REQUEST FOR EXPRESSIONS OF INTEREST
CONSULTING SERVICES – FIRMS SELECTION

Republic of Serbia
The Serbia Railway Sector Modernization Project (SRSM)
Project ID No. P170868

Assignment Title:

Technical Advisory for the preparation of Technical Specifications for the Procurement and Implementation of a Rail Infrastructure Asset Management System Implementation (RI-AMS) and the state-of-the-art analysis of the environment for its implementation

Reference No. SER-SRSM-QCBS-CS-21-22

For the purpose of financing Serbia Railway Sector Modernization Project, Phase 1 of the Multiphase Programmatic Approach (MPA), the International Bank for Reconstruction and Development (IBRD) and the Agence Francaise de Développement (AFD), jointly, granted to the Republic of Serbia EUR 102 million loan to support enhancing the efficiency and safety of existing railway assets and improving governance and institutional capacity of the railway sector. Republic of Serbia intends to apply part of the proceeds to payments for consulting services to be procured under this project.

Scope of Work

The objectives of the Services are to develop technical specification for the RI-AMS for Railway Infrastructure company and support the company during RI-AMS procurement and implementation. This will be achieved through: (1) state-of-the-art analysis of the existing RI-AMS environment at IZS and propose necessary intervention for its improvements; (2) through needs assessment with recommendations for necessary improvements of RI-AMS practices and a roadmap for RI-AMS rolling out with corresponding action plan, timelines, cost estimation and clear responsibilities; (3) development of Technical Specifications for the implementation of the RI-AMS system, and (5) provision of support to the Railway Infrastructure company in procurement and RI-AMS implementation stage.

The Scope of Work is divided into two Components:

- Component 1: RI-AMS Design stage that includes Activities from 1 to 5 which will be performed as Lump Sum payments with milestones against submission of deliverables and,
- Component 2: RI-AMS Procurement and Implementation stage that includes Activity 6 which will be performed as Time Based payments with periodic payments against time actually spent on the services.

Component 1 assumes the following activities:

- Activity 1: Inception
- Activity 2 Analysis of the current State-of-Play and State-of-Practice
- Activity 3: Rail Asset Management Needs assessment and roadmap for introduction of fully functioning road asset management system
- Activity 4: Preparation of Implementation plan and Technical Specifications for RI-AMS
- Activity 5: RI-AMS Trainings

Component 2 assumes the following activities:

- Activity 6: Procurement and Implementation supervision support

Contract duration for both Components: 24 months starting from the commencement date.

The detailed Terms of Reference for the above referenced consulting services is posted on the website of the Ministry of Construction, Transport and Infrastructure (MoCTI)

https://mgsi.gov.rs/cir/dokumenti/serbia-railway-sector-modernization-project-srsm-rail-infrastructure-asset-management

The Central Fiduciary Unit (CFU) of the Ministry of Finance now invites eligible Consultants to indicate their interest in providing the Services. Interested Consultants should provide information demonstrating that they have the required qualifications and relevant experience to perform the Services.

The Consultant firm will be selected in accordance with QCBS (Quality and Cost Based Selection) method set out in the World Bank's Procurement Regulations for IPF Borrowers (July 2016, revised November 2017, August 2018 and November 2020).

The assignment will require a qualified consulting company or consortium that can demonstrate extensive experience in Technical assistance service for the contract.

The following shortlisting criteria will be applied to all consulting firms that have submitted EoI:

i) The Consulting firm must be a legal entity;

ii) **General Experience:** Experience in railway sector with at least 2 projects in railway related sector in the past 8 years;

iii) **Specific Experience:** The consultant (individual company or joint venture altogether) must demonstrate extensive experience in delivering similar size scope work by presenting, at least 2 projects successfully completed in the last 8 years in the field of Asset management information systems in state-owned railways enterprises.

As a proof, the Consultant firm shall prepare a table listing following information: name of the relevant assignment, name of a firm that conducted the assignment, short explanation of scope of work, year of contract implementation, country/region, contact reference (name, e-mail, phone number).

iv) **Availability of qualified experts within the organization/JV** with relevant experience in the field of Rail asset management system.

As a proof, the Consultant firm shall provide organization chart and list of qualified experts within the firm who are relevant to the assignment, position in the firm and short description of relevant qualifications and experience.

Consultants may associate with other firms to enhance their qualifications but should indicate clearly whether the association is in the form of a joint venture (JV) and/or a sub-consultancy. In the case of a joint venture, all the partners in the joint venture shall be jointly and severally liable for the entire contract, if selected. Furthermore, Expressions of interest of JVs will be evaluated based on the composition of JV submitted, whereas the experience of other firms not included in the JV will not be considered in the evaluation. The experience of any proposed sub-consultancy shall not be included in the evaluation.

Key Experts' CV are not required and will not be evaluated at the shortlisting stage.

Allocation of points:

i. General Experience 30 points
ii. Specific Experience 40 points
iii. Availability of qualified experts 30 points

The attention of interested Consultants is drawn to paragraphs 3.14, 3.16 and 3.17 of the World Bank's Procurement Regulations for IPF Borrowers – Procurement in Investment Project Financing Goods, Works, Non-Consulting and Consulting Services (July 2016, revised November 2017, August 2018 and November 2020) ("the Regulations") setting forth the World Bank's policy on conflict of interest.

Further information can be obtained at the address below during office hours 09:00 to 15:00 hours.

Expressions of interest in English language must be delivered in a written form to the email below, by **August 15, 2022, 12:00 hours, noon, local time**.

Contact:	E–mail:	Address:
To:	zorica.petrovic@mfin.gov.rs Ms. Zorica Petrovic Procurement Specialist	Ministry of Finance Central Fiduciary Unit 3-5 Sremska St 11000 Belgrade, Serbia Tel/Fax: (+381 11) 765 2587
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Ministry of Construction, Transport and Infrastructure

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AGENCE FRANÇAISE DE DÉVELOPPEMENT

The Serbia Railway Sector Modernization (SRSM) Project
Phase 1 of the Multi-Phase Programmatic Approach

TERMS OF REFERENCES

for

Technical Advisory for the preparation of Technical Specifications for the Procurement and Implementation of a Rail Infrastructure Asset Management System Implementation (RI-AMS) and the state-of-the-art analysis of the environment for its implementation

SER-SRSM-QCBS-CS-21-22

July, 2022

1 Background information

1.1 Beneficiary country: Republic of Serbia

Client: Ministry of Construction, Transport, and Infrastructure of Republic of Serbia (MCTI).

Final Beneficiary: Infrastruktura železnica Srbije (Serbian Railway Infrastructure – IZS).

1.2 Relevant country background

The International Bank for Reconstruction and Development (IBRD) launched the Multiphase Programmatic Approach (MPA) to support the Government of Serbia in continuation of institutional, physical and operational modernization of the railway sector in an integrated manner through providing financial support to Serbia Railway Sector Modernization Project as part of the Multiphase Programmatic Approach to be implemented in three overlapping phases over the ten-year period.

For the purpose of financing Serbia Railway Sector Modernization Project, Phase 1 of the MPA (the Project), IBRD and the Agence Francaise de Développement (AFD), jointly, granted to the Republic of Serbia EUR 102 million loan to support enhancing the efficiency and safety of existing railway assets and improving governance and institutional capacity of the railway sector.

Project will be managed by the Ministry of Construction, Transport and Infrastructure (MoCTI) through the Project Implementation Unit (PIU) supplemented by the Project Implementation Teams (PITs) in Railway Directorate (RD) and in railway companies, respectively Serbian Railway Infrastructure (IZS), Serbia Voz (SP) and Serbia Cargo (SC). PITs will act as subordinate implementing agencies and provide technical support for specific Project subcomponents or activities of the MPA that pertain to their area of expertise. Primary responsibility for Project execution lies on PIU which will ensure that the Project development objectives are met.

These Terms of References (ToR) relate to consultancy firm for Technical Advisory on preparing Technical Specifications for the procurement and implementation of a Rail Infrastructure Asset Management System (RI-AMS), including Life Cycle Costing (LCC) and Reliability, Availability, Maintainability and Safety (RAMS) techniques as standard constitutive parts. MCTI with support of IZS intends to engage a highly qualified consultant to provide services more closely described below.

1.3 General information

The position of Serbia in the European railway network is such that it forms part of the shortest traffic line between West and South-East Europe. The length of the railway lines in the Republic of Serbia is 3736 km, of which 3441 km are single-track and 295 km of double-track railway lines, of which 1546 km are electrified. Railway lines on the territory of the Republic of Serbia are more than one century old, and over half of all railway lines were built in the 19th century. This network consists of the railway lines which are part of the Pan-European corridors, lines of international importance connecting Serbia with neighboring countries, and regional-local lines.

Due to its position on the geographic borderline between the East and West, Serbia is often referred to as a gateway of Europe. The important European Corridor X – the international highway and railway corridor, part of the core TENT-T network through Republic of Serbia (RoS), provides excellent connections with Western Europe and the Middle East.

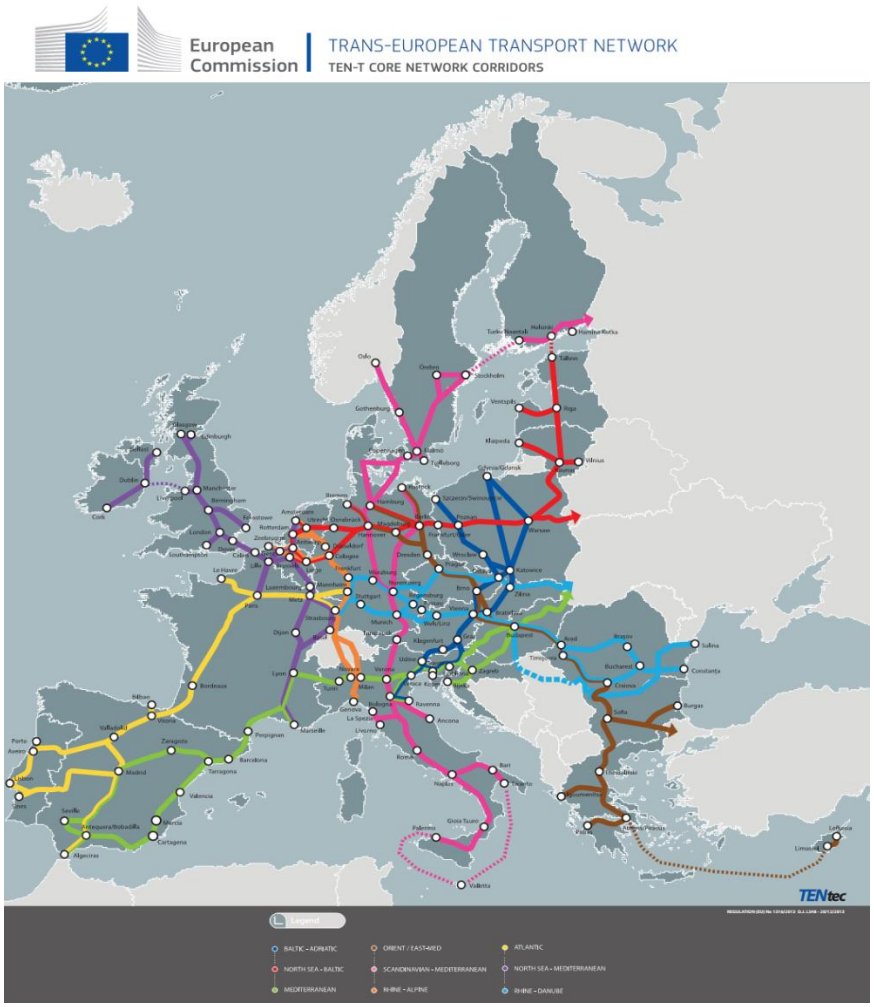

Figure 1: TENT-T core Network corridors

In RoS, the Core rail Network extends for 1414 km and it encompasses Corridor X (with branches Xb and Xc -770 km), Route 4 (421 km), Route 10 (84,5 km) and Route 11 (138 km). Except for one section on the Corridor Xc (Nis – Dimitrovgrad), Corridor X is electrified with 108 km of double track sections and 219 km of single track sections. As for Route 4, connecting RoS with Montenegro and Romania, approximately 157 km is in very good and good condition, major part of route 4,212km is in medium condition, single track, electrified except for the section Pančevo – Vršac with diesel traction. Largest part of Route 10 traversing RoS is in good condition, and Route 11 section from Požega to Kraljevo is in very good condition.

Infrastructure modernization is essential to address various cross-cutting performance issues like safety, resilience, inclusion, and digitalization. Decades of low investments, outdated management structures and practices, and neglect of maintenance have led to serious deterioration of the rail network infrastructure, obsolescence of the rolling stock, and low service quality. As one example, an average of 39 percent of scheduled passenger and 37 percent of scheduled freight trains were cancelled during the period 2016-2018. The current design state of the railway lines enables operation of rolling stock from 12 t/axle to 22.5 t/axle, with the latter maximum load capacity possible on only 50 percent of the network, which is an obstacle to growth of rail freight traffic. Services are greatly hampered by the current severe regime of continuous speed restrictions across the network. The average speed is low at 38 km/h, and the network has many slow and dangerous spots. In 2017, railways in Serbia had a derailment rate of 9.14 derailments per million train

kilometres, compared to 1.5 in Bulgaria and 0.1 in Croatia. Derailments are the leading cause of accidents on the system (39 percent), followed by level crossings (22 Percent). In 2017, the level crossing accident rate in Serbia was 5 per million train-km, compared with only 1.14 in Bulgaria, 0.5 in Croatia, and 0.09 in Germany. If this problem is not addressed now, it is likely that more accidents and fatalities will occur once train speeds increase.

However, as the consequence of the above, RoS has also over the past several years, initiated several projects related to the renewal, reconstruction and modernization of the main routes on its Network, primarily the Corridor X, connecting its North-West with the link to Central and Western Europe with its South-East, connecting to North Macedonia, Greece, and further to Turkey and Middle East. Most notable is the modernization of the North branch of the Corridor X in Serbia, from Belgrade via Novi Sad to Subotica and onward to Hungary, where the speeds were increased to 200 km/h, for the first time in RoS' history. The key section on this line, between Belgrade and Novi Sad, the two largest cities, is completed and open for commercial service in March 2022, while on the second North-stretch, from Novi Sad to Subotica, the works have commenced. After the completion of this section, the intention of RoS is to extend the modernization works towards its South end of the Corridor X as well as on other main lines i.e. towards border with Montenegro and Romania together with other important main and regional lines within Serbian rail network.

Implementation of Rail Infrastructure Asset Management Systems (RI-AMS) and Safety Management Systems (SMS) coupled with cost-effective technologies will bring safety in the Serbian rail sector to a level comparable with regional standards. Thus, infrastructure investments are necessary for the railways to increase speeds and safety, but the "soft" components for improving institutions and enabling the sector to attract more passengers and freight are essential for the railways to play a larger role in a more environmentally friendly mobility system. Also, quality and responsible maintenance of transport infrastructure implies the existence of a planned system of preventive / predictive maintenance based on a detailed recorded condition of railway infrastructure and an efficiently organized maintenance system. Indeed, global experience shows that the economic return from costly investments in infrastructure is substantially lowered if the railway companies are not well managed or if they do not have the commercial capacity to understand and respond to the needs of customers. Implementing targeted system initiatives such as Intelligent Railways, Safety Management, and Infrastructure Asset Management not only goes hand-in-hand with EU's standards, but also promotes the modernization of human capacity and organizational change toward a culture of putting customers at the center of the organization's activities.

RI-AMS concept exclusively relies on the condition-based approach, where assets are regularly monitored, i.e., their condition measured and analyzed. This information is further utilized for two equally important, but distinct purposes:

- ***Real-time (or "near-real-time") discovery/identification of important defects*** requiring immediate response (due to the adverse implications onto the rail traffic safety)
- ***Understanding of long-term asset behavior***, through generation of deterioration trends within suitable Deterioration Models (DMs), which are then all utilized by the dedicated/specialized RI-AMS for the determination of place and time of need of particular Maintenance & Renewal (M&R) activity, as well as the optimal type of such M&R activity

to be performed (based on the embedded analytical functionalities, such as FMECA[1], CBA[2], LCC[3] and RAMS[4])

RI-AMS systems are tools of invaluable assistance to infrastructure managers (IMs) at all sophisticated railways world-wide, as they fully support the modern condition-based M&R management approach, linking all necessary data from Railway Infrastructure Assets' (RIA) Asset Register/Inventory and exploitation, via condition monitoring and measurements, to the M&R work history and resource allocation, through a unique and sophisticated automatic process of deterioration-modelling and powerful rule-(engine)-based work-planning.

RI-AMS systems, in short, represent engineering information systems which contain asset database (Asset Register – AR), containing all RIA' characteristics, as well as RIA condition-monitoring data, allowing these systems not only to "know" the condition of all RIA at any given time, but also their behaviour (change of condition over time), through suitable Deterioration Models (DMs), all of which, in the end, allow RI-AMS to forecast RIA condition, as well as timely and cost-effectively plan appropriate M&R activities, aimed at preserving/repairing RIA condition, but ultimately guarding traffic safety at all times and balancing effectively the achieved quality with the costs of M&R works (as well as inspections and other consequences like traffic disruptions, availability, etc.), which enables significant cost savings.

In the present-day conditions, a cost-effective railway infrastructure can be obtained only by regular monitoring of the RIA performance, and by using reliable prediction, planning, and optimization methods, all of which are the main goals of RI-AMS.

In order to satisfy the complex combination of requirements, RI-AMS must be created as a distinctly modular system, with all modules being completely independent and thus detachable, i.e., deployable individually or in any combination of the modules, yet working in complete unison when necessary. Standard RI-AMS modular structure can best be seen in Figure 2, which must be included in the RI-AMS specifications as the minimum requirement for the system to be offered to be implemented at IZS.

[1] FMECA - Failure Mode, Effects and Criticality Analysis is an extension of FMEA (Failure Mode and Effects Analysis), which represents a bottom-up, inductive analytical method that may be performed at either the functional or piece-part level. FMECA extends FMEA by including a criticality analysis, which is used to chart the probability of failure modes against the severity of their consequences. The result highlights failure modes with relatively high probability and severity of consequences, allowing remedial effort to be directed where it will produce the greatest value. FMECA tends to be preferred over FMEA in space and North Atlantic Treaty Organization military applications, while various forms of FMEA predominate in other industries.

[2] CBA - Cost-Benefit Analysis

[3] LCC - Life Cycle Costing - Life-cycle costing (LCC) is a technique used to estimate the total cost of ownership. It is a system that tracks and accumulates the actual costs and revenues attributable to cost object from its invention to its abandonment. It allows comparative cost assessments to be made over a specific period of time, taking into account relevant economic factors both in terms of initial capital costs and future operational and asset replacement cost. Life-cycle costing is also known as total cost of ownership (TCO).

[4] RAMS - Reliability, Availability, and Maintainability (RAM or RMA) are system design attributes that have significant impacts on the sustainment or total Life Cycle Costs (LCC) of a developed system. Additionally, the RAM attributes impact the ability to perform the intended mission and affect overall mission success. The standard definition of reliability is the probability of zero failures over a defined time interval (or mission), whereas Availability is defined as the percentage of time a system is considered ready to use when tasked. Maintainability is a measure of the ease and rapidity with which a system or equipment can be restored to operational status following a failure.

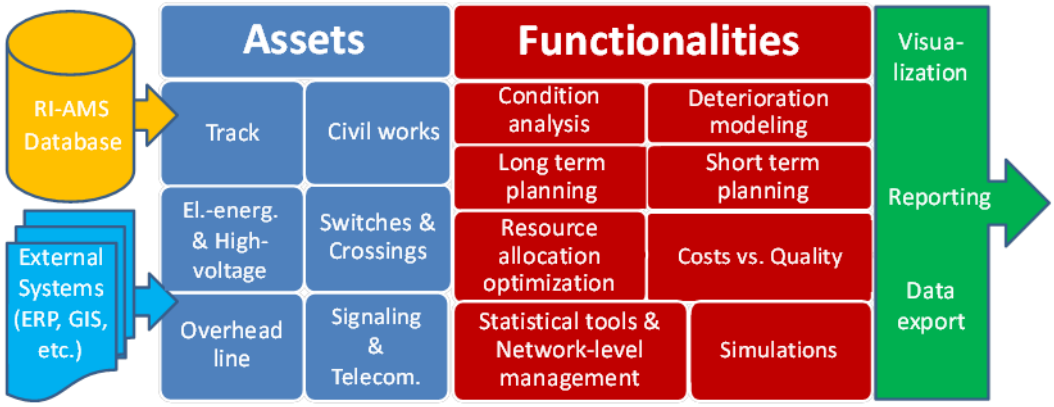

Figure 2: Example of modular architecture of RI-AMS

By providing all this, RI-AMS allows true targeting of M&R works, i.e., ensuring that the right works are always performed at the right places, at the right time and for the right reasons. This in turn enables considerable cost-savings, while keeping full and constant control over the traffic safety and quality of RIA. Finally, the RI-AMS allows railways to simulate, test and explore various M&R policies and their consequences.

In order to RI-AMS be cost-effective, i.e., yield true benefits, assets must have value. In other words, RI-AMS cannot unleash its full potential for heavily depreciated assets, as there is no value to be saved, i.e., RI-AMS cannot demonstrate its full potential at railways with old infrastructure. In such situations, RI-AMS can bring benefits in terms of prioritizing M&R activities by targeting most important/problematic assets and/or locations on the network and thus indirectly improving traffic safety, but can hardly bring tangible savings, as the largest savings come in the long-run, by extending (i.e., preserving) assets' Service Lives (SLs), demonstrated through RI-AMS's LCC analyses. This is also because such railroads, which allowed their assets to deteriorate so much, often do not have sufficient M&R budgets to keep their networks at the required quality level in the first place, as such deteriorated assets require high volumes of M&R every year. This is why such IMs simply tend to continue decreasing train speeds on their network as virtually the only measure they can afford.

As opposed to this, new assets, or newly renewed, reconstructed and/or modernized assets (e.g., as the Belgrade-Novi Sad High-Speed Line (HSL) and other reconstructed lines), i.e., new/reconstructed rail networks can benefit immensely from RI-AMS, as there is sizable "value" to be saved, which would have otherwise been lost if condition-based approach is not applied, and which is effectively embodied by RI-AMS.

In the light of the on-going extensive infrastructure reconstruction works (High-Speed Line Belgrade – Novi Sad - Subotica, reconstruction and electrification of Niš – Dimitrovgrad which is only non-electrified section along Corridor X and planned reconstruction of the Route 4 line towards Montenegro), and especially the even more extensive strategic plans of Serbian Railways Infrastructure (IZS) to reconstruct most of its network in the coming years, primarily focusing on the ~ 872 km on the Corridor X, introduction of RI-AMS at IZS would enable significant cost-savings every year, due to proper management of RIA and preservations/extension of their Service Lives of this extremely expensive infrastructure that was built/reconstructed, while guarding rail traffic safety at the same time. Taking this into account, there is currently a great need for consistent and systematic RIA management, ensuring their optimal quality and availability at all times, while minimizing potential traffic disturbances and safety risks.

RI-AMS would be utilized not only by IZS, but also by all other important stakeholders, respective of their interests and roles. With implementation of RI-AMS, MCTI will have the ability, along with IZS, to simulate various M&R policies and scenarios and related budgets, in order to identify the optimal one – i.e., the one that provides the best trade-off between costs and quality, where quality always has its implications on rail safety.

The rollout of RI-AMS is foreseen to be established in its full scale i.e. by establishing the proper environment in IZS for procurement of advanced RI-AMS that will cover all RIA (Track Superstructure, Civil Works, Engineering structures, Overhead Line, Power systems, Signalling and Telecommunications systems etc.) with the integration of RIA register/inventory with the existing IZS's financial/accounting system (ERP – Enterprise Resource Planning / EAM – Enterprise Asset Management).

2 Objective of the Services

The objectives of the Services are to develop technical specification for the RI-AMS for Railway Infrastructure company and support the company during RI-AMS procurement and implementation. This will be achieved through: (1) state-of-the-art analysis of the existing RI-AMS environment at IZS and propose necessary intervention for its improvements; (2) through needs assessment with recommendations for necessary improvements of RI-AMS practices and a roadmap for RI-AMS rolling out with corresponding action plan, timelines, cost estimation and clear responsibilities; (3) development of Technical Specifications for the implementation of the RI-AMS system, and (5) provision of support to the Railway Infrastructure company in procurement and RI-AMS implementation stage.

3 Scope of work

The Consultant is expected to perform following activities, grouped in two components, as a part of the Services:

- Component 1: RI-AMS Design stage that includes Activities from 1 to 5 which will be performed as Lump Sum payments with milestones against submission of deliverables and,
- Component 2: RI-AMS Procurement and Implementation stage that includes Activity 6 which will be performed as Time Based payments with periodic payments against time actually spent on the services.

Component 1: RI-AMS Design stage

3.1 Activity 1: Inception

Activity 1 includes the following tasks:

- Kick-off meeting, coordination, and agreement on the assignment with the key stakeholders, including PIU, MCTI, IZS, World Bank and FDA,
- Organization of the assignment's inception (logistics, content, etc.) so that subsequent activities can run smoothly.
- Preparation of detailed work plan and expert mobilization according to technical proposal;
- Obtaining and reviewing previous studies, maintenance programs and accompanying reports on the implementation of planned maintenance, reports and data bases done under previous technical assistance that included RI-AMS component, interviews with people

involved in maintenance management and other background information to become fully familiar with the current situation:

Deliverables under Activity 1: The Consultant is expected to deliver **Inception Report**, consisting of analysis of reviewed documents and reports on discussions held with key stakeholders and findings/conclusions of the interviews which should highlight and summarize the existing situation, detailed work plan, tasks allocation, timings, issues, and detailed resource utilization forecast.

3.2 Activity 2 Analysis of the current State-of-Play and State-of-Practice

Under Activity 2 the Consultant will analyze the current state of play and state of practice to identify gaps and practices regarding the approach to railway infrastructure maintenance, railway infrastructure condition, condition of depots (workshops), machinery and equipment, staff that will serve as input to determine needs assessment and definition of RI-AMS implementation roadmap. Activity 2 will include but not limited to:

- Analysis of the current situation concerning **the characteristics of railway infrastructure, maintenance approaches and budgeting**:
    - Analysis of railway infrastructure characteristics in the context of railway network length, number, and type of engineering structures, power supply system, signalling system, age and condition of the railway infrastructure, presentation of completed projects in the last 10 years and planned projects in the next 10 years,
    - Analysis of the current state of railway infrastructure in the context of characteristics and residual service life of the existing railway lines and identify sections whose service lives have exceeded the expected ones
    - Detailed investigation of the existing M&R practices at IZS, M&R rules, regulations, and standards,
    - Detailed examination of different approaches for maintenance, like for example on the capabilities and effectiveness of IZS in performing M&R versus the capabilities and effectiveness of third-party Infrastructure Maintenance Contractors (IMCs) through suitable contractual arrangements, such as PBMC (Performance-based Maintenance Contracting, etc.),
    - Examination of allocated funds for M&R in the last 10 years by sources of financing, its spending, and justification of previous M&R interventions.

- Analysis of the **current situation concerning RIA Register/Inventory**:
    - Investigation of all the existing RIA data and data-sources, e.g., any eventually existing Infrastructure Database (ID) or infrastructure Asset Register (AR) (also including eventual references to the infrastructure data in the IŽS ERP system). The task is to be done in a close co-operation with IŽS responsible personnel, at all levels, and parties responsible for data collection, e.g., Geometry Measuring Cars, Ultrasonic Inspections, Work Execution, etc. If certain M&R works are performed by the Infrastructure Maintenance Contractors (IMCs), they should also participate in this Activity, for what concerns the parts of the IŽS network under their jurisdiction, i.e. where they perform(ed) the M&R works.
    - Examination of the current practice related to the data storage regarding M&R works and RIA data and, if needed, update the existing electronically databases in order to create full inventory/register of assets;

- Data checking and its verification regarding quality, completeness, consistency and reliability;

- Analysis of the **current situation concerning the RIA condition-monitoring capabilities**, practices, systems, vehicles and tools, including:
  - establishing the baseline concerning the existing RIA condition-monitoring capabilities of IZS, including measuring vehicles, systems and other devices (e.g., hand-held, trolleys, etc.) and the manner of their use, network-coverage, frequency of measurements, and above all, the manners in which the measured data are utilized for the purposes of infrastructure M&R planning, and all for the purposes of its eventual optimization for the introduction into and utilization by the future RI-AMS.
  - examination of the current condition-monitoring approaches, if any, and provision of recommendations for the most cost-effective ways of performing condition-monitoring, starting first with mere Track Geometry measurements, followed by its extension onto the other important condition-monitoring (rail profile, ultrasonic rail inspections, rail corrugation, overhead line (OHL) geometry, OHL wire wear, Ground Penetrating Radar - GPR, etc.).

- Analysis of the **current situation concerning IZS M&R Fleet/Machinery/Depots & Equipment**, including
  - examination of the existing IZS M&R fleet/machinery/depots and equipment in terms its conditions and service life.

- Analysis and detailed considerations of the **organizational aspects of IZS, and investigation of the optimal and most suitable forms of RI-AMS implementation and deployment on the IZS rail network**:
  - detailed analysis of the IZS organizational structure for the purposes of establishing optimal manners of RI-AMS implementation in the given environment. Within this, particular attention must be placed on the possibility of future outsourcing of M&R works to the Infrastructure Maintenance Contractors (IMCs), and the suitable application and utilization of RI-AMS (e.g., defining RI-AMS functionalities that might be allowed to IMCs as possible RI-AMS Users, etc.), as well as the capabilities of IZS to perform the controlling function of the M&R works performed by the IMCs (RIA condition-analysis prior and after the performance of the M&R works, with and without utilization of the RI-AMS)
  - Analysis of at least two European IMs in terms of organizational structure that have successfully introduced RI-AMS in their business and have a similar railway network as IZS. The Consultant should show what were the effects that the introduction of proactive maintenance had in railway infrastructure management and present IMs 'vision in the context of asset management, if any.

- Analysis of **all important aspects concerning the indispensable linking of RI-AMS with the existing IZS financial/accounting ERP system**, with proposals for mandatory modifications/upgrades of the existing ERP system(s) and tools to serve and ensure optimal functioning of the RI-AMS system and its symbiosis with the ERP system, as well as the overall RI-AMS framework, including:
  - Detailed analysis of the current status and functioning of the IZS financial/accounting ERP system, primarily concerning its relation to the infrastructure assets, as ERP system always represent systems of vital importance

to all railway operations and processes, as they record all transactions, all property-ownerships of IZS, and are therefore crucial for all M&R processes. This is especially important in case of outsourcing of M&R works to IMCs, as all records of the works performed by them will be stored in this (ERP) system, as well as all transactions/payments made by IZS to the IMCs as compensations for those works. On the other hand, ERP must contain M&R plans, as based on them M&R works will be performed and financed. This is why RI-AMS system must indispensably be linked with the IZS ERP system, at least in the form of uploading the M&R plans based on technical assessment of RIA, and downloading the M&R records, as they govern the change of RIA and their components, or their condition

- Analysis of all **important aspects concerning the existing IT environment (hardware and software) and its suitability for the implementation of a modern State-of-the-Art RI-AMS**, including proposals for eventual improvements thereof and related budgets and time-frames, including:
    - Examination of the IZS's existing hardware (computers) and an analysis of whether existing hardware can support the implementation of RI-AMS and, if necessary, make recommendations for its improvement with cost breakdown;
    - Examination of the IZS's Information Technologies concerning the RI-AMS domain (basic software packages, systems & tools, financial/accounting systems - e.g., Enterprise Resource Planning (ERP) and Enterprise Asset Management (EAM), DBMS[5], CAD[6], GIS[7], LAN network environment, application servers, etc.).

Deliverables under Activity 2: The Consultant is expected to deliver RI-AMS State-of-Art-Analysis report, which will include analysis of the current state including proposals for the improvement in approaches and related budgets and time-frames, at minimum for the above listed elements:

a. **Railway infrastructure characteristics,** age and service life, maintenance approaches, budget analysis,
b. **RIA data**, data-sources and data-collection procedures, as well as the related Infrastructure Database (ID) and/or Asset Register (AR)
c. **RIA condition-monitoring capabilities**, practices, systems and tools
d. **RIA condition-analysis practices** and capabilities for the purposes of RIA M&R Planning
e. **Suitability of the current IZS organizational structure** and processes for the application of the future State-of-the-art RI-AMS system, to be specified here
f. **Linking of RI-AMS with the existing IZS ERP system**, with proposals and specifications for the mandatory modifications of the existing ERP system to serve and ensure optimal functioning of the RI-AMS system and its symbiosis with the ERP system

[5] DBMS – Database Management Systems, e.g., Oracle, SQL Server, Informix, etc.
[6] CAD – Computer Aided Design, e.g., AutoCAD, MicroStation, etc.
[7] GIS – Geographic Information System, e.g., ArcGIS; QGIS, GeoExpress, etc.

g. **All important aspects concerning the existing RI-AMS IT environment** (hardware and software) and its suitability for the implementation of a modern State-of-the-Art RI-AMS.

3.3 Activity 3: Rail Asset Management Needs assessment and roadmap for introduction of fully functioning road asset management system

Under Activity 3, the Consultant should define together with IZS and MCTI a vision for proactive rail asset management and prepare a needs assessment as a framework for designing a fit-for-purpose product that will match the needs and capacity of IZS. Activity 3 includes, but is not limited to:

- Preparation of **ten-year vision** for rail asset management by MCTI and IZS in consultation with other stakeholders (Ministry of Finance, Directorate for Railways, etc.) with the support of the Consultant. Asset management vision should include:
    - statement accompanied by a summary of objectives and tasks that will serve as a basis for introducing a proactive M&R approach and developing operational RI-AMS. In order to identify the expectations of MCTI and IZS and other government agencies regarding the need for modern RI-AMS and the new approach to railway infrastructure maintenance, the Consultant will conduct interviews and surveys and relevant other analyses.
    - Strategic goals should be defined to meet high level requirements for the railways from the perspective of customers, i.e., passenger and freight operators, and the Government.
- Development of **needs assessment** that should translate Vision into specific recommendations in order to meet high level requirements for the railways and facilitate the introduction of RI-AMS. Needs assessment analysis should include but not limited to:
    - Proposal of intervention plan and define urgent M&R needs to bring the network to the usual level of average residual service lives with an assessment of the costs of these activities,
    - Recommendations for possible external sources of funding (loans) according to the analysis of the state budget burden,
    - Proposal for the most suitable M&R approach for IZS, including inter alia analysis of current contractual arrangements analysing possibilities and providing proposals for the optimal M&R outsourcing contractual concept, market situation, cost of maintenance per km, required equipment for maintenance if to be performed by IZS,
    - Identification of the needs to introduce RI-AMS practice and modern condition-based approach to M&R planning works with respect to the performance of this concept and analysis of the current state of play and state of practice.
    - Examination and recommendation of the RI-AMS type that will be possible to introduce in IZS based on the outputs of the previous analysis: 1) software to be installed and run from a computers, or 2) web-based solution that could be accessed through standard web-browser interfaces; This is supposed to serve as the preliminary investigation for the purposes of preparation for the implementation of the RI-AMS system, as the final investigation will be performed by the eventual supplier of the RI-AMS system during implementation,
    - Identification of the missing data regarding RIA Register/Inventory and investigation of the possibilities and optimal manners of their collection/acquisition in future, e.g., during RI-AMS implementation,

- Identifications of all data that must be exchanged between the ERP and RI-AMS system, in both directions, as well as optimal manners and procedures of performing such exchange (e.g., based on standard web-based Service-Oriented Architecture - SOA).
- Identification whether existing Information Technologies can support the implementation and integration with RI-AMS and, if necessary, makes recommendations for its improvement with cost breakdown;
- Proposal of various possibilities concerning the deployment and enhancement of the condition-monitoring systems, which serve as a direct input to all the tasks aiming at cost-reduction of M&R works, especially in terms of RIA condition-analysis and consequential M&R planning and prioritization, which also represents the core of the future RI-AMS system and thus the cornerstone for its development and network-wide implementation. Particular focus must be provided on trading off the repair, refurbishment and upgrading of the existing IZS condition-monitoring vehicles (e.g., EM80L and EM120 and TVEMA-SEVER), particularly in terms of their additional equipping with new/additional measuring systems and optimizing their deployment on the IZS network, i.e., their simultaneous or particular use on certain parts of the IZS network,
- Proposal for eventual necessary changes to be introduced into the IZS organizational structure for the purposes of the most efficient and effective deployment of the RI-AMS system, including identification of needs in terms of the existence of a sufficient skilled workforce and their knowledge about the approach to proactive and predictive maintenance and understanding of the need for implementation of a RI-AMS system.

- Development of **functional RI-AMS configuration** in order to obtain fit-to purpose system. The functional scheme should include but not limited to:
  - Examination of functional characteristics of the RI-AMS configuration in order to meet the requirements specified in vision and needs assessment,
  - Examination of potential phasing approach and several scenarios for RI-AMS implementation in close cooperation with IZS in order to design fit-to purpose system that will satisfy IZS current and future needs.

- Preparation of **RI-AMS implementation roadmap** that considers overall phasing of the identified improvement initiatives to close the identified gaps and RI-AMS implementation. Roadmap should include but not limited to:
  - Preparation of Action plan with detailed description of key improvement initiatives for RIA inventory, maintenance approaches, budgeting, staffing etc. that are focused on achieving successful implementation of the RI-AMS program and realizing its associated benefits. Initiatives should be prioritized in close cooperation with MoCTI and IZS, categorization in short term and long-term activities with defined timelines, define appropriate governance structure and processes that will manage and guide the implementation of the improvement initiatives and cost estimates for each.
  - Preparation of Action with detailed agreed phasing for RI-AMS implementation with description of the implementation approach/methodology, timeline and cost estimates.

Deliverables: 1) State-of-Play and State-of-Practice report 2) Need assessment report, 3) Functional configuration of RI-AMS, 4) Roadmap for establishing environment for RI-AMS introduction and its implementation.

3.4 Activity 4: Preparation of Implementation plan and Technical Specifications for RI-AMS

Under Activity 4 the Consultant will include preparation of implementation plan as basis for the development of bidding documents as well as bidding procedure, evaluation and contracting procedures and Technical Specifications for advanced RI-AMS which need to be formulated into specific itemized (point-to-point) requirements, for which the prospective Suppliers of RI-AMS solutions must provide tangible written proofs that their offered RI-AMS indeed satisfies these requirements.

3.4.1 Sub-Activity 4.1: Implementation Plan

Under Sub-Activity 3.1 the Consultant will prepare the Implementation plan that should include, but not limited to:

- Performing the Market analysis and existing suppliers. The Consultant should do the analysis so that IZS and MCTI to gain awareness of the products that are available for procurement and their price estimation,
- Analysis of suitable procurement procedures and methods in accordance with the Bank's Procurement Regulations, forms of contracts, with an overview of its advantages and disadvantages and make recommendation for both, time and cost-efficient procurement method.
- Defining procurement strategy with the presentation of several procurement scenarios, their analysis with briefly summarized pros and cons of each approach and make a recommendation for the best strategy.
- Developing comprehensive qualification criteria (economic and financial capacity, professional capacity, and technical capacity) for the Bidding Documents, which will be prepared by the CFU;
- Identification of risks for the procurement strategy and risk management process
- Preparation of overall procurement time schedule with bidding procedures planner.

3.4.2 Sub – Activity 4.2: Technical specifications and Procedural aspects

Under Sub-Activity 4.2 the Consultant will prepare Technical specifications that should include, but not limited to:

I. Overall scope of RI-AMS and its important general characteristics:

- RI-AMS should enable collection, storing, displaying and analyzing all data concerning railway infrastructure, including (but not limited to) inventory, condition, work-history, layout and operating, as well as all other relevant data, coming either from hard-copy sources, and those from eventually existing 3rd party systems and tools, through a single RI-AMS user-interface and allow detailed and comprehensive visualization, long-term trending based on deterioration modeling, and automatic rule based M&R planning;
- RI-AMS should be full scaled, i.e. to support data-storage capability, displaying all relevant information, data-analysis capabilities and automatic M&R planning capabilities for all rail infrastructure assets: 1) Track and Switches & Crossings, 2) Engineering Structures

(tunnels, bridges, etc.), 3) Level Crossings, 4) Overhead Line and Power Supply Systems (e.g. EEP & ETP), and 5) Signalling and Telecommunications Systems;
- RI-AMS should allow M&R works to be planned in period of every week/month/year in advance. The plan should include details concerning the types of M&R works and related location information. On the basis of this plan, necessary (weekly/monthly/annual) financial funds should be predicted;
- RI-AMS should include a set of tools, modules and functionalities, to assist in the overall RIA M&R works and inspection recording, RIA condition-analysis, predictive/preventive M&R planning, as well as integration capabilities with EAM/ERP systems and other 3rd party supporting IT systems, databases and/or file-systems within IZS' IT environment;
- RI-AMS should contain and support multi-Level User-types, which would allow the establishment of roles within RI-AMS that would enable users to use various RI-AMS functionalities based on their specific roles, in order to enforce the most efficient workflow and outmost security of the system;
- RI-AMS should automatically generate appropriate reports whose form, content and purpose should be agreed with the IZS. RI-AMS system's reports should be subject to modification so that changes can be made to the contents/format of the automatic reports. RI-AMS should be able to export data into MS Excel formats.

II. Key RI-AMS functionality aspects that must be described in detail within the Technical Specifications, where each of the following functionality aspects must be devoted a separate chapter with detailed itemized (point-to-point) requirements:
- ***Completely flexible database structure***, providing full freedom in the incorporation or linking of data in (as many as possible) different formats, thus considerably facilitating the connection to external systems (e.g., the already existing IZS financial/accounting systems, i.e., ERP/EAM) and/or databases as well as condition-monitoring systems.
- ***Full Inventory of RIA***, with their location, properties (e.g., types of rails, sleepers, ballast, fastenings, overhead-line contact wire, third rail, etc.), their installation dates (providing age & accumulated tonnage), speeds, grades, annual tonnage, condition (e.g., all kinds of measurements & inspections, performed by measuring vehicle(s) and/or by walking and visual inspections) and activities (e.g., M&R works, inspections).
- ***Ability to model the entire railway infrastructure***, i.e., all RIA, both the linear/spatial ones, such as rails, sleepers, OHL, etc. (using "Link" and "Node" objects), as well as all kinds of singular (point/discrete) objects (e.g., Switches & Crossings, Bridges, Culverts, Level-crossings, etc.) and their sub-components.
- ***Liner/Spatial referencing of all "distributed" properties*** (e.g., track geometry parameters, rail profile, rail corrugation, overhead line (OHL) geometry and wear parameters, etc.
- ***Capability to handle both GPS and linear asset referencing*** (chainage), with the ability of generating Geographic Information System (GIS)-like Thematic Maps.
- ***Superb Visualization of all relevant data*** (e.g., inventory, layout, condition, operation/exploitation, activity history, economy, work plan, images, videos, etc.) (**Error! Reference source not found.**).
- ***Flexible Segmentation*** (user-defined, modifiable, unlimited number of criteria and dependencies), effectively performing a discretization or conversion of linear/spatial assets into track segments, i.e., singular assets of any user-defined length, as well as bound to any user defined strategy (e.g. depending on the infrastructure characteristics, layout and operating data, etc.).
- ***Sophisticated generic Deterioration Modelling & condition forecasting*** (applicable to all assets and their condition parameters (e.g., rail wear, any of the track geometry parameters,

OHL contact wire geometry, OHL contact wire wear, etc.), with utilization of linear and non-linear deterioration curves, short and long-term behavior analysis, forecasting and consequential M&R works planning).

- ***Inference Engine with a completely flexible creation of Decision Rules and Thresholds*** (flexible, user-definable and modifiable Decision Rules making use of Deterioration Models, completely free and user-friendly Rule Editor; ability to plan any kind of activity (M&R Works, Inspections, etc.) or choose any of the already available Decision Rules in the standard/default Rule-base; ability to use official & unofficial rules for simulations, etc.).
- ***Automatic M&R Planning and Grouping and support for Maintenance Resources Budgeting***, flexible, user-definable and modifiable.
- ***Extensive Network-level Management, Reporting, Exporting and Statistics functionalities***, flexible, user-definable and modifiable.
- ***Simulations*** (allowing testing and checking of various M&R Policies, different standards and strategies, and evaluating their outcomes in terms of achieved quality and incurred costs, both in short and long term).

III. ***Essential aspects of the RI-AMS analytical processes*** that must be described in detail within the Technical Specifications, where each of the following aspects must be devoted a whole chapter with detailed point-to-point requirements:

- Analyze of information coming from condition-monitoring sources to be analyzed through the Table/Strip-Chart view, where users can set parameters to filter by date, region, type of data, and other parameters to generate a tabular list of defects. Users should be able to select a particular defect to display it on a map and/or view raw-data waveforms/traces based on time or distance (e.g. continuous track geometry data, rail profile data, OHL geometry data, etc.) or multi-media files (such as photos). RI-AMS should contain a standard engineering "Track Chart" view (Figure 3) which should be able to bring RIA inventory, condition, defect and M&R information together into one geospatial graphical interface. The RI-AMS Track Chart view should allow schematic representation of lines and tracks connections, e.g. in stations and yards, and which represents the key component of the Table/Strip Chart view and which includes schematics of the linear and point/singular assets, as well as curves. RI-AMS Track Chart view should also enable users to query for M&R information to be shown on the Track Chart. In this sense, the Track Chart view should enable as minimum the following key functionalities with respect to M&R tasks:
    - Display of M&R tasks at various stages (Proposed, Completed, etc.) on the track view as icons.
    - Display of M&R icons for linear RIA (assets) as bars adjacent to the Track Chart schematics
    - Color-coding of M&R icons based on the severity of the M&R.
    - Display of predicted RIA deterioration with the Track Chart.
    - Dynamic capability where users can select an RIA (asset) to bring up that asset's form, and where similarly, users can click on a M&R task and bring up the corresponding M&R form.
- Map View functionality similar to the Track Chart view, but which needs to provide a geospatial map and have the ability to add satellite imagery to view the RIA data. Also similarly to the Track Chart view, the Map View should be able to bring asset inventory, defect and M&R information together into one geospatial interface. The Map View should also allow the filter and view of RIA inventory, defect and M&R information in the map,

as well as possess a dynamic capability where users can select a RIA (asset) to bring up that asset's and M&R forms, just like in the Track Chart View.

– Enable two levels of data-analysis:

  - Low-level Analyses which include manual deep/thorough analyses (usually for shorter track stretches and on a short-term basis) of any of the RIA condition parameters, independently or in cross-examination with any number of other given parameters.

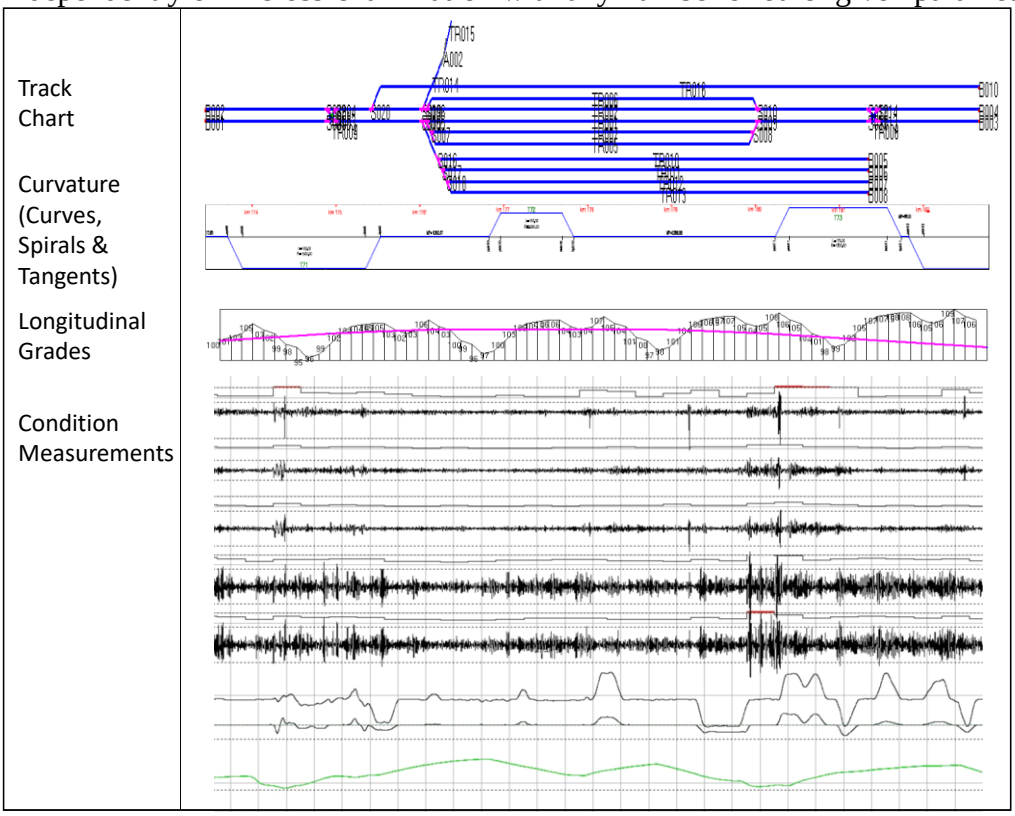

Figure 3: An example of RI-AMS Visualization Concept

  - ***High-level Analyses*** which include an automatic analysis of any asset (or any group of assets), or any part of a network (usually of larger scale, such as network-regions or even the entire network) on a short-, middle- and/or long-term basis, based on the User-defined sets of Decision Rules and Thresholds, powered by the Deterioration Models.
  - ***Essential aspects of the analytical processes which RI-AMS needs to meet:***

- All measured RIA condition-information (e.g., coming from various measuring vehicles or visual inspections) must be subjected to DMs appropriate for each and every asset/object/component and their particular condition-parameter, for both singular assets/objects (and their components), and segmented linear/continuous assets/objects. The DMs must be able to "capture" the behavior of designated condition-parameters throughout the "known past" (for/during which the condition-measurements are available), after which this captured behavior must be possible to be used for forecasting purposes.
- All designated data must be processed automatically to define optimal M&R plans, according to given (manually and automatically modifiable) scenario characteristics and constraints.
- For resulting M&R works there must be a possibility for checking against available resources and given (modifiable) constraints in order to run the Prioritization,

yielding an optimum set of M&R works to be performed to achieve the desired quality, or moreover the (definable/modifiable) balance between costs and quality, as well as between maintenance and renewal volumes.

- For highest priority set of realistically feasible M&R works (within the given resource constraints) must be gathered together to achieve the best economical effect/savings coming from performing works together within the same track possession periods (TPPs), respecting given (modifiable) capacity of available machinery and staff, as well as durations of available TPPs.

IV. RI-AMS must contain a dedicated RIA Inspection Recording Application (IRA). Key aspects of the RIA Inspection Recording Application:

- Must allow management of RIA inspection scheduling, defect recording (mobile application dedicated to field/in-track logging of identified defects during walking inspections), as well as regulatory and management reports.
- Must be compliant with recognized international rules and regulations related to RIA inspection record keeping, such as UIC[8], CEN[9] or AREMA[10].
- Should be able to operate both "Online" and "Offline", in case of inspections occurring in remote areas of the railway network where no mobile signal-reception exists. RI-AMS IRA should enable Offline (disconnected) operation with no substantial installation and configuration requirements.
- Should contain and support multi-Level User-Roles, which would allow establishment of roles within IRA that would enable users to use various IRA functionalities based on their specific roles, in order to enforce the most efficient workflow and outmost security of the system.
- Should enable creation, modification and application of flexible business rules engine that would allow for IZS specific needs. Business rules to be developed and agree with IZS.

V. RI-AMS must contain a dedicated M&R Work Recording Application. Key aspects of the M&R Work Recording Application (WRA):

- Represents a mobile application dedicated to field/in-track recording/logging of all important aspects concerning the performed M&R Works, including, but not limited to:
    - type of M&R work
    - time/duration and place (line/track, chainage) worked,
    - reasons for undertaking the M&R work
    - defects eliminated by the M&R work
    - material used within the M&R work
    - assets modified (e.g., replaced) within the M&R work
    - gang/IMC[11] performing the work, with staff-members info
    - machinery used for the performance of M&R work etc.

[8] UIC – *L'Union internationale des Chemins de fer* (International Union of Railways)
[9] CEN – European Committee for Standardization
[10] AREMA – American Railway Engineering Maintenance of Way Association
[11] IMC – Infrastructure Maintenance Contractor

VI. Essential aspects of the intended RI-AMS utilization:

- ***RI-AMS must allow its utilization not only by the IZS, but also by all other recognized important stakeholders***, respective of their interests and roles. Here, the most important examples would be the Ministry of Construction, Transport, and Infrastructure (MCTI) and possibly also Ministry of Finance (MoF), as well as Rail Directorate (RD).

VII. Key non-functional RI-AMS aspects (each aspect to be devoted a separate chapter with itemized/point-to-point requirements):

- Anticipated RI-AMS Software Architecture;
- Anticipated RI-AMS Hardware Architecture;
- Linking RI-AMS with the IZS ERP system;
- Data Conversion and Migration needs and procedures;
- Number and geographical locations/disposition of the RI-AMS users within IZS.

Beside the technical aspects in the specification, the document should also address **procedural aspects** concerning the overall RI-AMS implementation process (each aspect to be devoted a separate chapter with itemized/point-to-point requirements)**:**

- RI-AMS Procurement/Development and Implementation Plan
  - Inception Period
    - Establishing current situation concerning RIA register & RI-AMS
    - Analysis of the current situation/environment at IZS for the purposes of RI-AMS implementation
    - Preparing RI-AMS Supply/Development & Implementation plan
  - Implementation Period
    - Performing full-scale RI-AMS Implementation at IZS
      - Extracting IZS RIA location and characteristics information and incorporating it into RI-AMS
      - Extracting IZS RIA condition information and incorporating it into RI-AMS
      - Supplying/developing RI-AMS and performing its full-scale Implementation at IZS
      - Linking RI-AMS with the Client's ERP
    - Demonstration run of RI-AMS and the Acceptance Test
    - Submission of the Final Implementation Report
  - Dissemination Period
    - RI-AMS Training
    - RI-AMS Commissioning (i.e., monitoring/supervising the use of RI-AMS by IZS' personnel ensuring its stable and reliable use) with a minimum duration of 3 months
- RI-AMS Supplier Staff Requirements
  - Key experts
  - Non-key experts
  - Support staff & backstopping
- Additional, Non-Engineering Requirements for the RI-AMS
  - RI-AMS operating Language (Serbian)
  - IZS Operating System & IZS IT Environment
    - RI-AMS Database for Back-End
    - RI-AMS Source code

        - RI-AMS Software Warranty, Maintenance & Support Licenses and Contract (minimum 3 years of Warranty, followed by 7 years of Maintenance & Support to be included and priced within the RI-AMS Supply Offer)
        - RI-AMS Documentation Requirements
    - Project management
        - Responsible body
        - Management structure
            - Operating Structure
            - End Recipient of Assistance
            - Senior Representative of the End Recipient (SRER)
            - Steering Committee (SC)
    - Logistics and Timing
        - Location
        - Start date & period of implementation
    - Project Reporting
        - Reporting requirements
        - Submission & approval of reports
- APPENDICIES

Deliverables: The Consultant should deliver detailed Technical Specifications for the procurement with cost estimates and procedural aspects for implementation of a State-of-the-art condition-based RI-AMS.

3.5 Activity 5: RI-AMS Trainings

The Consultant will organize and run eight trainings (one per month) in general aspects of application of RI-AMS systems and overall best-practices in the RI-AM and M&R-management domain. The specific content of the trainings will be confirmed during the Inception phase of the Services and may cover the following topics:

a. Railway asset management principles and international regulatory framework;
b. RIA characteristics, their behavior and lifecycle, data relationships between assets and operations/budget;
c. Migration strategies for shifting from corrective, prescriptive and cycle-based maintenance approach towards predictive and condition-based approach;
d. RIA Registering/Inventorying
e. RIA condition-monitoring and data-collection
f. Systematic RIA field-inspection, including track-walks and relevant on-site data recording (in-track, mobile application)
g. Systematic RIA M&R Works recording (in-track, mobile application)
h. RIA condition-analysis for the purposes of M&R planning
i. Formulation of RIA M&R decision-rules by their conversion from relevant IZS Standards, Regulations and Rulebooks and their application for M&R planning
j. M&R Grouping & Scheduling, for the purposes of resource-allocation optimization, including track-possession windows, staff and machinery
k. Basics of the key RI-AMS constitutive techniques, such as:
    i. Failure Mode, Effects and Criticality Analysis (FMECA),
    ii. Cost-benefit analysis (CBA),
    iii. Life-Cycle Costing (LCC) and
    iv. Reliability, Availability, and Maintainability (RAMS);

The Consultant can suggest other areas that should be covered by trainings based on the conducted interviews of IZS and MCTI employees in order to fill out eventual knowledge gaps.

Within the proposal the Consultant must elaborate the main concept of training delivery, channels of training delivery, etc. Before the start of the training, the Consultant must develop the Training Plan, including desired profiles of the attendees, proposed content and durations of the Training sessions for each of the topics and submit it to IZS for approval. Full-scale detailed Training material must be distributed to all participants. Serbian translations of the Training documents must be submitted at least 1 week before the Training date in order to increase the effectiveness of the Training.

Trainings will be attended by a group of 15 to 20 IZS and MCTI staff. Each training is expected to last a day. The trainings need to be conducted in the Serbian language.

Deliverables: Training plan subject of approval of the client and Training material with collected feedback from participants on usefulness of the training, recommendations for improvements etc.

Component 2: RI-AMS Procurement and Implementation stage

3.6 Activity 6: Procurement and Implementation supervision support

3.6.1 Sub-activity 6.1: Procurement stage

Under Sub-activity 6.1, the Consultant should provide technical and operational support to PIU and IZS and assist in bidding, bids evaluation, contract finalization to facilitate the timely and effective implementation of the introduction of RI-AMS in IZS operations.

Within this activity, the Consultant will provide support in the incorporation of qualification criteria and technical specifications in the bidding documents and it will be involved as an observer in the selection process to ensure compatibility with requirements and achieve agreed project objectives and results.

3.6.1 Sub-activity 6.2 Implementation Stage

Under Sub-activity 6.2, the Consultant is expected to support the IZS and PIU in supervising the implementation and ensuring that developed system and features are fully in line with the technical specification. Within this activity, the Consultant is expected to provide hands on support and rapid feedback and guidance to the RI-AMS developer and IZS and PIU.

During this phase, the consultant will be available to IZS and MoCTI in order to ensure the practical application of the system, i.e. to enable fully operational functioning of both the equipment itself and the employees who will work on the implementation. The activity will include support in implementation of the systems, including supervisory services during installation, testing and commissioning/acceptance run of RI-AMS as well as software and hardware systems, carried out by appointed supplier(s) to ensure adherence to all requirements and specifications. Consultant should participate to meetings with the RI-AMS supplier provider and monitor and update the its delivery plan. Following successful installation, commissioning and testing of the RI-AMS, a User Acceptance Test (UAT) is to be carried out (either as part of the commissioning or after) and a UAT report should be reviewed by Consultant before approval by the MCTI. Also, The Consultant will supervise submission of a comprehensive Operation and User – Maintenance Manual, Training/Capacity Building for the staff on the manual and RI-AMS, followed by handing over of the completed RI-AMS.

Deliverables: The Consultant should deliver monthly progress reports of these activities.

4 Timeline and deliverables

4.1 Timeline

The Services are expected to start in December 2022. The commencement date will be five days from the date of Contract award.

The period of implementation of activities from 1 to 5 (Component 1) will be 12 months starting from the commencement date. Activity 6 (Component 2) will commence once the RI-AMS bidding document is issued and it will last up to additional 12 months.

The Consultant will carry out the Services in line with a detailed time schedule to be submitted as part of his proposal.

4.2 Deliverables

The deliverables related to Activities 1 to 5 should be delivered in accordance with the following timetable, and linked to the payments as a percentage of Lump sum amount:

Deliverables	Description	Due date	Payment
Inception Report	Describe the initial findings, progress in collecting data, any difficulties encountered or expected, the proposed approach to the project, taking into consideration the situation at the starting date of the assignment. It will also set out a detailed work plan for completion of the activities. If there are any proposed modifications to the original Terms of Reference due to changed circumstances after arrival on site, these are to be discussed and agreed in principle with the Client and IZS before the submission of the Report (up to 20 pages)	1 month after commencement	15 %
RI-AMS State-of-the-Art	Report presenting data collection, analysis, findings and conclusions from Activity 2.	6 months after the commencement	25%
Vision towards proactive Rail asset management, Needs Assessment Report, RI-AMS functional configuration and Roadmap	Report presenting data collection, analysis, findings and conclusions from Activity 3.	8 months after the commencement	25%
Technical and functional specifications with cost estimates and procedural aspects for the procurement and implementation of the RI-AMS	Report presenting data collection, analysis, findings and conclusions from Activity 4.	No later than 10 months after commencement	20%

Deliverables	Description	Due date	Payment
RI-AMS Trainings	For each one of the 8 trainings described in Activity 5: training material, attendance list, feedback from participants on quality of training, and minutes with main observations from training	No later than 12 months after commencement	5%

The deliverables related to Activity 6 should be delivered in accordance with the following timetable:

Deliverables	Description	Due date	Payments
Quarterly Progress Reports	Report should include as minimum information on: progress of works, identified problems and possible risks, with proposed mitigation measures, test result with identification of any gaps, incompleteness or failings occurred during testing and remedial actions, cost assessment/analysis and recommendations, time assessment/analysis and recommendations, activities planned for the next month (reporting period), minutes of meetings	Not later than 1 week after the end of month	Quarterly payments according to the actual working days spent and fixed daily fee rate for the experts
Final report	There must be a final report for the Contract, final invoice and the financial report at the end of the period of execution. Final Report shall, inter alia: • Describe the overall status of the RI-AMS rollout, including a critical study of any major problems which may have arisen during the RI-AMS implementation; • Describe the status and results for the assistance given to IZS; • Present any recommendations the Consultant wishes to make in view of improving the design and implementation of any future similar activities.	No later than 1 week upon completion of the activities under the contract	

Consultant should submit the quarterly progress reports containing detailed description of the project progress (technical and financial) including problems encountered, planned activities for the next 3 months (up to 30 pages)

Quarterly reports must include a summary of the progress of the services defined under Section 4 of these ToR, with particular reference to major activities and those on the critical path for completion of the works.

The reports must detail delays and difficulties encountered and proposed mitigation measures to alleviate them and provide future projections for implementation of the activities.

5 Client organization, Services input and Contract monitoring

5.1 Client organization

a) IZS is final beneficiary of this technical assistance and it will nominate the competent and dedicated employees i.e. staff with necessary qualifications with respect to planning and carrying out inspection and maintenance operations and authorization to provide full support to the consultant and help collecting the data and stakeholders during performed work;

b) In addition, Project Implementation Team (PIT) within IZS will be involved in day-to-day activities related to the Services. The PIU/MCTI and the IZS through its nominated shall be involved in the decision-making processes regarding the Contract implementation and shall be kept informed in all stages related to contract(s) monitoring and implementation. The cooperation with the final beneficiary will be sustained and managed by the PIU;
c) The background documents and reports stated in this ToR will be supplied by the IZS and/or the PIU in a timely manner

5.2 Client input to the Services

- Strategic plan IZS for the period 2017 to 2027
- Technical Assistance Reports and Data Bases:
  - **CONNECTA Consortium.** Technical Assistance to Connectivity in the Western Balkans: *Preparation of Maintenance Plans 2018-2022 for Road/Rail TEN-T indicative extensions to WB6*. EuropeAid/13785/IH/SER/MULTI.
  - **World Bank.** Technical assistance on the Enhancing Infrastructure Efficiency and Sustainability Program for-Results: *Serbia Railways Asset Management Plan Using Life Cycle Costs.*
  - **KPMG.** Technical assistance on Comprehensive Railway Reform. Deliverables: Asset Management Strategy (2017), Asset Management Guidelines and Asset Management Plan (2019)
- Programs for construction, reconstruction and maintenance of railway infrastructure, organization and regulation of railway traffic and their accompanying reports on it implementation,
- Current RIA registers,
- Information on the current state of the railway infrastructure maintenance machinery.
- and Other relevant documents prepared for the Client in the previous period, which can facilitate and optimize the work of the Consultant for the preparation of this Study.

5.3 Contract monitoring

All reports and other outputs, if any must be written in English and translated into Serbian language. The draft version of the reports (electronic copy) shall be submitted to PIU for distribution to the MoCTI and IZS.

The commenting period for the outputs is 3 weeks. In case of no-reaction to the submitted outputs such status will be interpreted as “no objection” and shall be deemed as approved.

All reports are subject to approval of the MoCTI.

Consultant shall prepare the Minutes of Meetings (MoM) for the monthly progress meetings, meetings with other stakeholders and meetings with suppliers. All Meetings must be ensured to lead to clear decisions, persons in charge and deadlines. MoM will be distributed by the Consultant. MoM must be commented within 7 calendar days by participants. MoM for the monthly progress meetings will be always in the agenda of the next monthly meeting to be approved and followed up.

All deliverables will be sent as electronic copies to PIU.

Hard copies of the deliverables will be send to address of PIU of SRSM project, presently 22-26, Nemanjina street, office 16, 11000 Savski Venac, Republic of Serbia.

6 Requirements and evaluation criteria

6.1 Qualifications and experience of the firm

The Consultant firm will be selected in accordance with QCBS (Quality and Cost Based Selection) method set out in the World Bank's Procurement Regulations for IPF Borrowers (July 2016, revised November 2017, August 2018 and November 2020).

The assignment will require a qualified consulting company or consortium that can demonstrate extensive experience in Technical assistance service for the contract.

The following shortlisting criteria will be applied to all consulting firms that have submitted EoI:

i) The Consulting firm must be a legal entity;
ii) **General Experience:** Experience in railway sector with at least 2 projects in railway related sector in the past 8 years;
iii) **Specific Experience:** The consultant (individual company or joint venture altogether) must demonstrate extensive experience in delivering similar size scope work by presenting, at least 2 projects successfully completed in the last 8 years in the field of Asset management information systems in state-owned railways enterprises.

   As a proof, the Consultant firm shall prepare a table listing following information: name of the relevant assignment, name of a firm that conducted the assignment, short explanation of scope of work, year of contract implementation, country/region, contact reference (name, e-mail, phone number).

iv) **Availability of qualified experts within the organization/JV** with relevant experience in the field of Rail asset management system. As a proof, the Consultant firm shall provide organization chart and list of qualified experts within the firm who are relevant to the assignment, position in the firm and short description of relevant qualifications and experience.

Key Experts' CV are not required and will not be evaluated at the shortlisting stage.

Allocation of points:

i. General Experience 30 points
ii. Specific Experience 40 points
iii. Availability of qualified experts 30 points

6.2 General team requirements

The Consultant shall establish his Team in accordance with the needs and requirements of this ToR. The Team shall consist of a core team made of key experts with the qualifications and skills defined in Section 6.3 and non-key experts, as needed (Section 6.4).

The Consultant shall be responsible for organization of its Team in such a way to ensure the technical assistance services are executed in accordance with the Services. The Consultant is obliged to ensure adequate staff in terms of expertise and time allocation, as well as needed equipment in order to complete the activities required under the scope of work and to achieve the objectives of this Contract in terms of time, costs, and quality.

The Team, as a whole, shall include experts familiar with RoS' regulations. The team organization, proposed staff availability and number of working days assigned to specific activities and backup will be evaluated as one of the major criteria within the evaluation of the proposed methodology and time schedule.

All the team members assigned by the Consultant must be able to communicate effectively in English. A sufficient number of the Consultant's team should be fluent in Serbian language.

The employment of local experts will be welcomed by the Client. The Consultant should pay attention to the need to ensure the active participation of local professional skills, and to provide a suitable mix of international and local staff in the Team.

Higher women representation among key experts will be considered as advantage.

All experts shall be free from any conflicts of interest in the responsibilities they take on.

Staff of the public administration of the Republic of Serbia cannot be proposed as experts.

6.3 Key experts

The Key-experts team for Activities 1-5 (RI-AMS design stage) includes the following profiles.

Title	Qualifications/Experience	Other Skills
Team Leader (RI-AMS expert, or expert in other linear/spatial infrastructure Asset Management)	Education: • Minimum a M. Sc. Degree in appropriate rail (or other linear/spatial) infrastructure engineering (e.g., roads) Relevant professional experience: • At least 15 years of general professional experience of which at least 7 years' experience in implementing railway (or other linear) infrastructure asset management systems • At least 10 years of working experience and at least 2 similar projects providing services in the field of RI-AMS Design or Management, RIA Condition-monitoring, Condition-analysis and M&R Management/Planning or undertaking • Have a focus of professional experience in design and implementation of asset management systems especially for network linear/spatial infrastructure (minimum two projects)	Excellent command of the English language. Computer literacy. Knowledge of Serbian language will be an advantage
Financial management systems (ERP/EAM) analysis and Business Modelling expert	Education: • Minimum a M.Sc. degree in financial and management accounting, or business administration with strong accounting component. Relevant Professional Experience: • At least 10 of general professional experience of which at least 5 years in accounting/audit at public enterprises	Communication skills, fluency in English. Knowledge of Serbian language will be an advantage

Title	Qualifications/Experience	Other Skills
	and/or companies related to linear/spatial infrastructure networks (e.g., rail, road, pipelines, powerlines, etc.) • Have a focus of professional experience in design and implementation of financial management systems (ERP, e.g., SAP, MAXIMO, Ellipse, etc.) meeting relevant international accounting standards for major public and private enterprises (minimum 2 projects)	
Railway infrastructure maintenance/ Infrastructure Assets Condition-monitoring expert	<u>Education:</u> • Minimum a M.Sc. in Civil engineering or another relevant engineering field; <u>Relevant Professional Experience:</u> • At least 10 years of general professional experience of which at least 5 years of experience in the domain of rail infrastructure maintenance management, execution and/or condition-based M&R Management/Planning • At least 5 years of experience with RIA condition-monitoring vehicles, systems and tools including at minimum: Track Geometry, OHL Geometry, Rail profile, OHL Contact-wire wear, Rail corrugation, and preferably also machine-vision systems, Ground Penetrating Radar (GPR), ADAS/UAV (Automated Data Acquisition Systems – Unattended Aerial Vehicles, e.g., "drones" and drone-based RIA monitoring/measuring systems). Experience both at Suppliers/producers of the mentioned systems as well as at their Users (e.g., railways, infrastructure managers, infrastructure maintenance contractors, professional providers of RIA condition-monitoring services etc.) is equally acceptable.	Communication skills, fluency in English. Knowledge of Serbian language will be an advantage
Railway Infrastructure Asset Maintenance & Renewal Machinery expert	<u>Education:</u> • Minimum a M.Sc. degree in Mechanical engineering or another relevant engineering field; <u>Relevant professional experience:</u> • At least 10 years of working experience in the field of infrastructure maintenance and renewal • At least 5 years of experience with RIA maintenance management and/or undertaking, including at minimum working with: Tampers, Grinders, Ballast-cleaners, Track-laying Machines/Trains, Switch-tampers, Dynamic Track Stablizers (DTS), rail-laying machines, sleeper-laying machines, maintenance draisines, etc. Experience at Suppliers/producers of the mentioned machinery, or at companies dealing with their maintenance, repair and refurbishment, or at their Users (e.g., railways, infrastructure managers, infrastructure maintenance contractors, etc.) is equally acceptable.	Communication skills, fluency in English. Knowledge of Serbian language will be an advantage
Information Systems expert	<u>Education:</u> • Minimum a M.Sc. degree in one of the fields of computer engineering, electrical and/or electronics engineering, industrial engineering, computer sciences, information technologies <u>Relevant professional experience:</u> • Minimum 10 years of working experience as a system analyst and/or IS expert on information systems	Communication skills, fluency in English. Knowledge of Serbian language will be an advantage

Title	Qualifications/Experience	Other Skills
	development projects for nation-wide organizations, covering a large number of end-users. • Minimum 5 years of working experience in all phases of database development (logical design, physical design and implementation) with the relevant DBMSs. • Minimum 5 years of working experience as a software development team/component coordinator/leader in information systems development projects will be considered as advantage. • Tangible, proven hands-on experience with IT hardware, especially that needed in the domain of IS. • Experience in implementing RI-AMS or alike will be considered as advantage	

The Key-experts team for Activity 6 (RI-AMS procurement and supervision stage) should consist of the following experts from the previous table: Team Leader, Railway Infrastructure Assets Condition-monitoring expert and Information Systems expert.

6.4 Non-key experts (NKE)

Consultants are expected to include in their proposals other positions that they consider necessary for the assignment. If shortlisted, the CVs for non-key experts should be submitted in the proposal, however they would not be subject of evaluation. Non-key experts may include for example:

- Railway Electrification (power supply and overhead-contact line) expert
- Railway Signaling & Telecommunication expert
- Geodetic expert
- LCC expert
- RAMS expert and FMECA expert
- CBA expert
- Database Design & Development specialist
- Software Design & Development specialist
- GIS expert
- Procurement expert
- Administrative and support staff.

6.5 Location and travel

Operational base for the Contract will be Belgrade. Internal travel within the RoS might be required. The Consultant is expected to be flexible in terms of travelling.

6.6 Office accommodation

Office accommodation for each expert working on the Contract is to be provided by the Consultant.

The Consultant shall ensure that experts are adequately supported and equipped. In particular, it shall ensure that there is sufficient administrative, secretarial and interpreting provision to enable experts to concentrate on their primary responsibilities.

No equipment is to be purchased on behalf of the neither Client (MCTI), PIU or Beneficiary (IZS) as part of this service contract or transferred to the Client or beneficiaries at the end of this Contract.

7 Terms of Payment

The Consultant should note that the proposed contract for this assignment will be as follows:

- For Activities 1-5 (Component 1: RI-AMS Design stage) – Lump Sum payments with milestones against submission of deliverables and,
- For Activity 6 (Component 2: RI-AMS Procurement and Implementation stage) – Time Based with periodic payments against time actually spent on the services.

8 Conflict of Interest

The engaged Consultant firm must not be involved in any other related activity to this Project.