IMPLEMENTATION OF E-MAINTENANCE CONCEPT ON THE IRON ORE LINE IN SWEDEN

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SUMMARY

The Swedish railway is after deregulation composed of several different stakeholders, each one with individual objectives and strategies to maintain their assets and rolling stock. Although some maintenance data are common between the stakeholders, no greater sharing of these data exists. The insufficient data availability impacts the effectiveness in maintenance decision making.

The Luleå Railway Research Center (JVTC) has in more than a decade conducted research in eMaintenance. One of the objectives with eMaintenance research is to develop maintenance decision support tools through enhanced use of information and communication technology for data analytics from various data sources. These tools can also be used to enable condition-based maintenance to minimize disruptions and optimise the maintenance cost in a railway system. Another objective this research is to discover how to offer operators, infrastructure managers and system integrators access to central computerised data to support decision making within operation and maintenance.

eMaintenance solutions for railway are now being implemented in a pilot project called ePilot119 in the northern part of Sweden on track section 119 between Luleå and Boden. ePilot119 delivers a collaborative platform aimed to enable the development of eMaintenance solutions based on the needs and requirements from various stakeholders. These solutions are expected to enable and transform the Swedish fragmented rail industry to an integrated system, both from an organizational and technical point of view. Some of the objectives are to enhance the sharing of data, developing decision support, define the information and communication technology (ICT) infrastructure and transform ePilot119 to a common natural process for sharing maintenance decision support for the railway.

However, implementing eMaintenance solutions to support effective and efficient maintenance decision-making related to a complex technical system (i.e. railway) and with a large number of heterogeneous stakeholders is challenging, and requires appropriate tools (e.g. framework, approaches, methodologies, and technologies).

Hence, this paper aims to identify some of the significant factors which need to be considered in order to develop an appropriate implementation process and collaboration platform, which aim to facilitate maintenance decision-making through eMaintenance solutions. By identifying these factors that might hinder the execution of the project and implementation of good results, there is a possibility to jointly create the best prerequisites for the operation and maintenance of the railway system.

1. INTRODUCTION

The Swedish railway sector was deregulated in the end of 1990 and the beginning of 2000 ending up in a vertical organization containing of infrastructure managers, traffic operators, real estate managers and suppliers of trains. The collaboration between the parties involved is regulated in contracts, often without incentive and some time without objectives to deliver available and safe railway transports. [1]

According to a pre-study conducted by the Swedish Forum for Innovation within the transport sector [2] there are requirements for new structures for system integration, e.g. in the form of joint ventures between different parties in the market, in order to drive innovations.

The implementation project ePilot119 is the first joint venture between TRV, academia and the
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railway industry to implement eMaintenance through enhanced collaboration.

There is a need to identify why good ideas stop at good ideas in the railway industry - can the collaboration method within ePilot119 be the cure that resolves the problem and aid successful transfer of new technology?

This paper aims to identify some of the essential factors which need to be considered in order to develop an appropriate implementation process and collaboration platform, which aim to facilitate maintenance decision-making through eMaintenance solutions in the railway industry.

2. EPILOT119

ePilot119 is a pilot project undertaken in cooperation between Luleå Railway Research Center (JVTC) at Luleå University of Technology (LTU), TRV, railway companies, maintenance contractors for vehicle and infrastructure as well as suppliers and consultants. The project will run between 2014-16 on track section 119 between Boden and Luleå. The format of the project and the new knowledge will be packaged, transferred and started up at other sections of the railway.

ePilot119 provides a collaboration platform (demonstrator) for the development of solutions for maintenance decision support. The support is based on the needs and requirements from various stakeholders in order to enable and transform the Swedish fragmented rail industry to an integrated system. The solutions should result in improved punctuality and minimized disruption in rail services and an insurance of greater accessibility and quality together with more efficient maintenance.

The approach is based on enhanced collaboration methodology with a main project and a support team that is unifying for developing smaller sub-projects. The results from the subprojects should then be implemented by the ePilot stakeholders in the railway system.

The main objective of ePilot is to implement relevant results based from research and development. The project is expected to contribute to a more robust rail system, better punctuality and improved availability through more efficient maintenance.

Additional objectives are to:

- Provide information and disseminate results with the railway industry in Sweden and around the world.
- Provide educational materials and providing training opportunities within the railway industry in Sweden.
- Transfer results of at least two subprojects to other parts of the railway sector, by the project’s third year.

The aim is to get all stakeholders to jointly improve the maintenance process of the whole railway system through enablement of context-based condition-based maintenance.

2.1 Track section 119

Section 119 between Boden and Luleå is a 34 km long single track with six meeting stations, see Figure 1.

![Figure 1. The Iron Ore Line](image)

The traffic consists of mixed traffic i.e. both passenger and freight traffic, and has an annual volume corresponding to approximately 23 MGT. On average about 50 trains pass the section, each day, including ore trains with an axle load of 30 tonnes, freight trains with axle loads of 22.5 – 25 tonnes and passenger trains. The speed varies from 50 km/h for loaded ore trains up to 140 km/h for the passenger trains.

There are several parties involved in operation and maintenance of the system, see Figure 2.
These parties have different requirements for collecting data for maintenance decision support. The infrastructure manager needs information about how the section is operated in terms of amount of trains and axles, train speed and actual axle load, vehicle characteristics, but also data about asset condition and the degradation rate. The traffic operator needs condition monitoring information, e.g. trend data for wheel degradation. The maintenance contractor’s need data on asset condition, amount of traffic, type of vehicles, amount of train kilometres and the supplier wants to know where the asset/component is installed how it is used and what kind of failures that has occurred.

3. THE EMAINTENANCE CONCEPT

There have been many attempts to define eMaintenance. Crespo-Marques and lung [4] defines eMaintenance as “maintenance support which includes the resources, services and management necessary to enable proactive decision process execution. This support includes e-technologies (i.e. ICT, Web-based, tether free, wireless, infotronics technologies) but also, eMaintenance activities (operations or processes) such as e-monitoring, e-diagnosis, e-prognosis”.

Today there are five different views:

- A maintenance strategy, where tasks are managed electronically using real-time analysis [5]
- Support system to execute a proactive maintenance decision-process [6]
- A predictive maintenance system that provides monitoring and predictive prognostic functions [7], [8]
- A model enhancing maintenance efficiency [9]
- eMaintenance is a technological approach: Here, e-Maintenance is considered to be the integration of all necessary ICT-based tools for the optimization of costs and improvement of productivity through utilization of Web services [9]

However, eMaintenance addresses new needs and provides various benefits in form of increased availability, reduced lifecycle cost and increased customer value (Kajko-Mattson et al, 2011). The eMaintenance Lab has been developed by a research team at LTU and is a platform for efficient decision making in maintenance. It provides a cloud based, one-stop-shop for data analysis, which aids research projects and maintenance practices. The eMaintenace Railway Cloud includes:

- A process for gathering information about remaining useful life, dynamic maintenance program, performance measurements, maintenance support and planning.
- Services, such as, wheel query, force data analysis, context adaption and data fusion.
- Data collected from Luleå Railway research station, Trafikverkets wheel impact detector and LKAB and Trafikverkets wheel profile detector.

It will also in short add measurement data of track quality, failure statistics and inspection data.

4. THEORY

4.1 Implementation

Implementation research is the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice, and, hence, to improve the quality and effectiveness of services [10].

Implementation is considered in innovation research as efforts being made after a decision has been taken on the introduction of an innovation [11]. In Rogers Theory of diffusion, implementation is included as follows to the innovation decision sequence: knowledge – persuasion – decision – implementation – confirmation.

The academic world is experiencing increased demand for proven benefits of publicly funded research. Implementation Research with a focus on issues of research utilization has evolved over a significant ambient pressure, with a rapid expansion of the field during the 2000s [12].

When the Organisation for Economic Co-operation and Development (OECD) evaluates Sweden’s politics regarding innovation the conclusions from a SWOT-analysis states that one of nine threats to the Swedish competitiveness is difficulties in
transferring technique between research and industry [13].

In the transport research investigation made by Jan Nylander [14] the analysis describes how academic competence and long term financing have to be combined with medium and short length projects. Some projects should be of a near-market or short-term problem-solving nature. Reinforcements of incubation and demonstration in the existing transport system create good conditions for innovation and growth. In order to balance long and short term projects together with governance and freedom, management and activities in incubators, platforms and projects need to be handled in a good way. Furthermore, demonstrators are described as an efficient instrument in the innovation process that makes meeting, mostly in pre-commercial phases, between developers, problem owners and innovators but also as a motor for new innovations to be created [14]. Innovations can be tested in realistic operating conditions where risk, costs and accidents can be decreased. Development and operation of demonstrators can be one of the most important paths to commercialize research results.

4.2 Implementation framework
A framework can help to help identify, describe and analyze the importance of various factors (determinants) for the output of the implementation process.

The output of an implementation is defined as changes among the implementers and outcome as changes among those targeted with the policy [15]. Output will be the implemented results from the different sub-projects.

The Consolidated Framework for Advancing Implementation Research (CFIR) constructed by Damschroder et al (2009) could be a good support in finding influencing factors. CFIR is a meta-theoretical framework consisting of a synthesis of existing theories, models and frameworks. The idea with CFIR is that "researchers can select constructs of CFIR that are most relevant for their particular study setting and use these to guide diagnostic assessments of implementation context, evaluate implementation progress and help to explain findings in research studies or quality improvement initiatives" [16]. This together with an attempt to use a standardized language is the motivation for using CFIR.

CFIR describes five major domains:
- I. Innovation characteristics
- II. Characteristics of the individuals involved
- III. Inner setting
- IV. Outer setting
- V. Process of implementation

According to Damschroder the innovation characteristics relies on key stakeholders perceptions of where the intervention is developed, the evidence strength and validity, advantage to other solutions, adaptability, trialability, difficulty of implementation, design quality and packaging and cost. CFIR aggregates an analysis of characteristics of individuals to team or unit level based on knowledge and beliefs about the intervention, self-efficacy, individual stage of change together with perception of the organization and commitment to the organization. There are constructs describing the inner settings like structural characteristics, networks and communications, culture, implementation climate and readiness for implementation. The outer setting includes constructs for when the receivers' needs and resources are known, degree of connections to other organizations, peer pressure, external policies and incentives. On a process level four activities will have an impact on implementation consisting of planning, engaging, executing, reflecting and evaluating.

4.3 Enhanced collaboration
The method "enhanced collaboration" is used by two or more organizations to achieve specific business goals by maximizing the effectiveness of each participant's resources. The system is based on common goals, an agreed methodology for problem solving and an active search for continuous measurable improvements. The concept focuses on:
- Team building between key individuals from the different parties.
- Confidence building.
- Openness between the parties.
- To create a win-win situation.

The framework for enhanced collaboration states that all parties should have the same status and ability to communicate openly and that the balance of power should be equal. The six key factors that are needed are: the need for trust, the "right" personalities, the openness of communication, organizational culture and organizational learning, team building and management commitment.

A critical success factor is that before you start, it have to be clear, why you are cooperating and how the cooperation is related to the overall company strategy. The method enhanced collaboration has been discussed by a number of authors such as Olsson [17, 18], Barlow [19] and Espling [19]. Since the ePilot is performed in enhanced collaboration, TRV requested that each party involved in the subprojects also contribute with their own effort that can be offered in kind or in
monetary resources. Enhanced collaboration also means that a subproject must involve at least three parties of the railway industry for the current railway route.

5. CASE STUDY

This case study will analyze how the project ePilot119 is constructed in order to identify, describe and analyze the factors that might hinder the execution of the ePilot project and implementation of the eMaintenance project.

According to Kothari [20] a case study means a careful and complete observation of a social unit, be that unit a person, a family, an institution, a cultural group or even the entire community. It is a method of study in depth rather than breadth. The case study places more emphasis on the full analysis of a limited number of events or conditions and their interrelations. The case study deals with the processes that take place and their interrelationship.

Methods to be used in this case study are:
- Collection of secondary unpublished data
- Active observations
- Analysis of the data

Participants in the ePilot project have been interviewed regarding their participation in the project and the interviews have been documented [3,21]. Based on the documentation and active observations through participation in the project, analysis and conclusions regarding affecting factors has been made.

5.1 The organization of the ePilot

The project is run by a virtual organization, see Figure 3.

TRV is the project sponsor and appoints a “host organization” (HO) to operate and staff the virtual organization. It can for an example be a center for railway research or a group formed for industry collaboration. For the ePilot119, JVTC at LTU was appointed HO. The JVTC board delegated the authority of management and control of the project to a steering group consisting of a chairman, a secretary and members appointed by the stakeholders in the sector. TRV holds the role of chairman and LTU has appointed a secretary and a member of the steering group. The project has a Staff working to support the project in issues relating to economics, law, information and communication.

The engine in the virtual organization is the Support who will be staffing and building the project structure, starting up activities and projects, acting as impellers, monitoring progress and document and support implementation of the results.

The Support is led by one from TRV appointed project leader. The project leader has delegated the operational work to a Project Coordinator. The support also includes a process manager, an information logistics expert and a Project Administrator. An evaluation panel is an aid for the Support in the process of evaluating and assessing project ideas and project specifications. Approved subprojects are delegated to a subproject manager for effectuation.

The stakeholder group participates as an idea generator and sounding board. The stakeholder group consists of companies and individuals who are interested in contributing to the development of railway maintenance in terms of the entire industry.

5.2 Neutral platform

The project is conducted on a neutral platform that allows enhanced collaboration between the parties. The platform is considered neutral since it has no own commercial interest. The platform has the same legal base as JVTC, meaning that it is based on a membership agreement containing among other things rules for the organization and management of the project, how intellectual property is managed, confidentiality, publication, and financing. All subprojects writes a subproject agreement referring to the JVTC membership agreement, i.e., that the rules of the cooperation are agreed upon. If there are deviations from the membership agreement the deviation must be specified and approved by the JVTC Board. If parties of a subproject are not members of JVTC, permission must be granted by the JVTC board to participate.

5.3 Financing

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**Figure 3. The ePilot virtual organization**
TRV is funding the project in two parts. Investments in assets are one part and the other part is to create and maintain the platform. The investments in assets part is to be used for subprojects that improve operation and maintenance of the rail system. Funding from other stakeholders is divided into monetary resources and in kind (time). In kind has a value of 500 SEK/hour throughout the project. This hourly rate shall be applied by all parties. HO requisition funds budgeted for investments in assets and the platform. HO requisitions monetary fund’s immediately from other parties after the subproject contract is signed. Each subproject manager requisition funds from HO, according to the settlement stated in the subproject contract.

5.4 Process flow ePilot
The process can be divided in four phases:
- Preparation
- Execution
- Follow-up
- Implementation

5.4.1 Preparation
In the preparation phase TRV decide on which railway line to be included in the ePilot. All major stakeholders (transport operators, contractors and suppliers) acting on the identified route is invited to participate. TRV also announces that an enhanced collaboration method will be used in the project and give a clear description of what this means. This is done at a meeting at an early briefing to which all parties involved in the operation and maintenance of the route are invited.

All parties interested in participating write a letter of intent. If the interest is low, a new railway line should be chosen.

TRV appoints HO and signs an assignment contract. HO appoints a support organization that is commissioned to establish a project specification including the budget. When the project specification is approved by all parties an agreement of cooperation is established for the ePilot.

The support proposes in consultation with the parties, the staffing of the steering committee and staff. The stakeholder group and evaluation panel are staffed at a later stage, e.g. at the kick-off.

The support invites all the parties to a kick-off and this is the start of the execution phase

5.4.2 Execution
The execution phase starts with a kick-off and a workshop. A baseline for the collaboration is established where:

- A vision and measurable goals are proposed (what do the project sponsor want to achieve, and is it industry-wide?).
- The execution of the ePilot is described.
- The track section regarding traffic, information and problem areas are described.
- The concept eMaintenance is explained.
- The participants get to know each other.

During the workshop the objective is to find and prioritize areas for improvement. The following questions should be answered:

- What improvements are needed? Then prioritize the proposed improvements. The highest priority gets the weight 10, the next weight 9, etc.
- Can the improvements be executed within the ePilot?
- What is the potential with making these improvements? The highest potential gets the weight 10, the next weight 9, etc.
- Who owns the solutions?
- Who needs the information?
- Who will benefit from the solutions?

The workshop will result in a list of a number of prioritized areas of concern that need to be resolved. The kick-off participants get as homework to identify ideas for improvement, which they send to the Support. If the evaluation panel believes that the idea has great potential, can be implemented quickly and provide rapid results, the innovator is asked to write a project specification containing a budget and proposals for staffing.

A situation analysis that describes the conditions when the project starts is performed at an early stage.

5.4.3 Follow up
In the final stage of ePilot, a final meeting will be held chaired by an independent process leader. At this meeting the same people who were involved in the kick-off should be present. The purpose of the meeting is to evaluate:

- How well were the objectives met?
- How did the group develop?
- How did the collaboration work?
- How accurate was the project budget?
- What went well or better than expected and why? What went worse than expected and why?
- What have we learned?
- How should we work in the next project?

The overall result should then be written down in a report.

5.4.4 Implementation
The next and improved ePilot will start up at another track section with the aid of the process manager, documentation and manuals.

5.5 Subproject process flow
All subprojects runs through a process flow that can be illustrated as shown in Figure 4 [22], which describes the steps from idea to implementation.

Figure 4. The subproject process flow.

The process flow of a subproject is divided into three parts:
- Preparation of the subproject (that consists of activities until signed subprojects contracts)
- Execution
- Implementation

5.5.1 Preparation of subproject
A project idea or project specification is submitted to the Support. The project specification should contain Letters of Intent where participants approved their participation. The ideas and project specification is presented to the evaluation panel that recommends start, completion or rejection. Then the support and evaluation panel assesses the idea based on the overall objectives. The support provides from the evaluation panel a recommendation to the project manager and the steering committee for the decision to start-up or not. The steering committee decides on startup or preparation of a project specification for decision. The Support will investigate in parallel if all parties involved are members of JVTC and if there are deviations with regard to IP. The PC then supports the signing of agreement for subprojects. The subproject can start when all parties have signed where the Subproject manager organizes the kick-off.

5.5.2 Execution
The subproject is now being executed and the work is done by carrying out the activities specified in the project specification. The subproject manager is responsible to manage the budget and deliverables to the steering group.

5.5.3 Implementation
The results from the subproject should be implemented by the participating parties.

6. RESULTS
ePilot119 has so far resulted in 38 subprojects of which 10 has started within the first year. These projects are focused both on solving problems for train operators, infrastructure managers, maintenance contractors and suppliers. The project has accomplished to increase the capacity for the iron ore trains due to a new inspection station. A method for simplifying the wheel inspection at the border between Sweden and Norway has been developed. The tools and provision of data for prognostics and diagnostics providing better advance warning of incipient faults on the infrastructure has been developed. New technology is being tested to keep track of critical infrastructure that does not work.

The case study showed a number of factors that have impact on achieving the goals of the ePilot project. These factors can have a significant impact on the collaboration and the implementation of the results.

6.1 Collaboration influencing factors
The factors discovered in the case study and are based in the interviews [3,21] are listed in table 1.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legal</td>
<td>Intellectual property</td>
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<tr>
<td></td>
<td>Rules and Regulations</td>
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<tr>
<td></td>
<td>Data ownership</td>
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<tr>
<td></td>
<td>Data access rights</td>
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<tr>
<td>Organization</td>
<td>Commitment / communication</td>
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<tr>
<td></td>
<td>Methodology readiness</td>
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<tr>
<td>Financing</td>
<td>Money / in kind</td>
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<td></td>
<td>Return on investment (ROI) strategies</td>
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<td></td>
<td>Benefit models</td>
</tr>
</tbody>
</table>

Table 1 Collaboration influencing factors

The factors have been classified in three topics in order to generalize for future use.

Intellectual property:
- How to handle the background, progress and solutions of the subprojects i.e. who will be owner of data, demonstrator and the results have to be defined as early as possible in the collaboration project.

Rules and regulations:
- Complicated administration. The innovator must personally request authorization from the transport board to test and implement new innovations. This must follow special
formalities where risk assessment plays a key role.

Data ownership:
- It is unclear who owns the data.

Data access rights:
- Who is allowed to use the data and for what purpose.

Commitment and communication:
- The collaboration is built on the long-term dedication and commitment of the stakeholders.
- A lack of time due to leaner organizations can cause the project to lose key players.
- A lack of communication can cause the parties to not have understood the meaning of enhanced collaboration methodology.

Methodology readiness:
- Is the organizations and project participants willing to participate in the project according to the conditions for enhanced collaboration?

Money or in kind contributions:
- Sudden negative budget changes can cause the faith in the project to falter.

Return on investment (ROI) strategies:
- Unclear how to get a commercial advantage from participating in the project.

Benefit models
- Unclear how to benefit from participating in the project.

6.2 Implementation influencing factors
The factors that can influence implementation of results discovered in the case study and are based in the interviews [3,21] are listed in Table 2. The factors have been classified in topics according to the CFIR framework in order to develop a supporting framework for ePilot119.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Innovation characteristics</td>
<td>Evidence strength &amp; Quality (0)</td>
<td>Technological development system</td>
</tr>
<tr>
<td></td>
<td>Adaptability (0)</td>
<td>Usability / marketing</td>
</tr>
<tr>
<td></td>
<td>Design Quality and Packaging (0)</td>
<td>Business models</td>
</tr>
<tr>
<td>II. Outer setting</td>
<td>External Policy &amp; Incentives (0)</td>
<td>Ownership / responsibility</td>
</tr>
<tr>
<td></td>
<td>Operation of the train</td>
<td>Operation of the train</td>
</tr>
<tr>
<td>III. Inner setting</td>
<td>Implementation climate (1) - Organisational Incentives &amp; Rewards (4)</td>
<td>Business agreements / contracts</td>
</tr>
<tr>
<td></td>
<td>Readiness for Implementation (1) - Available Resources (2)</td>
<td>Organizational uncertainties</td>
</tr>
<tr>
<td>IV. Characteristics of individuals</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>V. Process</td>
<td>Planning (4)</td>
<td>Competence / strategy</td>
</tr>
</tbody>
</table>

Table 2 Implementation influencing factors

Technological development system:
- There is a lack of analytical tools that enable trending the degradation rate.
- There are consequences for the progress of the projects when the data quality is corrupt.
- Limits for alarm levels are missing.

Usability / marketing:
- The usefulness of the demonstrator has not been sold in to the potential users e.g. by visualizing cost savings, extended wheel life or of improving quality and reliability.
- There is too much data presented and requires both knowledge and a trained eye to find the errors. The user must actively visit the demonstrator and look up information which might cause that it is not being used.
- The requirements for the end users have not been investigated.

Business models:
- The end user cannot see the benefits from implementing the results. The services has not been packaged and priced.

Ownership / responsibility:
- There can be unclear responsibility in the case of operators running other owners’ rolling stock causing maintenance data to be lost.

Operation of the train:
- The operators driving conditions with regard to where the vehicles rolled linked to the condition of the track, weather and who drove them.

Business agreements / contracts:
- There are internal agreements amongst different parties, making the responsibilities the maintenance activities unclear. Business models with the division of stakeholders make it difficult to see where the liability limits are.
- There is a lack of incentives in the contracts for the stimulation of innovation, implementation, collaboration and information sharing.

Organizational uncertainties:
- The choice of the prospective recipients to evaluate the demonstrator is not always the same as those that has the responsibility to initiate inspection and a maintenance activity.
Competence / strategy

- There is a lack of an implementation strategy e.g. a plan for how the demonstrator would be used and evaluated causing a delay in the project.

7. DISCUSSION

The railway system requires extensive technical system competence which today is divided into several "independent" commercial and non-commercial parties such as regulatory authority, infrastructure managers, operators, suppliers, maintenance workshops, consultants, maintenance contractors and research units. The parties govern cooperation through agreements and contracts that often lack performance management, incentives and collaboration requirements.

Whatever the intent of the parties is to implement improvements originating from the ePilot, there are a number of factors such as regulations and short-term contracts lacking of incentives, which must be considered.

Implementation models of the type ePilot119 opens up the possibility to reduce the gap between the parties and the gap that exists between research and its application, by applying a holistic approach, an experience and data exchange that will reduce costs, downtime and train delays.

The next step is to propose a supporting framework for the ePilot119 to avoid the identified factors to have a negative impact on the collaboration and implementation of results. The supporting framework for the implementation of results can be constructed based in the CFIR topics and descriptions.

8. CONCLUSIONS

The purpose of this paper is to identify some of the significant factors which need to be considered in order to develop an appropriate implementation process and platforms, which aim to facilitate maintenance decision-making through eMaintenance solutions.

In this work, a major case study has been conducted with the ePilot project.

The case-study has identified and analysed a number of performance influencing factors.

Based on the results from the conducted study, it can be concluded that the development and operation of demonstrators can be one of the most important paths to commercialize research results.

Furthermore, it can be concluded that in order for innovations from the ePilot119 to be implemented on a de-regulated market, it is important to monitor and analyze the progress of the project. Not only to identify the technical system's advantages and disadvantages, but also the possible organizational, financial and legal barriers to introduce and implement new innovative products, processes and systems in order to learn from and avoid these barriers in future ePilot projects.

As for the next step in this research, a framework aimed to support collaboration and innovation processes related to a complex technical system (i.e. railway) will be developed. The framework is expected to facilitate the risk management related to identified factors, as described in previous sections.

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REFERENCES