

PAPER • OPEN ACCESS

## Implementation Of Road Asset Management In Poland

To cite this article: Professor Adam Zofka and Andrzej Maciejewski MBA 2021 *IOP Conf. Ser.: Mater. Sci. Eng.* **1202** 012003

View the [article online](#) for updates and enhancements.

You may also like

- [Development of hydropower sustainability assessment method in Malaysia context](#)  
Faiz Mohd Turan, Kartina Johan and Nur Atiqah Omar
- [Text and Image: A new hybrid authentication Scheme](#)  
Noor Afiza Mohd Ariffin, Akram Abduljabbar Abdulhalem and Nor Azura Husin
- [The role of performance and self-assessment to determine students' science process skills in SMP Negeri 11 Kota Tangerang Selatan](#)  
F U A K Sejati, S Saputro and N Y Indriyanti



**ECS**  
The  
Electrochemical  
Society  
Advancing solid state &  
electrochemical science & technology

**DISCOVER**  
how sustainability  
intersects with  
electrochemistry & solid  
state science research

## IMPLEMENTATION OF ROAD ASSET MANAGEMENT IN POLAND

Professor Adam ZOFKA<sup>1</sup>, Andrzej MACIEJEWSKI, MBA<sup>2</sup>

<sup>1</sup>*Institute of Roads and Bridges Research, Warsaw, Poland*

<sup>2</sup>*General Directorate for National Roads and Motorways, Warsaw, Poland*

**Abstract.** Road asset management (RAM) is a crucial aspect in the development of transportation network. RAM framework should be understood as a rational approach to business model for road authority, which dictates its business processes in a systematic and objective-based manner to ensure that strategic goals of an agency are reached. In a case of road network, such objectives are typically related to travel safety, time and comfort that should be maintained throughout the life cycle of the road assets at optimal costs. As such RAM enables road agencies to meet expectations of its customers to provide safe and reliable road network in effective and efficient way. Nowadays it becomes even more important to adopt performance-based and data-driven approach for road agencies considering current trends in transportation like connected, cooperative and automated mobility.

There are many aspects of RAM including legal, economic, technical and managing aspects. These aspects are inter-connected and nowadays agencies build and incorporate RAM system to establish a common denominator for all agency activities at all organizational levels. This paper discusses selected aspects of RAM in Poland. Since national road network in Poland is relatively new, it is particularly important to go over well designed and detailed implementation process. It should comprise numerous items including self-assessment and gap analysis, change strategy and transportation asset management plan (TAMP). This paper present update on these activities as well as presents future plans in order to establish modern, effective and sustainable RAM framework in Poland.

**Keywords:** public services, accountability, value, asset management, asset management system, performance, risk, cost, optimisation

### Introduction

In the last 15 years Poland has invested tens of billions of Euros in the road infrastructure development, resulting in thousands of kilometres of new motorways and expressways. This huge investment programme is constantly carried out and in the recent years it has been enlarged into the separate programmes regarding construction of at least hundred bypasses, reconstruction of existing network aimed at improving of the road safety and rehabilitation and reconstruction of roads targeted to improvement of current network bearing capacity.

These efforts lead to defining of the possible future challenge in respect to the periodic maintenance regarding funding constraints recognised worldwide and already faced in the countries with extensive road network such as United States or western EU Member States.

For that reason Ministry of Infrastructure, General Directorate of National Roads and Motorways (GDDKiA) and Road and Bridge Research Institute (IBDiM) initiated the special project for defining of the method of the optimisation of the decision-making process regarding the road network rehabilitation and reconstruction.

Ultimately the project has been inaugurated at the end of 2018 by the consortium of the three aforementioned institutions and additionally Wrocław University of Technology.

Works within the project have been foreseen for 3 years, divided into two phases and seven assignments.

Phase A (which has been finalised in May 2021) was focused on the elaboration of the method for the planning of the periodic maintenance works which includes inter alia:

- definition of public services provided by the road network,
- establishment of the performance measurement framework
- root cause distress analysis and associated analytic hierarchy process
- deterioration forecasting models
- relation to the demand forecasting model
- approaches to incorporation of economic efficiency and risk management models
- optimisation model allowing for the multi-objective decision analysis.

Apart from the method Phase A was focused on the creation of the prototype of the set of tools supporting the method and the decision-making processes.

Phase B, which was initiated in June 2021 is focused on the piloting of the defined method and provided prototype and allows all involved parties for the revision of proposed computing models and modules with aim to formally approve the new approach by the end of the project (November 2021).



Concurrently to these the Ministry of Infrastructure carries out works on the revision of the legislation and regulations for the life cycle management of the road infrastructure assets, thus to have comprehensive asset management system for the road infrastructure including not only IT tools but first of all dedicated method, appropriately embedded within the internal business processes of the National Road Authority and aligned with the technical regulations.

## 1. Understanding of Asset Management

### 1.1. Accountability of public organisations for service delivery

To address the challenges of road sub-sector governance and to design solutions for better road network performance, these should be considered in the wider perspective of governance of the state. According to the United Nations glossary for Public Administration this may be defined as *“the exercise of economic, political and administrative authority to manage a country’s affairs at all levels. It comprises the mechanisms, processes and institutions through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and mediate their differences”*<sup>1</sup>.

According to the United Nations report on Responsive and Accountable Public Governance<sup>2</sup>, to enhance public sector responsiveness, it is crucial to focus on satisfying people’s expectations of quality, quantity and promptness of the public services delivered within limited resources available. Achievement of responsive governance depends on how policies, strategies, programs, activities and resources are anchored to people’s real needs.

In parallel, establishing strong governance and accountability is essential to delivery of expected goals. An accountable organisational culture deters waste and mismanagement of resources. Accountability for performance serves to guide, monitor and evaluate public institutions and programs, informing needed improvements. Therefore, building the capacity for financial and performance accountability builds trust for leveraging resources and safeguarding funds. For instance, the Office of the Auditor General of Canada defined five principles for effective accountability<sup>3</sup> that have been identified by as being a key to accountable governance:

1. Clear roles and responsibilities: The decision-making roles and responsibilities of the parties in the accountability relationship should be well understood and agreed upon.
2. Clear performance expectations: The objectives pursued, the accomplishments expected and the operating constraints to action, which include means, operating principles and procedures, human resource management issues and adequate financial control should be explicit, understood and agreed upon.
3. Balanced expectations and capacities: Performance expectations should be clearly linked to and balanced with each party’s capacities (authorities, skills and resources) to deliver.
4. Credible reporting: Credible and timely information should be reported to demonstrate what has been achieved, whether the means were appropriate and what has been learned (including reporting requirements, modalities, sufficient information for Parliament, etc.).
5. Reasonable review and adjustment: Fair and informed review and feedback on performance should be carried out by the parties, achievements and difficulties recognized, appropriate corrections made with appropriate consequences for the concerned individuals.

In addition, other institutions (such as Australian National Audit Office) emphasize the importance of shared risk management, both in terms of delivery of services and the management of any contract.

Therefore accountability denotes responsibility for results and outcomes, and not only processes (with their related inputs and outputs). When operating effectively, it serves to ensure that public governance can flourish, related institutions perform well, and services are delivered to citizens effectively and efficiently<sup>4</sup>.

Adoption of responsive and accountable of governance requires an organisation to re-asses its role in public services delivery and to address a number of challenges for the public sector, like:

1. Change of demographic profiles
2. Increasing customers’ expectations
3. Awareness of public services’ users and demand for greater transparency
4. Demand for greater transparency
5. Budgetary constraints
6. Global competition to attract investments

Achievement of these requirements for the good governance needs sound understanding of what are the public services and how they may be provided. Delivering public services may be based upon six key strategic enablers, as given below:

<sup>1</sup> <http://www.unpan.org/Directories/Glossary/tabid/1398/language/en-US/Default.aspx>

<sup>2</sup> World Public Sector Report, Responsive and Accountable Public Governance, 2015

<sup>3</sup> Accountability Audit Guide, Office of the Auditor General of Canada, August 2004

<sup>4</sup> Accountability Audit Guide, Office of the Auditor General of Canada, August 2004

1. Understanding the customer
2. Transparency
3. Removing silos between governmental/ public organisations
4. Building capacity
5. Improving the service delivery model
6. Continual improvement

The challenges involved in achieving these requirements include those listed in the following table.

Table 1. Challenges for the strategic enablers for the public services delivery (Source: Maciejewski 2020)

Strategic enabler	Challenges
1. Understanding of the customer	Customer focus is often challenged by public sector culture, hierarchical organizational structures and differing public sector priorities, whereas public agencies priorities need to be aligned to customer requirements.
2. Transparency	To ensure that customers may access information held internally by the organisation. Such information concerns the overall decision making processes - its basis, data taken into consideration, positions and opinions of citizens and both governmental and non-governmental organisations. Transparency therefore promotes good governance through holding government and key decision-makers to account what improves public policy, its effectiveness and efficiency.
3. Removing silos between governmental/ public organisations	This needs “connected government” expressed in common vision, supported by integrated objectives, outcomes or process flows. Key elements for “connected government” should include – <i>inter alia</i> – common service standards. It is vital to break down intra-agency silos before starting to break down cross-agency silos.
4. Building capacity	Capacity building main pillars are: <ul style="list-style-type: none"> <li>• long-term planning,</li> <li>• organisational and process design,</li> <li>• use of technology,</li> <li>• support for people and for the organisation</li> <li>• culture change in the organisation</li> </ul>
5. Improving service delivery model	To define the roles organisations should play: <ul style="list-style-type: none"> <li>• Policy maker,</li> <li>• Regulator,</li> <li>• Service provider.</li> </ul> To articulate: <ul style="list-style-type: none"> <li>• quality of service,</li> <li>• cost of service,</li> <li>• suitability of different service delivery channels for different customers segments.</li> </ul> To define: <ul style="list-style-type: none"> <li>• how technology may support to achieve the organization’s goals,</li> <li>• how public-private partnership can deliver targeted outcomes</li> <li>• how to manage the risks.</li> </ul>
6. Continual improvement	To benchmark carried out activities, finding the answers for following three questions: <ul style="list-style-type: none"> <li>• what to innovate?</li> <li>• where to learn from?</li> <li>• how to adopt?</li> </ul>

## 2. Asset Management to facilitate public services delivery

The increase of transport volumes, bringing new investment needs in high-capacity transport networks and ageing infrastructure require improved road construction and maintenance. The traditional way of doing business, which postpones repair activities until major deterioration occurs, is not sustainable. It is too expensive over the long term and it drains the value of road network assets.

As the costs of operating, repairing or constructing are increasing and – at the same time – available funding decreases, it has become more challenging for governments to meet the demands of an ageing infrastructure whilst meeting public expectations.

The challenge is to provide the same or even better value for less money. There is also strong demand for transparency and accountability from road sub-sector organisations, requiring justification for decisions and responsibility taken for results.

As stated above, public sector organizations (irrespective of their legal form) are being increasingly subjected to both legislative and competitive pressures forcing them to reconsider their relationships with users and customers in order to develop a more overt customer orientation (as the primary driver of organisational performance).

The creation of “value” supports the development of a customer orientation, and is a requirement, to which more public sector organisations nowadays subscribe. This applies to all sectors of the economy, also to the road sub-sector.

In modern society, road infrastructure has become an essential part of daily life. Individual road users, a wide variety of commercial enterprises, logistics companies and public transportation agencies expect reliable and safe road infrastructure to carry out their transportation or wider mobility operations, moving goods and people. “Just in Time” supply chains are at the heart of modern manufacturing and retail enterprise and they rely totally on predictable and stable journey time.

Reliable, accessible and safe infrastructure is a cornerstone for socioeconomic progress. It enables productivity growth, shortens travel times and costs, creates jobs, and connects different parts of society.

Recent research<sup>5</sup> indicates that a proactive roads periodic maintenance strategy would only cost 65% when compared with a reactive management strategy. In other words, better management of the network, up to date condition data and planning of the optimum time for an intervention would lead to substantial financial and economic benefits

This is supported by NCHRP Research Report 866 (2018) “*Return on Investment in Transportation Asset Management Systems and Practices*” where a similar level of savings (30-40%) were found to arise from the implementation of a Transportation Asset Management (TAM) system. Such a system is designed to:

- help road authorities make the best use of resources available for maintaining, rehabilitating, and replacing existing physical assets such as pavements, bridges, traffic and safety devices, and facilities; and
- help road authorities make better use of limited resources to maximize asset life, manage risk, and provide safe and efficient travel for passengers and goods.

Asset management has become a popular approach for the asset-heavy industries affecting the organization and management of a number of companies and institutions from multiple sectors of the economy.

This approach is also increasingly popular in the transport infrastructure sector, where planning and scheduling of works or services requires not only the delivery of multifaceted value for road network users, but also for other stakeholders from the general public to particular interest groups (i.e., transport and logistics).

Unfortunately, quite often people confuse the terms asset management and asset management systems, and tend to limit their understanding of asset management systems to a more or less sophisticated set of IT tools.

This understanding is not sufficient and misleads public organisations, which instead of carrying out comprehensive and complex revision of their business models concentrate their efforts on the technical challenges associated with the systems implementation without sound understanding how to redesign their internal processes and procedures, align different level of organisations management and only having these in place adjust IT tools.

Different approach and starting with purchasing of IT system usually leads to the vendor lock-in risk and timely and costly implementation processes. Asset management should therefore be understood as a value creation process which aligns the strategic, tactical and operational levels of an organization’s management through technical, engineering, and business principles and practice driven by economic rationale. On the other hand, an appropriate combination of management levels, principles and practices is made possible through the asset management system.

### 3. Asset Management System

According to the international standard ISO 55000, an asset management system is a set of interrelated and interacting elements of an organization, the function of which is to establish the asset management policy and asset management objectives, as well as the processes needed to achieve those objectives.

The selected processes should therefore enable an organization to understand customer needs and expectations, create and deliver a product and/or service, and collect enough data and information to measure the achieved performance while simultaneously serving as a basis for further improvements.

The general framework for designing the appropriate sequence of processes can be reflected by the popular approach of the Deming Cycle, also known as the Plan-Do-Check-Act (Adjust) cycle (PDCA).

<sup>5</sup> Zofka, A. “*Proactive Strategy for Road Infrastructure Management*” p.147, Roads and Bridges Research Institute, Warsaw 2019

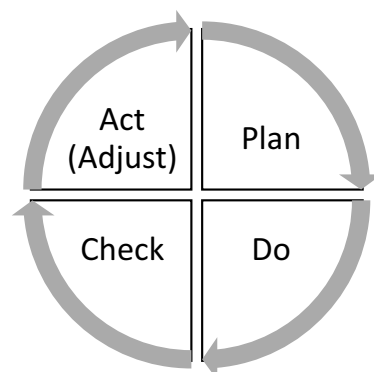


Figure 1. Deming's Circle. *Source: W. Edwards Deming, The New Economics for Industry, Government and Education* (Boston, MIT Press, 1993).

The outcome of the planning phase ("Plan") is to establish objectives and furthermore operational processes to deliver desired results.

The phase "Do" is focused on the execution of the planned activities to achieve the given objectives.

During the "Check" phase, the data and results gathered from the previous phases are evaluated. Data is compared to the expected outcomes to identify any similarities or differences between what was planned and what has been achieved. This phase may be called also as "S – study" as it helps to determine the reasons of any observed deviations from the assumed outcomes.

Finally, the phase "Act" (or, even better, "Adjust") is focused on the processes and overall system improvements, building on the results of the performance evaluation done in the preceding step.

PDCA should, however, only be an inspiration for the more detailed design and selection of the system of internal business processes.

As asset management is a value creation process, an asset management system can be described as an organization's value chain and the necessary procedures, systems and competencies enabling the organization to carry out its activities in a logical sequence to ensure operational activities satisfy the strategic objectives of the organization and its customers' needs.

The generic concept of the value chain<sup>6</sup> requires some adjustments for public sector organizations like road authorities, which tend more toward managing road networks through subcontractors than producing services or works by themselves.

Understanding the essence of the value chain for road authorities requires understanding the needs and expectations of communities, tax payers, road users and other stakeholders, translating those needs and expectations into more technical language that makes it possible to plan and programme relevant activities (capital, maintenance and operational interventions in the road network), contracting these activities through the supply chain, supervising the works and services delivery process and, finally, assessing if the quality of the provided works and services is sufficient to achieve satisfactory performance both throughout the whole network and for each individual asset when compared to the expected outcomes.

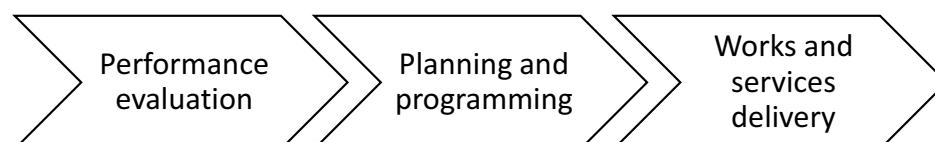


Figure 2. High level value chain for the road authority (Source: Maciejewski 2020)

While the third phase of the above approach seems to be well established among road authorities – essentially their most exercised competency – usually planning and performance evaluation processes require the application of more

<sup>6</sup> Michael E Porter, *Competitive advantage: creating and sustaining superior performance* (New York, Free Press, 1985).

sophisticated tools. This is because road authorities are responsible not only for the delivery of the technical standards of particular assets defined in formal documents but also for providing more diverse outcomes from the whole network and its life cycle perspective, including both economic and customer experience factors.

#### 4. Total Value Management

Adopting an asset management approach and implementing a comprehensive asset management system within the organization (e.g., road authority) requires both top-down and bottom-up activities.

Top-down means a sound understanding of internal and external strategic contexts of an organization, while bottom-up capabilities refer to:

- Operational processes and procedures
- Systems supporting and automating the above procedures
- Competencies reflected within the structure of an organization, job descriptions and the actual capacities of employees

It is not enough to simply have these two approaches implemented or reflected in the organization structure. It is necessary to ensure that they are aligned, meaning that all necessary operational activities, procedures, systems and competencies are designed to fulfil strategic goals and objectives valued by the customers. What is required is a comprehensive management system that identifies and satisfies the needs and expectations of consumers better than the competitors (in this case perhaps seen as other government bodies competing for funding)<sup>7</sup>.

Technical quality – as in total quality management (TQM) – addresses aspects of quality with reference to the functions a product must perform, though this is only one of the many value characteristics that need to be considered by an asset manager (including road asset managers)<sup>8</sup>.

With conventional TQM processes, it is difficult to address all aspects of the value expected by customers and stakeholders, such as (in the road sector):

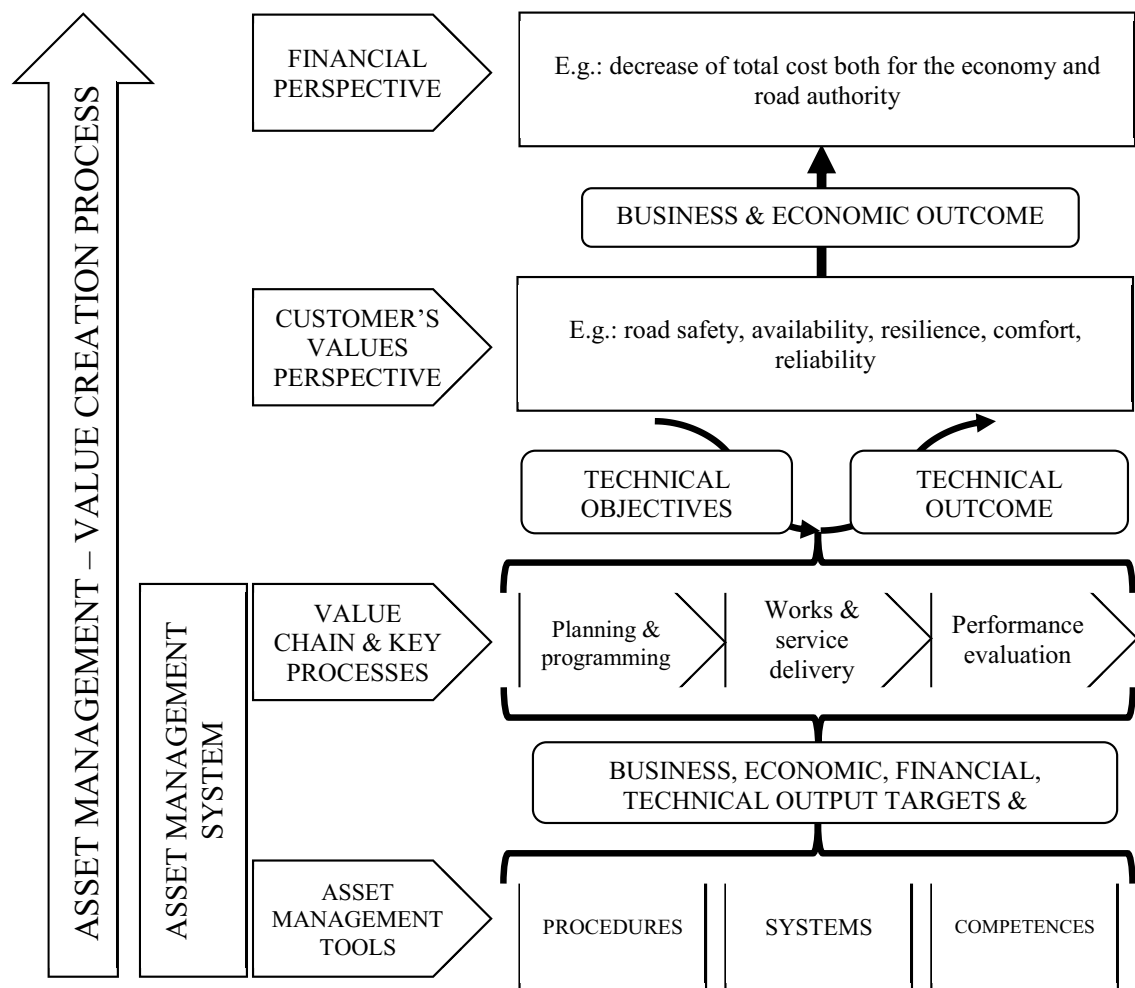
- Cost-efficiency
- Effectiveness and performance
- Safety and security
- Network and assets resilience
- Accessibility, connectivity and availability

The response to these challenges could be total value management (TVM). TVM efforts can be achieved through implementation of the asset management approach including all necessary processes, procedures and tools being part of an asset management system (an organization's value chain) to ensure that all detailed activities are aligned and lead to the creation of the expected value (the essence of asset management), as depicted in Figure 3 below.<sup>9</sup>

<sup>7</sup> Competition, as observed in the private sector, may not seem to be applicable for road authorities or more broadly public sector organizations, but taking into account competition in terms of access to taxpayer funds or state budget funds, the relevance of this term should be accepted.

<sup>8</sup> Biren Prasad, "Total Value Management: a knowledge management concept for integrating TQM into concurrent product and process development", *Knowledge and Process Management*, vol. 8, No. 2 (April/June 2001).

<sup>9</sup> Alternatively, instead of implementation of TVM through comprehensive asset management, organizations may wish to work on value creation and management through other approaches like 5P, recently presented by McKinsey: P – portfolio strategy and products (assets in the case of roads), P – people and culture, P – processes and systems, P – performance metrics, P – positions and engagements. The distinction between different approaches may, however, be misleading as the essence is still to deliver value to the customer. Sebastian Leape and others, "More than a mission statement: how the 5Ps embed purpose to deliver value", *McKinsey Quarterly*, 5 November 2020.



Presented above considerations and understanding of the Asset Management and Asset Management System has been translated within the Project's Team into the proposal of the more implementation-oriented Asset Management Framework, which should support efforts of road authorities in initiation of such processes.

Elaborated framework consists of 6 areas which are as follows:

1. Performance measurement framework
2. Methods and tools for planning and programming
3. Methods and tools for services and works delivery
4. Methods and tools for continuous improvement
5. Organisation
6. IT architecture

## 5. Performance measurement framework

Performance measurement framework allows an organisation to assess level of its performance regarding both level of service (compare to the customers' value perspective above) and financial outputs and outcomes (see: financial perspective above).

Apart from the customer and financial perspectives performance measurement framework addresses also internal



procedures, methods, systems and competences of an organisation (asset management tools as above) to support both assessment of their performance and to allow for the improvement planning.

The Project's team created an useful tool for creation of such a performance measurement framework as presented below.

Table 2. Metrix for setting of the performance measures (Source: Zofka, Maciejewski, 2021)

Categories and types of measures		OUTCOMES	OUTPUTS	INPUTS
RESILIENCE	FUNCTIONALITY	e.g.: % of gained/lost resilience (resilience sustainability)	e.g.: km of repairs	e.g.: level of funding
SAFETY				
COMFORT				
RELIABILITY				
SERVICE X				
COSTS		e.g.: vehicle operating costs (VOC)		
RISKS		e.g. objectives not achieved	e.g. long lasting procedures	e.g. not sufficient funding limits

## 6. Method for the periodic maintenance planning

The second area of proposed Asset Management Framework which was elaborated by the Project's team was a method for the periodic maintenance planning.

Proposed method encapsulates both engineering knowledge, standards and practice and then connects them with the economic efficiency model and risk management model. All of these elements are aimed at the preparation of appropriate set of data for the optimisation model and module, thus necessary for the objectives and constraints derived from the above-presented table.

This approach allows for being aware enough when planning the objectives and selecting whether the goal should be more associated to the cost, the functionality or to the risk dimensions. If for example an organisation will decide that its planning process and sub-sequent delivery plans and programmes should provide defined level of reliability, optimisation module will help to determine what costs and risks will this scenario bring.

Achieving of such an analysis is possible due to the maintenance scenarios generator envisaged within the proposed planning method, which derives from the deterioration forecasting model, demand model as well as from the work effect model.

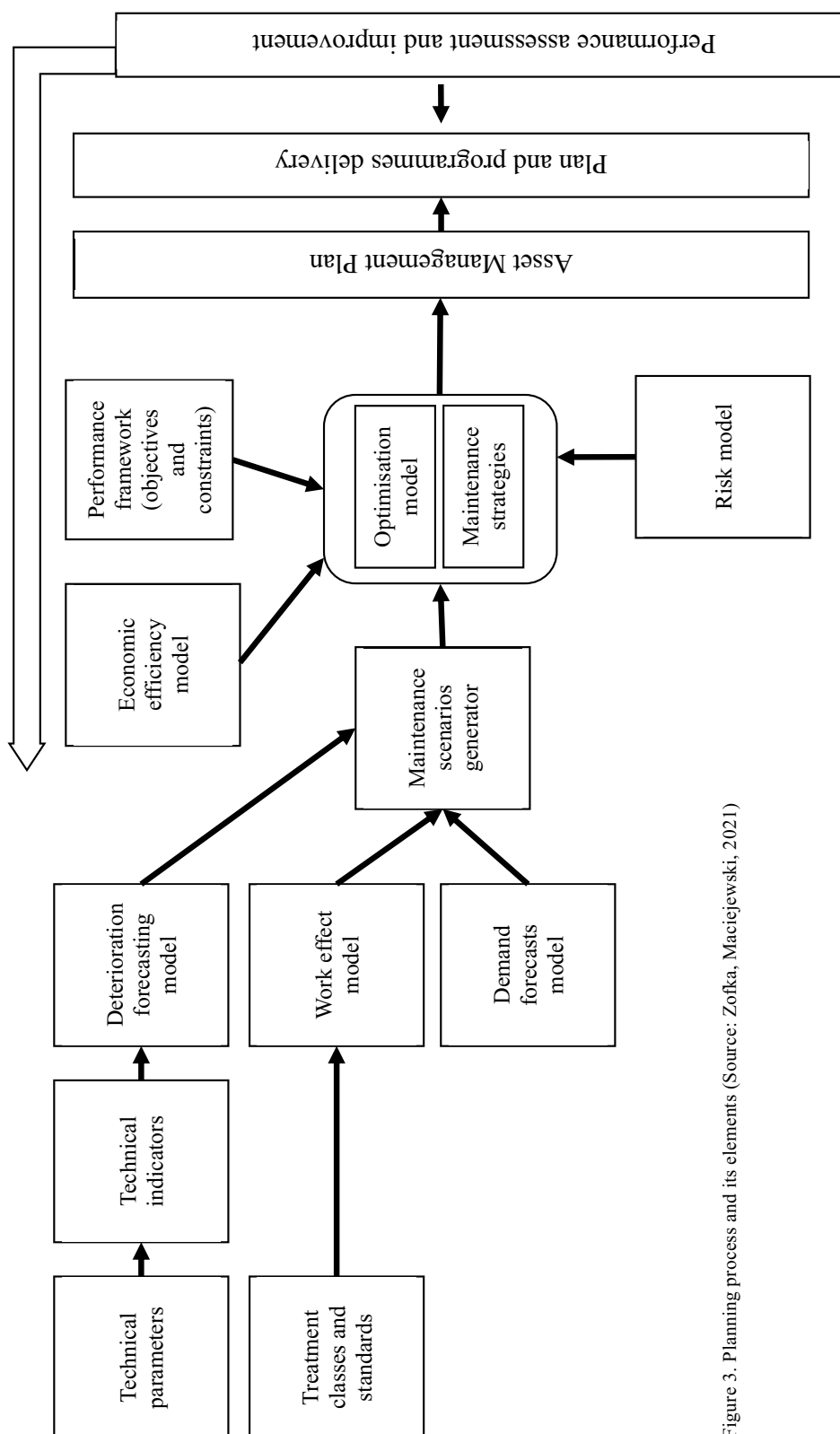


Figure 3. Planning process and its elements (Source: Zofka, Maciejewski, 2021)

## 7. Supporting tools

To make the method operational it was supplemented within the project's scope with the prototype of the supporting IT system.

Although such a systems are in general available on the market it was decided to assess the real needs regarding particular modules of such a system and adjust it to the overall IT architecture. The IT architecture including both asset and traffic management elements has been already created during the preparatory works for another project – National Traffic Management System, being concurrently under implementation.

This approach allows to ensure appropriate level of interrelations between both processes (of asset and traffic management), envisage one data warehouse and make data collecting and usage processes consistent.

This leads to the increased efficiency of road network operations as data are in reality collected once and used repeatedly.

The main elements of the created tool are:

1. Data warehouse
2. Computing modules for particular models as in the method
3. Business Intelligence platform for the visual analysis of the data.
4. The business intelligence platform is the interface for the end users.

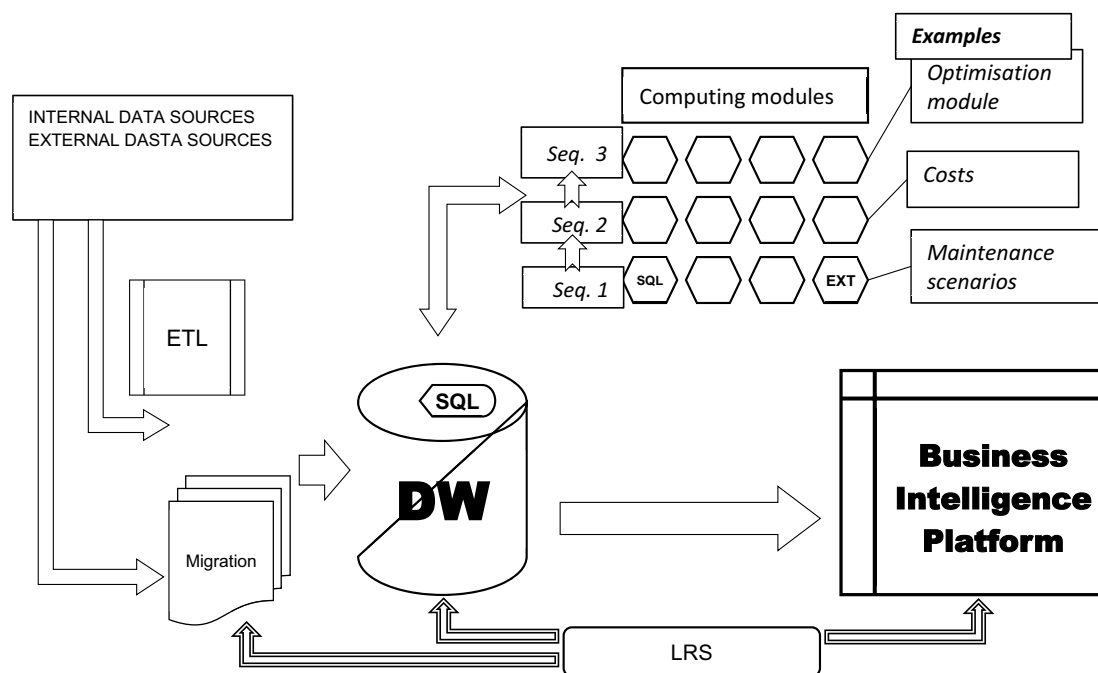


Figure 4. High-level IT architecture. (Source: Zofka 2020).

## Conclusions

Implementation of the Road Asset Management System in Poland seems to be scheduled in the appropriate timing regarding the still ongoing process of construction of new network of high speed roads.

As elsewhere such an effort faces some challenges regarding especially the need for moving from the perspective of separate activities to the more asset management mindset what requires seeing of the bigger picture and understanding that the role of the public organisations is to deliver their services in the most effective and efficient way at once.

Adopted approach is unique taking into consideration elaborated method and also due to independent creation of the supporting IT tools.

## Acknowledgments

This paper was created as a part of the research project SIEC11.5t funded by the National Centre for Research and Development (NCBiR) in Poland

## References

- Alexopoulos, Konstantinos and Wyrowski, Lukasz. *Innovative ways for financing transport infrastructure* (New York and Geneva, United Nations Economic Commission, 2017).
- American Association of State Highway and Transportation Officials. *AASHTO Transportation Asset Management Guide* (Washington, D.C., 2011).
- American Association of State Highway and Transportation Officials. *AASHTO Transportation Asset Management Guide*, 2nd ed. (Washington, D.C., 2020).
- Asian Development Bank. *Reforming the financing system for the road sector in the People's Republic of China* (Mandaluyong, 2015).
- Austroroads. *Guide to Asset Management*, 3rd ed., July 2018.
- Briessinck, Margo and others. *CEDR technical report 2017/06 – TG Asset Management Final Report 2017*, Conference of European Directors of Roads (Brussels, CEDR Secretariat General, 2017).
- Brocklebank, Peter. *Private sector involvement in road financing*, Sub-Saharan Africa Transport Policy Program (SSATP), discussion paper no. 102 (Washington, D.C., World Bank, 2014).
- Diamond, Jack. *Establishing a performance management framework for government*, IMF Working Paper WP/05/50 (International Monetary Fund, 2005).
- Farquharson, Edward and others. *How to Engage with the Private Sector in Public-Private Partnerships in Emerging Markets* (Washington, D.C., World Bank, 2011).
- Garemo, Nicklas; Hallemann, Brendan; and Hjerpe, Martin. *A better road to the future: Improving the delivery of road infrastructure across the world* (n.p., McKinsey & Company, 2018).
- Institute of Asset Management. *An Anatomy of Asset Management*, ver. 3, December 2015.
- Institute of Public Works Engineering Australasia. *International Infrastructure Management Manual*, 5th ed. (n.p., 2015).
- ISO 55000:2014, 55001:2014, 55002:2014.
- Kaplan, Robert S. and Norton, David P. *The Balanced Scorecard: Translating Strategy into Action* (Harvard Business Review Press, 1996).
- OECD. *Asset Management for the Roads Sector*, Road Transport and Intermodal Linkages Research Programme (Paris, 2001).
- OECD. *Performance Indicators for the Road Sector* (Paris, 2001).
- Osborne, David. "Reinventing Government: what a difference strategy makes", 7th Global Forum on Reinventing Government: Building Trust in Government, Vienna, 26-29 June 2007.
- Porter, Michael E. *Competitive advantage: creating and sustaining superior performance* (New York, Free Press, 1985).
- Prasad, Biren. "Total Value Management: a knowledge management concept for integrating TQM into concurrent product and process development", *Knowledge and Process Management*, vol. 8, No. 2 (April/June 2001).
- Public Sector Research Centre PricewaterhouseCoopers. *The road ahead for public service delivery: delivering on the customer promise* (n.p., 2007).
- Queiroz, Cesar and Kerali, Henry. *A review of institutional arrangements for Road Asset Management: Lessons for the Developing World*, Transport paper series, no. TP-32 (Washington, D.C., World Bank, 2010).
- Talvitie, Antti. *International experience in restructuring road sector* (Washington, D.C., World Bank, 1998).
- Task Group S4 Optimizing the financial resources available for roads. *Funding formulas for roads: inventory and assessment* (Brussels, CEDR Secretariat General, 2017).
- Transportation Research Board of the National Academies. *NCHRP Report 551: Performance Measures and Targets for Transportation Asset Management*, National Cooperative Highway Research Program (Washington, D.C., 2006).
- United Nations Department of Economic and Social Affairs. *World Public Sector Report 2015: Responsive and Accountable Public Governance* (New York, 2015).
- World Bank Group. "PPIAF Toolkit for Public-Private Partnerships in Roads and Highways" (January 2009).
- World Bank Group. Road Financing and Road Funds Knowledge Base. Available at [www.worldbank.org/transport](http://www.worldbank.org/transport)
- World Economic Forum. *Strategic Infrastructure: Steps to operate and maintain infrastructure efficiently and effectively* (Cologny/Geneva, April 2014).
- World Road Association (PIARC). *Asset management manual: a guide for practitioners* (Paris, 2017).
- Yeang Yng Ling, Florence and Hartman, Andreas. "Value creation of road infrastructure networks: A structural equation approach", *Journal of Traffic and Transportation Engineering*, vol. 3, No. 1 (February 2016).
- Zofka, Adam. "Proactive strategy for road asset management", *Studia i Materiały*, No. 82 (Warsaw, Instytut Badawczy Dróg i Mostów, 2019).