



**Brockmann & Büchner**

# Condition-Based Monitoring - A Maintenance Philosophy of the Future

*- Technology Focus: Condition-Based Monitoring*

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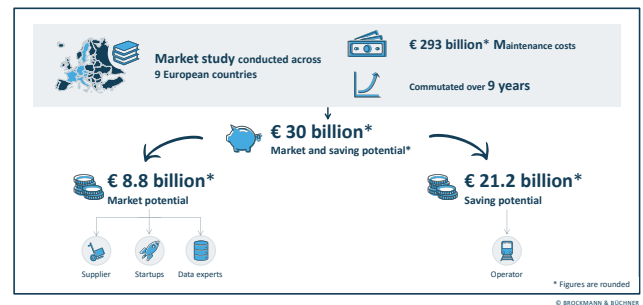
## The Future of Maintenance

Reactive or corrective maintenance practices are becoming outdated, making way for predictive maintenance and condition-based monitoring (CBM), which have now become a prominent trend across various industries, including rail. While regular check-ups remain essential, the integration of smart sensors and artificial intelligence has revolutionized the planning, acceleration, and cost reduction of maintenance processes. CBM technologies play a crucial role in automatically and continuously monitoring the condition of components and systems in real-time. The primary objectives are to enhance their availability and reliability, prevent failures, and minimize material and energy consumption. A wide array of parameters, such as vibration, pressure, and temperature, are meticulously recorded and analyzed through methods like acoustic noise and ultrasound analysis, thermal sensors, image and video material, laser-based systems, RFID, ground radar, as well as current or voltage analysis. CBM serves as a foundation for further digitization and automation within railway operations, opening up a field of new business models. As this field continues to grow, it promises to bring transformative changes to the rail industry, making it more efficient, reliable, and technologically advanced.

### Saving Cost with CBM

In a comprehensive market study conducted in early 2021, we discovered that the adoption of CBM technologies holds the potential to generate substantial savings, amounting to €30 billion in maintenance costs. This impressive figure represents the cumulative financial benefits projected over the next nine years (2022-2030) in nine European countries, namely Germany, France, Italy, the UK, Switzerland, Austria, Sweden, the Netherlands, and the Czech Republic.

Almost a third of this sum (€8.8 billion) will be directed to market players developing and selling CBM technologies and solutions to operators – startups, larger suppliers, and data experts. The remaining €21.2 billion will be the benefit of the operators after the deduction of costs and investment in the roll-out of such technologies.



## Revolutionizing Asset Maintenance

Since the industrial revolution, significant transformations have occurred. Machines and assets now face higher expectations, necessitating enhanced performance, increased flexibility and reduced failure rates. Owners and operators of fleets and infrastructure alike demand not only improved durability but also access to more comprehensive information. The process involves gathering operational data, generating alarms in the event of malfunctions, and delivering actionable insights:

- Where is the problem?
- How severe is it?
- Where and how do I need to intervene first to solve the most urgent problem in the most efficient way?
- What if I want to achieve the best possible outcome, but with the lowest possible investment?

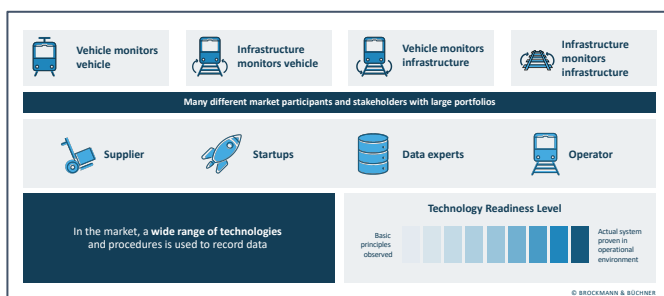
Real-time data is matched and compared with historical data, empirical values, and manufacturer instruction. Oftentimes operators set their own reference values and categorize deviations and anomalies according to their frequency and severity.

### How CBM Technologies are Redefining Inspection and Maintenance for Enhanced Efficiency

However, the heaviest workload is technically with the machines and systems themselves. Many innovative companies and startups have specialized in teaching or equipping assets so they can 'speak' and issue information that is collected, analyzed, and comprehensibly visualized. With the help of sensors and artificial intelligence, vehicle systems such as brakes, bogies, or drive systems, but also HVAC and sanitary systems, can monitor their own health and report wear and tear as well as defects.

Inspection and maintenance schedules can be adjusted and complete failure as well as costly interruption of the train operation avoided.

The same applies to components and systems of the railway infrastructure which are being equipped with CBM technologies to monitor track position, longitudinal and transverse profiles, switch tongue, overhead line, and more. Limmat, for example, develops smart infrastructure solutions. Using big data, machine learning, and the Internet of Things, the Spanish startup built a CBM platform that enables infrastructure and vehicle operators to anticipate faults and improve efficiency in maintenance, availability, and railway safety. This platform, called IMAS+®, integrates different specialization modules tailored to a variety of fields such as signaling and communication, electrification, rolling stock, infrastructure, and track components. Users can choose from different levels and use IMAS+® to digitize, monitor, and/or predict operational deficiencies and problematic conditions, thereby improving their maintenance decision-making process.



## Synergies Between Trains and Infrastructure

Some of the above-mentioned use cases become relevant again, when both infrastructure and passing trains monitor each other. Through wayside monitoring ('infrastructure monitors vehicles') dirt and graffiti can be detected and the condition of train wheels and pantographs assessed. When 'vehicles monitor infrastructure', vegetation control can be automatized and gravel movement, sleeper cracks or threshold breaks detected.

In all four areas, there exists a plethora of use cases, with some already being served by multiple vendors, while others have yet to be extensively addressed, offering significant potential for new digital business models. Certain components, such as pantographs and overhead lines, can be

monitored by both the vehicle and the infrastructure. In contrast, other use cases are exclusive to a single stream, such as the plumbing system or rail-specific cases. As developers work towards meeting the rail requirements, solutions may vary in terms of their readiness level. These challenges highlight the complexity of catering to diverse needs within the rail industry.

## CBM Emerges as Vital Component for Rail Industry

To correctly prioritize use cases before choosing and implementing solutions, operators consider several dimensions: potential maintenance cost savings, the complexity of the solution development and integration, and the effects the new technology and process may have on the operation overall. Guided by different motives, their approaches and evaluations of these use cases are not necessarily comparable. Nonetheless, it is evident that CBM has evolved into a critical aspect of the rail industry and, as digitization and automation strategies continue to advance, will soon become indispensable parts of rail operation worldwide – if they are not already.

## Limmat

Limmat is a technology startup based in Spain specialized in digitizing and optimizing the efficiency of infrastructures, with a particular focus on rail systems. Their core product is IMAS+®, a condition-based maintenance system that utilizes advanced analytics and machine learning to predict maintenance needs, reduce downtime, and improve overall asset management efficiency. Limmat's cutting-edge technology enables railway operators to optimize their maintenance schedules, detect anomalies in real-time, and make data-driven decisions to enhance safety and operational performance. Committing to innovation, sustainability, and customer satisfaction, Limmat is at the forefront of leveraging new technologies to transform the railway industry and industrial infrastructure in Spain and beyond. Their team of experts has a wealth of experience in developing cutting-edge technologies and implementing them in real-world settings, making Limmat a leading player in the digital transformation of industrial infrastructures.



[https://limmat-group.com/en\\_us/](https://limmat-group.com/en_us/)

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## Rail Alliance – Shaping the Future

*The concept of a Rail Alliance is a general success factor to exploit the full potential of the rail industry and solve the individual challenges of the market participants.*

*Triggered by possibilities of digitalization and recent trends, the rail sector is more and more taking on a new shape. The combination of numerous market participants and stakeholders is further increasing complexity.*

*If this sounds interesting to you - visit us on <https://rail-alliance.network/>*