4	85.0	83.1
Availability of a seat on the primary rail network in rush hour	94.3	95.1	95.5
Seat on the high-speed line in rush hour	91.2	94.0	94.9
Quality of NS connections to other providers	94.0	95.8	95.6
Customer rating for social safety on trains and at stations	81	89.9	83

- Freedom: “I can go anywhere and make good use of my time”. World-class stations with good transfer, chain, accommodation and commercial facilities. Seamless travel with quick door-to-door transport and easy access to all public transport and chain services. Appealing use of time with facilities that enable productive use of time (Wi-Fi and “quiet” seat arrangement in coaches), or a pleasant stay, such as time for reading, inspirational outings and experiences.

In the context of management of the concession, protocols have been established in relation to accountability information and frequency of consultation.

NS has a company-wide safety system with the relevant certification. NS has certified quality systems in place in the maintenance and asset management domain (ISO 9001 and ISO 55000). NS has developed a dedicated strategy for safeguarding the production quality of new stock. This strategy is based on the principles of risk-oriented prioritisation, early engagement, early recovery and active relationship management in addition to pure contract management. This strategy has been adopted by the Human Environment and Transport Inspectorate and is part of a proposal to improve roadworthiness.

In addition, NS participates in the International Round Rail Table, a partnership initiative between a number of rail companies and rolling stock suppliers with the objective of reducing the Total Cost of Ownership of rolling stock with shorter lead

times, standardised stock configurations, simple customisation and process improvements aimed at extending the service life of new rolling stock.

In the transport domain, NS is developing the certified safety management system into an integral quality management system aimed at quality of the transport process. To remain on track, NS also regularly evaluates various elements of operational management against benchmarks from other businesses.

The 2019 midterm review of NS performance for the current concession and in preparation for a future concession takes place from the start of 2020: the current 2019 KPIs, completion of agreed programmes, bedding down of HSL traffic and the consequences of decentralisation of local train services. A decision about the award of the concession for the main rail network in 2025 and beyond will take place based on this evaluation.

1.5 Attractive Physical Offering and Customer Journey

For NS, “the passenger comes 1st, 2nd and 3rd”. They have a primary rail network schedule that meets their need for a seamless, robust door-to-door journey. Physical accessibility, real-time availability of relevant information, ease of payment, service and social safety are priorities for the customer’s journey (Fig. 1.1).

Passengers need to be able to rely on arriving at their destination on time. Current passenger punctuality within a 5-minute margin stands at over 93% thanks to a robust timetable and fine-tuned operational processes. It is a challenge to maintain that with the high-density train programme (an intercity train every ten minutes). The first step of implementation on the Eindhoven–Amsterdam line was successful. This high level of punctuality and high density of trains on the network (5500 trains daily) puts the NS amongst the Top 3 in the world. See the benchmark in Fig. 1.2. Quality of connections to other transport providers stands at 95%, thus delivering and an important contribution to a predictable journey.

1.3 million customers travel on the main rail network every day. The probability of finding a seat with the current capacity of 250,000 seats is 95% thanks to higher

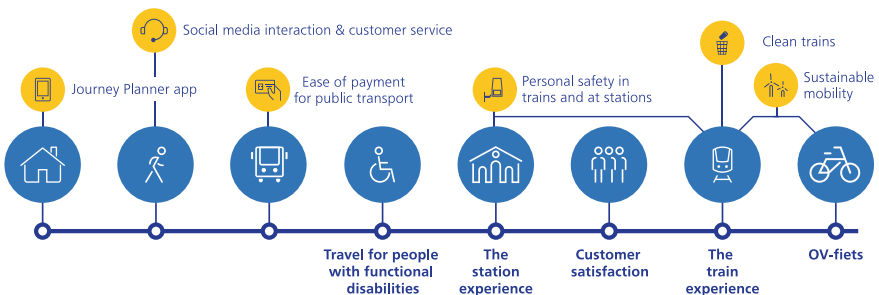


Fig. 1.1 Customer journey (NS Annual Report)

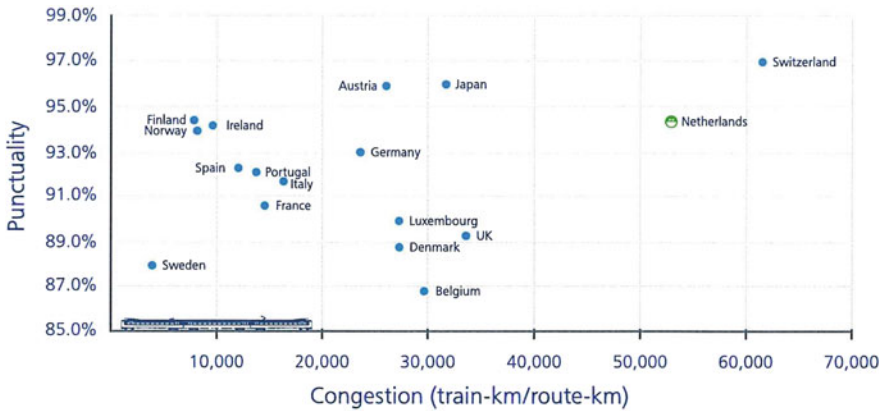


Fig. 1.2 Punctuality (NS Annual Report)

frequency of trains and longer trains, facilitated by expansion of the fleet. Passengers are continually updated on congestion and provided with travel advice via the NS App.

Thanks to these performance levels, 86% of passengers give a customer satisfaction score of 7 or higher, up from 75% in 2010 and 67% in 2005. Contributing to this result are the hospitality of staff on trains and at stations, clean trains, waiting area facilities and retail outlets at stations, good customer service, webcare and ease of payment. The reputation of NS is evaluated constantly according to the RepTrack method based on how the public views the best-known companies. It can be used as an indication of the overall performance of rail transport across the Netherlands. The RepTrack Pulse score has risen from 50 to 62 in the last 5 years.

1.6 Sustainability and Safety

With over 1.5 million journeys and visits to stations daily, NS has a great impact on society in terms of mobility, safety, emissions and spend: sustainability is therefore important! The environmental footprint is largely determined by energy consumption and waste generated at stations, from trains and from workshops.

NS is one of the biggest consumers of energy in the Netherlands: 90% for running the trains and 10% for buildings and facilities infrastructure. Since 2017, electric trains in the Netherlands produce no CO₂ emissions on balance, because the energy is generated by wind farms in the Netherlands, Belgium and Scandinavia (in a multi-annual contract with Eneco). The whole rail sector in the Netherlands participates in this scheme, because NS procures green energy on behalf of VIVENS, which comprises: ProRail, Arriva, Connexion, Kombi Rail Europe, DB Schenker, ERS Railways, HSL Logistik, Rotterdam Rail Feeding and Ruhrthalbahn Benelux.

NS has a multi-annual agreement with the government to save 2% energy annually. The objective is to be 35% more energy efficient in 2020 than in 2005. Meanwhile, the meter stands at over 30%. The best way to reduce energy consumption is to increase the rate of occupancy on trains: transport more people at times when there is space on the trains, for example, by encouraging off-peak travel with cost-effective subscriptions. Other measures have been implemented, such as energy efficient stabling (lights and heating off) and transport operation (switching off of the traction in time for coasting before braking). Development of the fleet with the decommissioning of old stock and introduction of new, more energy efficient stock is contributing to this objective.

New technical centres and workshops that are being built are BREEAM certified.

NS generates 18 million kilograms of waste from workshops, stations, trains and offices annually. The Green Deal Afval agreement was signed with ProRail and the Ministry of Infrastructure and Water Management. Over 80% of waste is separated at workshops. The volume of waste at stations and on trains is being reduced by distributing fewer newspapers and 25% of waste is separated for re-use.

86% of “old” train materials are re-used in the modernisation of trains: the frame, insulation, doors, screens, dashboard panels, destination guides, steps and wind-screens. Parts that cannot be used in modernisation, such as interior components and upholstery, are stored in the warehouse as spare parts for the old fleet. Components that need to be disposed of are separated for recycling. Between re-use and recycling, 95% of materials are given a second lease of life. Review periods are monitored critically in cyclical maintenance: for example, if a supplier prescribes an axle overhaul after eight hundred thousand kilometres and that can be extended to over a million kilometres based on maintenance research, it saves on components and materials.

NS has a single harmonised safety management system in place for the whole organisation geared towards railway safety. It describes all safety-relevant processes in a clear and consistent way, which promotes railway safety. The Human Environment and Transport Inspectorate conducted an evaluation and NS obtained certification on that basis. NS is thus prepared for the changes that will be implemented with the so-called Vierde Spoorwegpakket (fourth railway package) in the coming years via European legislation.

With the increasing density of trains on the network, NS is obliged to invest in further expansion of the ATB train safety system. Over and above that, work is underway to generate greater awareness amongst employees, innovations in the driver’s compartment and communication with employees about work load, concentration and distractions during work. Braking criteria (use of the emergency brake when approaching a red signal) on Intercity trains are also being tightened up. ORBIT has also been introduced: a system that warns drivers if they are approaching a red signal at an excessive speed. These measures are necessary for preparation for the introduction of ERTMS (European Rail Traffic Management System) and ATO (Automatic Train Operations). New technology is making it possible for different systems to communicate with one another: the next step in safety and reliability of the train service.

1.7 Future Developments

The mobility landscape will evolve rapidly in the coming years. New forms of transport (self-driving, automatic, demand-driven and electric) transport on the roads, in bus lanes and on the railways will be a seamless part of a single, integrated mobility system. ICT, digitisation, big data and interconnectivity are facilitating these developments. In addition, younger generations will experience a shift from ownership of capital assets to collective use thereof: mobility as a service! The provision of good connections according to the needs of passengers, companies and institutions is a challenge on an (inter)national scale.

NS is working with transport partners ProRail and the Ministry of Infrastructure and Water Management on implementation of the Lange Termijn Spoor Agenda (Long-term Rail Agenda): the Programma Hoogfrequent Spoor (High Frequency Rail Transport Programme) with an increase in frequency to 6 trains per hour on the most important intercity lines. Under the auspices of the Mobility Alliance, organisations from the bicycle, car, bus, taxi, tram, metro and train domains are working together, not just in the Randstad Area (Amsterdam, Rotterdam, The Hague and Utrecht), but also in the adjacent large cities and regionally. Apart from an improved physical connection between different modes of transport, integrated travel planning and information provision are facilitating quick and easy door-to-door travel.

The European Commission approved the fourth railway package in 2016. This aim of this package is to revitalise the rail sector through the creation of a single market for rail transport services on one hand and to remove the technical and administrative limitations of cross-border traffic on the other. The rail sector is thus being made more competitive. The fourth railway package consists, amongst others, of a review of the Directive on the interoperability of the rail system (EU 2016/797) and the Directive on railway safety (EU 2016/798) and provides for the establishment of a European supervisory body, the European Railway Agency (EU 2016/796). This has brought about a new way of operator licensing (one stop shop) and issuing of a single safety certificate. There is particular emphasis on promoting a culture of safety and harmonised, integrated Europe-wide ERTMS certification.

1.8 The Framework for Success

Given investment levels, deadlines for completion, lifespan and sustainability, it is inevitable that the relevant parties, such as government, political, consumer advocacy organisations, supervisory bodies, transportation companies and suppliers treat one another's strategic interests with respect: ultimately, product development comes about in those circles. We divided them into four categories of user, operation, technology, and supplier in our previous study as shown in Fig. 1.3. The study concluded that a close cooperation between these parties is a key to success (Rajabalinejad and Van Dongen 2018). A successful cooperation requires a clear set of goals for all

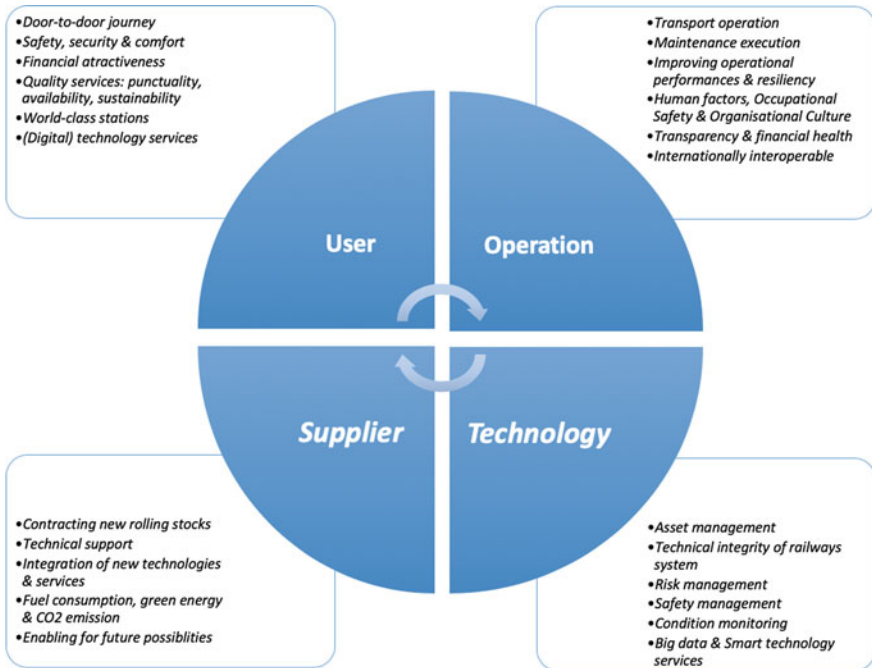


Fig. 1.3 Key factors for a successful transport system (reproduced by permission, Rajabalinejad and Van Dongen 2018)

the parties and close cooperation to achieve them. In other words, cooperation in the operational domain is the key demanding for openness, communication between one another, and promotion of long-term relationships in order to encourage collective innovation of product, process and technology. A focus on shared interests and opportunities as opposed to individual gain and risks will make the difference and assure success.

Although close cooperation is the key for delivering proper services, it should move towards co-creation in order to achieve a set of goals which are ultimately (almost) equally important for the public. In other words, co-creation presents a higher level of maturity in collaboration. Furthermore, these objectives are not static and require dynamic strategies and a resilient approach. Digital services are example services which are becoming continuously more important.

1.9 System Integration Is Inevitable

The previous paragraphs outlined essential cooperation across the axis of product, process and technology delivered by installation suppliers: “horizontal” cooperation

in the chain, with the increasingly compelling external influence as a result of market demands in respect of product quality and thus also on processes and technology (Fig. 1.4).

An integrated approach in the technical domain also plays an important role in cooperation: “vertical” system integration! Increasingly, rolling stock is becoming less of a “standalone” asset: consider the different elements of interrelated arenas: infrastructure, processes, people, IT and cyber security (Rajabalinejad 2018). With the forthcoming digitisation and technical complexity of installations, the independence of suppliers is increasing. Faster and faster developments in these interrelated arenas, coupled with forthcoming digitisation, are placing increasing demands on the flexibility of legislation and regulations. By definition, this trend follows reality and leads to more complex processes that have a strong influence on shaping cooperation in the chain and system integration.

The following have been integrated in the NS domain in past years: rolling stock, people, resources, methodologies and materials. More and more integration is taking place across the piece with a view to the future: an integrated railway transportation system. This integrated railway transportation system also consists of a logistics planning process with three assets (stock, infrastructure and personnel) connected by processes and procedures. Integration issues arise at different levels within the transport system (technical systems in rolling stock, technical interaction between trains and infrastructure, the interaction required between technology, people and procedures to run the trains and the interaction of moving trains with their environment). The growing complexity of these interactions due to technological developments, amongst others, is increasingly difficult to manage within the confines of a single organisation. Organisational boundaries are more likely to present obstacles than to facilitate solutions. Cooperation, therefore, needs to be shaped differently than in client-supplier relationships, for example, by working in networks.

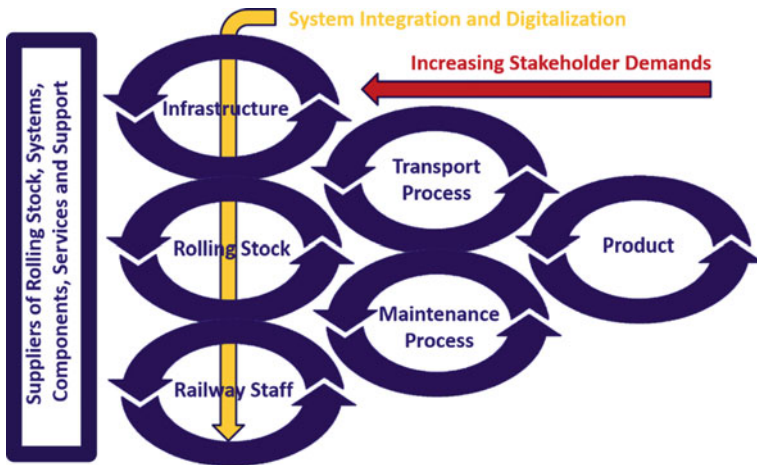


Fig. 1.4 Integrated transport system

By way of illustration, consider the collective interests of ProRail and NS, the Ministry of Infrastructure and Water Management and other transport providers in ERTMS, the 3,000 V study and Wheel-rail Conditioning, which is being trialed on Flirt as a potential replacement for Sandytte. These are examples of system advances that will have a big effect on the transport domain. System advances that are essential because the current infra system is pushing its technological boundaries. Classic technology is also undergoing a shift in interests with the increasing axle loads of Double Decker New Generation and axle counters in train detection, for example. There are solutions in the offing with Hallbusch bearings in bogies: to be provided in new, modernised units. In the maintenance domain, NS is progressing to condition-based maintenance with Real-Time Monitoring of the fleet. NS is working with ProRail on the Camino Rail project to monitor and evaluate the condition of the infrastructure with standard trains. This could produce an important spin-off for RTM across the entire railway system.

In the longer term, work is underway on the Prognostics and Health Management of the fleet of rolling stock: for example, assessment of axle-bearing condition in the field.

The University of Twente received a subsidy from TKI High Tech Materials and Systems for the “Systems for Railways Advancement” project. It concerns broad system integration, not just technology in infrastructure and stock, but in processes too: human factors, decision-making and knowledge acquisition and sharing.

In addition to cohesion in terms of infrastructure, train IT is increasingly being integrated with ground-based systems. The cyber security strategy requires the right division of tasks and responsibilities, translated further into information technology, operational technology (of the train) and the mobility chain. Besides, this digitisation and complexity of systems requires reflection on the manner in which knowledge and continuity of operational management are safeguarded in collaboration with suppliers.

1.10 Conclusions

The chapter presents an overview of the challenges for a frontier railway operator, the Netherlands Railways. It concludes that successful operation roots in proper organisational structure, political supports, and trans-organisational collaboration. It seems that future demands for mature collaboration, and all the stakeholders will need to work together to achieve their shared objectives. Furthermore, systems integration becomes continuously more important, and it enables delivering state-of-the-art services.

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