Routine Maintenance Management System (RMMS)
of Egnatia Odos Motorway

Ioanna Ch. KARAKAIDOU, Dimitrios E. EVANGELIDIS and Georgios A. BANTELAS, Greece

Key words: routine maintenance management, outsourcing, GIS

SUMMARY

The use of an information system for the management of the motorway routine maintenance on the Egnatia Motorway has resulted as a need after the company’s (Egnatia Odos SA) decision to proceed to the outsourcing of the relevant works, thus changing the traditional way of procurement, which was the direct labor.

"Egnatia Odos SA" (EOSA) uses an information system (Routine Maintenance Management System - RMMS) for the effective management of the routine maintenance of the motorway. This information system allows EOSA to control the works of the maintenance contractors, in order to improve the quality and effectiveness of the maintenance services. The principle aim of the RMMS is to manage and optimise the maintenance of the motorway with respect to traffic safety and maintenance costs. The RMMS database comprises information relating to the geographical location of the road network, maintenance requirements, required resources for planning maintenance works and the performance of the maintenance contractors.

ΠΕΡΙΛΗΨΗ

Η χρήση ενός πληροφοριακού συστήματος για τη διαχείριση της στοιχειώδους συντήρησης του αυτοκινητοδρόμου της Εγνατίας Οδού προέκυψε ως ανάγκη κατόπιν της αποφάσεως της εταιρείας (Εγνατία Οδός ΑΕ) να προχωρήσει στην εκτέλεση των σχετικών εργασιών με εξωτερικούς συνεργάτες, αλλάζοντας τον παραδοσιακό τρόπο εκτέλεσης των εργασιών που ήταν μέχρι σήμερα η μεθόδος της αυτοεπιστασίας.

Η Εγνατία Οδός ΑΕ (ΕΟΑΕ) χρησιμοποιεί ένα πληροφοριακό σύστημα (Σύστημα Διαχείρισης Στοιχειώδους Συντήρησης – ΣΔΣΣ) για την αποτελεσματική διαχείριση της στοιχειώδους συντήρησης του αυτοκινητοδρόμου. Αυτό το πληροφοριακό σύστημα παρέχει στην ΕΟΑΕ την ικανότητα να ελέγχει τις εργασίες των εργολάβων συντήρησης προκειμένου να βελτιώσει την ποιότητα και την αποτελεσματικότητα των υπηρεσιών συντήρησης. Ο απώτερος σκοπός του ΣΔΣΣ είναι η επαρκής διαχείριση και η βελτιστοποίηση της συντήρησης του αυτοκινητοδρόμου σε σχέση με την ασφάλεια της κυκλοφορίας και τις διαπάνω. Η βάση δεδομένων του ΣΔΣΣ περιέχει πληροφορίες σχετικά με τη γεωγραφική θέση του δικτύου του αυτοκινητοδρόμου, με τις απαιτήσεις συντήρησης, με τους απαιτούμενους πόρους για τον προγραμματισμό των εργασιών συντήρησης καθώς και με την επίδοση των εργολάβων συντήρησης.
Routine Maintenance Management System (RMMS) of Egnatia Odos Motorway

Ioanna Ch. KARAKAIDOU, Dimitrios E. EVANGELIDIS and Georgios A. BANTELAS, Greece

1. INTRODUCTION

Egnatia Odos SA (EOSA) is a state-owned company that has been commissioned by the Greek government to construct, maintain and operate the Egnatia Motorway. Egnatia Motorway (660 km long and 24.5 metres wide over the greatest part of its length) starts at the port of Igoumenitsa (Ionian sea, West) and ends at Kipoi (Greek-Turkish border, East). It is part of the Trans-European Road Network, thus the specifications of operation are very strict in the interests both of its national and international users. Currently, half of the Egnatia Motorway has been opened to traffic.

The Board of Directors of EOSA has decided to outsource the routine maintenance works. This fact led the managers of the Operations & Maintenance Division (OMD) to investigate the international market in order to purchase an information system adequate to cover the company’s maintenance needs.

The Routine Maintenance Management System (RMMS) is an integrated information system comprising computerized procedures used by motorway organizations for the effective management of the routine maintenance of motorways. Routine maintenance comprises maintenance works at regular intervals, the frequency of which depends on the weather conditions or on the traffic volume in conjunction with the weather conditions. The RMMS is based on a Relational Data Base Management System (RDBMS) for the storage and retrieval of data, as well as on a Geographical Information System (GIS) for their graphic representation.

This information system allows (EOSA) to control the works of the maintenance contractors, in order to improve the quality and effectiveness of the maintenance services. The principle aim of the RMMS is to manage and optimise the maintenance of the motorway with respect to safety and maintenance costs.

The need for using such an information system, i.e. the RMMS, is based on reliable data for the motorway items and their condition, the scheduling of motorway maintenance works as well as on the assessment of the maintenance contractors.

EOSA employs the software system “highways by exor” developed by the Exor Corporation UK. The basic structure of the software is presented in figure 1.

![Figure 1. The EOSA’s RMMS structure](image-url)
2. RMMS MODULES

OMD currently uses the first two modules (Network Manager and Maintenance Manager) in order to manage: 1. The Motorway Network, 2. The Motorway Inventory, 3. Inspections/Patrols and Defects, 4. Reports, 5. Budgets, Contracts and Contractors 6. Work Orders and Treatments.

This paper describes, in brief, the content of the above.

2.1 Motorway network

In order to describe the motorway network, the OMD created a Linear Referencing System (LRS). The network of the Egnatia motorway is divided into maintenance Links and Sections per direction of traffic [3]. The Network Manager is used for the definition and management of the LRS.

A maintenance Link consists of a motorway section between two successive grade-separated interchanges (ICs). For maintenance purposes, a maintenance Link can be further divided into one or more maintenance Sections. A further grouping of maintenance Links and/or Sections is called maintenance Group. At interchanges, each slip road represents a unique maintenance Section and, therefore, in this case, the Links coincide with the maintenance Sections. A 13-digit code is assigned to each motorway section per direction.

The use of the LRS is necessary for the unique and accurate identification of the inventory items and their possible associated defects. The item and defect identification is based on the maintenance section, the chainage (Ch) and the cross sectional position (XSP).

Data, describing the Egnatia motorway network, can be input through suitably configured forms of the Network Manager module, Figure 2. Simultaneously, a graphical representation of the motorway network is achieved using GIS, which provides a mapping representation of this information aiding the management of data. Any modification to the network data is depicted via the GIS once the data from the forms has been input and vice-versa.
2.2 Motorway inventory for Routine Maintenance

The motorway inventory records the visible road inventory items based on the LRS. The OMD created its own motorway inventory for routine maintenance based on the road inventory of the Highways Agency UK [1].

The inventory for routine maintenance comprises nine (9) categories of road items represented by a 2-digit code (roman numerals). For each item, the system stores a description, the associated attributes, conventions and certain rules that apply to each inventory item.

The inventory items are divided spatially into the following two categories:

1. **Point** items are those that occur at a specific location along the section and have virtually the same start and end chainage.
2. **Linear** items are those that occur over a particular length and have a start and end chainage.

The OMD undertakes **inventory surveys** in order to establish the motorway inventory for the sections opened to traffic. The OMD uses a combination of two survey methods: video survey for items visible on camera (e.g. markers, lighting columns, bridges, etc) and on foot surveys using odometers and Data Capture Devices (DCD) for items that are not visible on camera (e.g. culverts, boundary fences, etc). The outputs of these two methods are ASCII files that identify and describe uniquely every item of the motorway (spatial data - Sections, Ch and XSP based on the LRS - and attribute data). These files are uploaded to the RMMS database using specific procedures of the **Maintenance Manager** module thus creating the Egnatia motorway inventory for routine maintenance, Figure 3.
2.3 Inspections/Patrols and associated Defects

According to ENSA’s Motorway Maintenance Manual – Vol. 1: Routine Maintenance [2], Inspections (Safety and Detailed) and Patrols must be carried out on a regular basis on the motorway. The manual also specifies the procedures and frequencies of these inspections and patrols in order to determine what routine maintenance tasks are required.

- Safety Inspections (once a week) and Patrols (six days a week) are carried out by a slow moving vehicle, in order to identify defects, hazards and emergency events that are likely to be dangerous or cause serious inconvenience to the motorway users.

- Detailed Inspections are usually carried out once or twice a year in order to establish programmes of works for routine maintenance tasks not requiring urgent rectification.
These inspections are carried out by the maintenance contractors’ staff (inspectors) under the supervision of EOSA’s technicians.

The Contractors’ inspectors record defects on the motorway using paper forms and/or DCDs. Having identified a defect, the inspector is required to record its position (based on the LRS) and give a description of it using the predefined, by the OMD, codes and his/her judgement about the defects condition, necessary actions and required maintenance methods.


- **Category 1**: defects that require prompt attention because they represent an immediate or imminent hazard
- **Category 2**: all other defects

The recorded defects are supervised by EOSA’s engineers on a regular basis (usually every one-two days) and then are uploaded to the RMMS database. The OMD uses the **Maintenance Manager** module, in conjunction with the **Network Manager** module, to record and manage information concerning Inspections and Patrols, associated Defects and recommended Repairs, Figure 4 & 5. That way, there is a detailed list in the system of Inspections and Patrols, associated Defects and recommended Treatments. Inspections and Defects are uniquely identified by a serial reference number (Inspection ID and Defect ID) generated by the system, e.g. Inspection ID: 934 (Fig. 4) is associated with Defect ID: 842 (Fig. 5) and vice-versa.
2.4 Reports

Although the RMMS comes with predefined reports for almost all procedures and actions regarding maintenance, the OMD, in conjunction with EOSA’s IT Unit, have created in-house reports in order to cover specific needs of the Department. These reports (analytical and general) are based on the RMMS database, are fully customised and published on EOSA’s Intranet. Users can input selection criteria, Figure 6, and retrieve information regarding items of the motorway inventory, inspections/patrols and associated defects.
As mentioned, these reports, Figures 7 and 8, are supplementary to the software’s default reports for the motorway inventory as well as for inspections and defects.

Figure 7. Analytical Inventory form

Figure 8. General Defects form
2.5 Budgets, Contracts and Contractors

The RMMS provides the capability to create, maintain and review budget data of any maintenance contract. Financial years, work categories (item codes), budgets per work category, VAT rates, etc, can be defined in the system. The most important step is the definition of work categories based on those of the contract. The system provides information on the allocated and the actual amount as well as on the balance per work category, Figure 9.

![Figure 9, Budget Form](image)

2.6 Work Orders and Treatments

Using the Maintenance Manager module, the OMD is able to create work orders and forward them to the Maintenance contractor. The system requires specific data for use in the work order procedure (contract budget, bill of quantities and other information associated with the maintenance contract).

Having identified defects on the motorway, the OMD can raise work orders and instruct them to the maintenance contractors. Afterwards, following the maintenance specifications, the OMD can audit their actions and performance, Figure 10. There is always a unique link between works orders and their associated defects and inspections.

Currently, the OMD is in the phase of finalizing all the necessary procedures in order to use the RMMS in the production of the Works Orders. Additionally, works orders reports will be generated to cover specific needs of the Department.
3. GEOGRAPHICAL INFORMATION SYSTEM (GIS)

The RMMS of Exor uses a suitably customised GIS (Spatial Data Manager - SDM) for the management and graphic representation of the network and the items thereof. SDM is a map-based interface to “highways by exor”. It is mainly based on GIS technology and utilises ArcView Desktop GIS and the Spatial Database Engine (SDE). The SDE is a server based DBMS that can reside within Oracle for storing spatial data and indexes. On the client side resides ArcView, a Desktop GIS, with display, spatial analysis, querying and data capture functionality. Within the SDM routes are made up of road sections represented by arcs (line features) with intersections represented by nodes (point features).

The SDM, Figure 11, provides the following functionality:

- Full graphic editing of the motorway network held in Network Manager
- Graphic display of all associated network data
- Spatial query tools
- Spatial navigation of the RMMS database
- Spatial processing tools (e.g. buffer, within/without, nearest, etc)
- Map production tools

The SDM is essentially a data integration and capture tool that sits above the “highways by exor” system. Consequently, through the map, the user can manage any type of data.
4. CONCLUSIONS

For the first time in Greece, an integrated information system is being utilised for the effective management of the motorway routine maintenance. As the relevant maintenance works are carried out by private contractors, there is need for effective supervision and management. The RMMS provides the necessary means to implement management procedures for the routine maintenance of the motorway.

The OMD have customised the RMMS according to the specific needs of the motorway. The system enables all the relevant data (inventory, inspection, defect, treatment, work orders, etc) to be assessed and associated, thus providing the necessary information for the management and supervision of routine maintenance projects.

REFERENCES

BIOGRAPHICAL NOTES

Ioanna Ch. Karakaidou: Civil Engineer

Current Job Activities
- Alternate Director, Road Network Support Department, Operations & Maintenance Division, Egnatia Odos SA.

Other Professional Activities
- Manager, Traffic Signs and Signals Department of DESE, Region of Central Macedonia, Greece

Dimitrios E. Evangelidis: Dr. Civil Engineer - Maintenance Discipline Alternate Head, Road Network Support Department, Operations & Maintenance Division, Egnatia Odos SA

Current Job Activities
- Support of Road Network Management Department on Maintenance Issues
- Preparation of Operation & Maintenance Contracts
- Contracts & Designs Supervisor
- Preparation of the Motorway Maintenance Manual

Other Professional Activities
- Development of Pavement Management Systems
- Building Designs as Self Employed Engineer
- Lecturer GIS/CAD Systems, University of Thessalia, Greece
- Lecturer in GIS Systems, University of Macedonia, Greece
- Lecturer in Road Asset Management, Technical School of Thessaloniki

Georgios A. Bantelas: Surveying Engineer, MSc GIS - Motorway Inventory Engineer, Road Network Management Department, Operations & Maintenance Division, Egnatia Odos SA

Current Job Activities
- Motorway network management
- RMMS operation and management
- Motorway maintenance projects supervision
- Preparation of the Motorway Maintenance Manual

Other Professional Activities
- External associate (teaching, research projects, etc) at the Aristotle University of Thessaloniki (AUTH)
- Research student - PhD candidate (School of Civil Engineering - AUTH).
- Self Employed Surveying-GIS Engineer
CONTACTS

Ioanna Ch. Karakaidou
Civil Engineer
Egnatia Odos SA, 6th km Thessaloniki - Thermi,
P.O. Box 30, GR - 57001 Thermi, Greece,
Tel: +30 2310 470 453,
Fax: +30 2310 470 181,
e-mail: gkara@egnatia.gr
www.egnatia.gr

Dimitrios E. Evangelidis
Dr. Civil Engineer
Egnatia Odos SA, 6th km Thessaloniki - Thermi,
P.O. Box 30, GR - 57001 Thermi, Greece,
Tel: +30 2310 470 451,
Fax: +30 2310 470 181,
e-mail: devan@egnatia.gr
www.egnatia.gr

Georgios A. Bantelas
Surveying Engineer, M.Sc. GIS
Egnatia Odos SA, 6th km Thessaloniki - Thermi,
P.O. Box 30, GR - 57001 Thermi, Greece,
Tel: +30 2310 470 454,
Fax: +30 2310 470 181,
e-mail: gbant@egnatia.gr
www.egnatia.gr