

Human-Related Barriers for Implementation of Predictive Maintenance at the Dutch Navy

Introduction

The Royal Netherlands Navy (RNLN) uses a substantial share of its operating budget for maintenance activities. RNLN aims to reduce maintenance costs and has selected Predictive Maintenance (PdM) as an effective means to do so. Currently, RNLN applies time-based maintenance policies. In the future, RNLN would like to see more sensor-based PdM polices implemented on all of its seagoing vessels.

An internal group called *Data voor Onderhoud* (Data for Maintenance, DvO) has been tasked with implementing this new approach to maintenance and wants to ensure that there is both a technical and strategic fit between PdM and the organization. However, the maintenance employees who will work with these new approaches to maintenance are largely unfamiliar with PdM. In order to boost the successful implementation of PdM into employees' working routines, this research uncovers the human-related acceptance factors within the RNLN.

We performed in-depth interviews with employees of the RNLN that have been involved with the implementation of PdM. Based on the interviews, we were able to identify various human-related barriers to successful PdM implementation and could formulate strategies through which the influence of these social barriers can be reduced.

Methods and approach

Due to the limited sample size of participants, we selected a qualitative approach to ensure as much information as possible is collected from each participant. In-depth interviews were performed to inquire participants'

attitudes and beliefs towards PdM. Moreover, interviews allow the researcher to induce the participants' preferences and priorities directly.

Interviews are analyzed in NVivo (QSR International Pty Ltd., 2020): a specialized software for processing interview data. The interview transcripts are coded, which means the researcher assigns increasingly general, classification labels to specific statements in the interviews. As such, issues with PdM implementation can be identified across participants. We apply predefined codes from the Unified Theory of Acceptance and Use of Technology model (UTUAT; Venkatesh et al., 2003): Performance Expectance (PE), Effort Expectance (EE), Social Influence (SI), and Facilitating Conditions (FC). UTUAT is a well-known representation of human behavior when interacting with technologies. The meaning of and the relationships between the variables are presented graphically in Figure 1.

Results

In total, twelve interviews were performed, all of which took place between October and December of 2021. Four participants have a military function, eight are civilian employees. Five participants are service engineers, seven are managers. Interviews lasted for approximately one hour each. Recording the interviews was prohibited, so detailed notes were kept on paper during conversation and transcriptions were made immediately after the conversation had ended. From the interviews, eight distinct human-related barriers for successful PdM implementation emerged. These barriers are classified by their code and presented below.

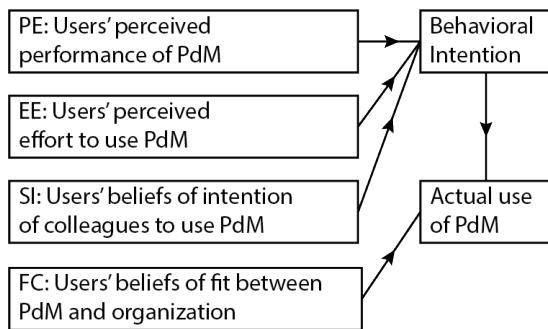


Figure 1: Simplified representation of UTUAT, adapted from Venkatesh et al. (2003)

Performance Expectancy: employees' perceived performance of PdM

1. Employees are unsure what personal benefits PdM can have for them.
2. Employees have different expectations of what PdM can and should do for RNLN.

Effort Expectancy (EE): employees' perceived effort to use PdM

3. Service engineers regard PdM as an addition to their current work activities, rather than as a tool that is integrated in performing those activities.

Social Influence: employees' beliefs regarding intention of colleagues to use PdM

4. Employees believe that the strict military hierarchy reduces the efforts of superior staff to properly inform employees of the PdM use case, hurting actual uptake.
5. Service engineers are unaware of the progression of PdM implementation efforts and feel uninformed.

Facilitating Conditions: employees' beliefs regarding organizational suitability for PdM

6. Employees are generally skeptic about using new innovations and experience 'innovation fatigue'.
7. Employees fear the organizational and technological infrastructure at the RNLN is unsuitable for PdM.
8. There are little training and introduction possibilities available to prepare and educate service engineers for PdM.

The eight issues can be attributed to two drivers: ineffective communication and limited resources. Ineffective communication between DvO, managers and service engineers fragments the view of PdM (goals) among employees, prevents employees from embracing the PdM use case and benefits, and invokes a hesitance towards using PdM as a consequence. The lack of resources inhibits sufficient education for PdM, leads the service engineers to believe that the organization is ill-prepared for PdM, and feeds the belief that PdM implementation will burden the understaffed service engineers further.

Recommendation

Given that increasing the available resources is a political choice outside of RNLN's control, DvO should better involve service engineers in its communication regarding PdM to decrease the number and influence of RNLN's human-related barriers to PdM implementation.



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