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IMPLEMENTATION OF REMOTE CONDITION MONITORING SYSTEM FOR PREDICTIVE MAINTENANCE: AN ORGANISATIONAL CHALLENGE

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The “Health and Prognostic Assessment of Railway Assets for Predictive Maintenance” project is developing a Remote Condition Monitoring (RCM) system to manage asset degradation to enable predictive maintenance. Despite the benefits of the RCM systems, many of the programmes that seek to introduce them fail. Previous research shows that, beside technological challenges, there are organisational factors that contribute to the success of these programmes; the paper presents a three step approach taken to meet these challenges and some initial findings of the research.

Introduction

RCM systems are revolutionary e-systems that make use of contemporary advances in information technology solutions (Jonsson et al., 2010) to enable a shift in the maintenance of industrial equipment from mainly corrective (after failure) and preventive maintenance (maintenance performed on fixed schedule regardless of the condition of the asset) to predictive maintenance (maintenance in advance of failure) (Koochaki and Bouwhuis, 2008). Despite the obvious benefits that these systems can bring to the maintenance regime and although there is an increase in reported success stories in literature (Koochaki and Bouwhuis, 2008) many of the programmes that seek to introduce a maintenance regime based on asset condition monitoring, fail to achieve their objective (Mobley, 2002; Mitchell, 2007; Koochaki and Bouwhuis, 2008).

While it is widely accepted that there are technical challenges associated with the introduction of new condition-based maintenance systems (Jonsson et al., 2010), what is perhaps less understood is the human and organisational factors (Koochaki and Bouwhuis, 2008; Jonsson et al., 2010) involved in the successful implementation of such programmes and the changes that these systems demand in the organisation’s maintenance processes. The successful implementation of condition-based maintenance programmes and introduction of RCM systems requires changes and updates to existing processes within the organisation implementing the system.

Project background

The “Health and Prognostic Assessment of Railway Assets for Predictive Maintenance” project wants to produce and introduce a Remote Condition Monitoring (RCM) system that will provide reliable and dependable health assessment data for London Underground (LU) with the scope of managing the asset’s degradation so that maintenance interventions can be planned and undertaken at the optimum time, in advance of failure (Loughborough University Projects, 2014). The asset, which is used as a case study in the current project, is the escalator. The LU escalators are different from the ones usually found in shops and offices; they are longer, wider and more robust in comparison, such that they

can cope with high demand, running approx. 20 hours a day, 364 days a year and carrying up to 13,000 people an hour (Campbell, 2002). LU has more than 400 escalators with around 95% of them being operational at any given time (Campbell, 2002).

Maintaining these machines is also challenging due to the tight space constraints in which the escalators are located and the underground environment (tight spaces, operating hours, access routes) in which escalators operate. Maintenance is usually allocated to the few hours when the stations are closed; however, Transport for London (TfL) recently announced the introduction of a 24-hour service at weekends to start in September 2015, which will impact on these available hours. There are standards for good operations and maintenance (such as BS EN 13015:2001+A1:2008) in place as well as inspection and maintenance methods and schedules; however, as the escalators age and due to increasing operational demands, unplanned outages are increasing (Campbell, 2002) and this is one of the areas where the introduction of the CRM system will assist i.e. maintenance in advance of failure through provision of prognostic data.

Organisational factors

As mentioned previously organisational factors play an important role in the successful implementation of condition-based and remote condition-based maintenance systems. Koochaki and Bouwhuis (2008) in their case study carried out at an industrial plant found that knowledge sharing processes (retrieval and transfer), lack of shared ontology, lack of clarity between the roles and responsibilities between the teams and absence of a clear and shared organisational strategy are key organisational factors that contribute to a decrease in the effectiveness of a condition based monitoring system and hence failure of condition-based maintenance programmes.

More recently, Jonsson et al. (2010) looking at the opportunities and challenges related to the design and implementation of e-based systems for remote diagnostic of industrial equipment found that, for the RCM systems to be successful, they must not only be built based on cutting-edge technology but also they have to be based on comprehensive organisational models of the maintenance processes, such that the RCM system and the organisation(s) will achieve their predefined goals. In addition their findings show that the way knowledge is shared between organisations (customer, maintenance service providers, manufacturer) or domains within the organisations is a key factor in implementing RCM systems and that the introduction of these types of systems requires re-organisation of the business functions and maintenance routines.

Research approach

In order to address the organisational challenges related to the building and implementation of the RCM system into LU maintenance regime, a three-step approach has been devised. This is presented in Figure 1.

First a map of the maintenance processes within the organisation, as they should be according to the organisation's formal documentation is produced. In parallel, a model mapping the organisation maintenance processes as they are in practice is being created based on information gathered through semi-structured interviews and on-site observations. Secondly a gap analysis of the two models will be performed to build a comprehensive picture of the existing maintenance processes and highlight possible discrepancies between the formal and in-practice processes.

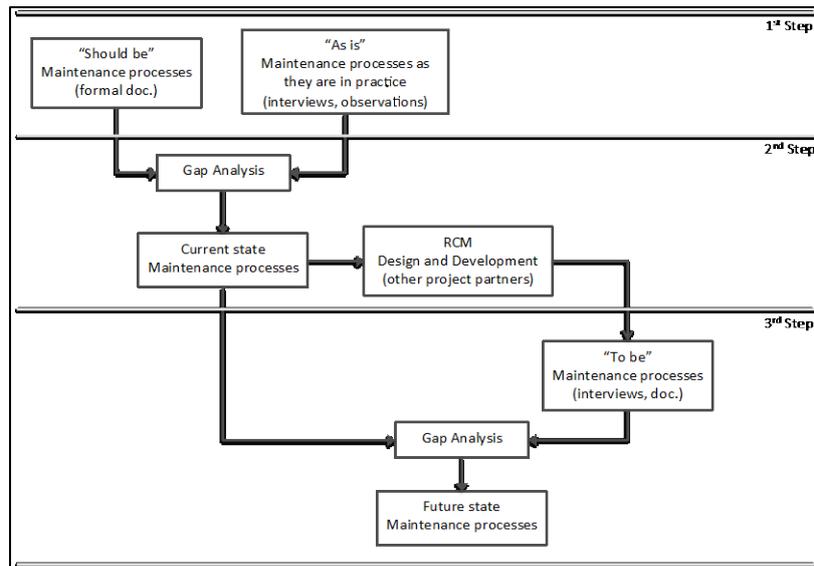


Figure 1. Research Approach

The last step in the research approach is to construct a comprehensive model of the future ‘ideal’ or required maintenance processes as they will be (“to be”) following the implementation of the CRM system. The model will be built based on empirical data gathered from the partner organisation building the CRM system using semi-structured interviews and analysis of the system’s documentation. The result of these phases in the research are then going to be compared with the model of the extant maintenance processes.

It is expected that the results of this comparison analysis will highlight the changes that the organisation will need to undertake to accommodate the introduction of the new system. The analysis of these organisational models will highlight the impact that the new system will have on the extant organisational structure and support LU in building a shared and integrated organisational strategy across the business, prior to the introduction of the new RCM system.

Finally to ensure the validity of the study, several strategies are going to be employed, such as triangulation of data (data collected through interviews and observations), member’s check (ongoing dialogue with the project partners regarding the interpretation of data), participatory modes of research (LU are going to be involved in all stages of the research) as well as providing detailed description of procedures, methods and techniques employed in the study (Creswell, 2009)).

Preliminary findings

The first phase of the research has been completed, a series of work instructions/ standards examined and the organisational maintenance processes mapped out. The analysis revealed that, although models of maintenance processes can be mapped based on these documents, a comprehensive model of the overall maintenance process cannot be built based only on the documents analysed. This suggests that there is a fractioned maintenance process within the organisation or that the maintenance regime does not entirely comply with the formal documentation. Format issues/inconsistencies within the documents have also been highlighted during the analysis. Further analysis is required to determine the causes of the issues seen and determine what impact such issues could have on the organisation, both currently and when future changes are implemented.

Discussions and conclusions

The key human factors issues associated with the introduction of a new maintenance regime are: need for clarity between teams regarding roles and responsibilities; need for shared ontology across business domains; need for clear knowledge sharing processes and need for clear and shared organisational strategy (Koochaki and Bouwhuis, 2008; Jonsson et al., 2010). Preliminary findings showed that there might be a fractioned maintenance process from an organisational point of view or a lack of rigorous formal processes in place to guide the organisation maintenance activities, which might indicate a lack of shared and/or integrated organisational strategy. Ongoing work includes a series of observations and validation interviews with Subject Matter Experts (SMEs) to determine if there is any missing information regarding the formal processes and to gather information regarding the maintenance processes as they are in practice, so that a comprehensive map of the existing organisation's processes can be built. Future work will address the issues identified by mapping out the interactions involved in the implementation of the new RCM system, investigating the impact of the new system on existing business structures/work processes and produce guidelines to aid LU, make the necessary organisational changes for a successful implementation of the RCM system.

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