

Heavy Equipment Demand Prediction with Support Vector Machine Regression Towards a Strategic Equipment Management

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- 1 Introduction
- 2 Strategic Construction Equipment Management
- 3 Demand Prediction Approach
- 4 Results and Discussion

Agenda

Introduction

Strategic Construction Equipment Management

Introduction

Digitization of construction industry

All industries

- Challenges and chances in the use of communication and information technologies to increase added value

Construction industry with focus on heavy-equipped construction processes

- Efficiency potentials through the transmission and processing of construction machines **condition** and **operation** data



Current Approaches focus either on

- condition monitoring -> life cycle based
- process monitoring -> project based
- resource planning? life cycle cost analysis?



Fleet management systems (FMS):

- Planning, monitoring and controlling of construction machines by different stakeholders using a local software application or a web-based application by recording and processing telematics data.



General Research Gap

Lack of holistic life cycle based fleet management regarding resource planning, condition and process monitoring and cost controlling



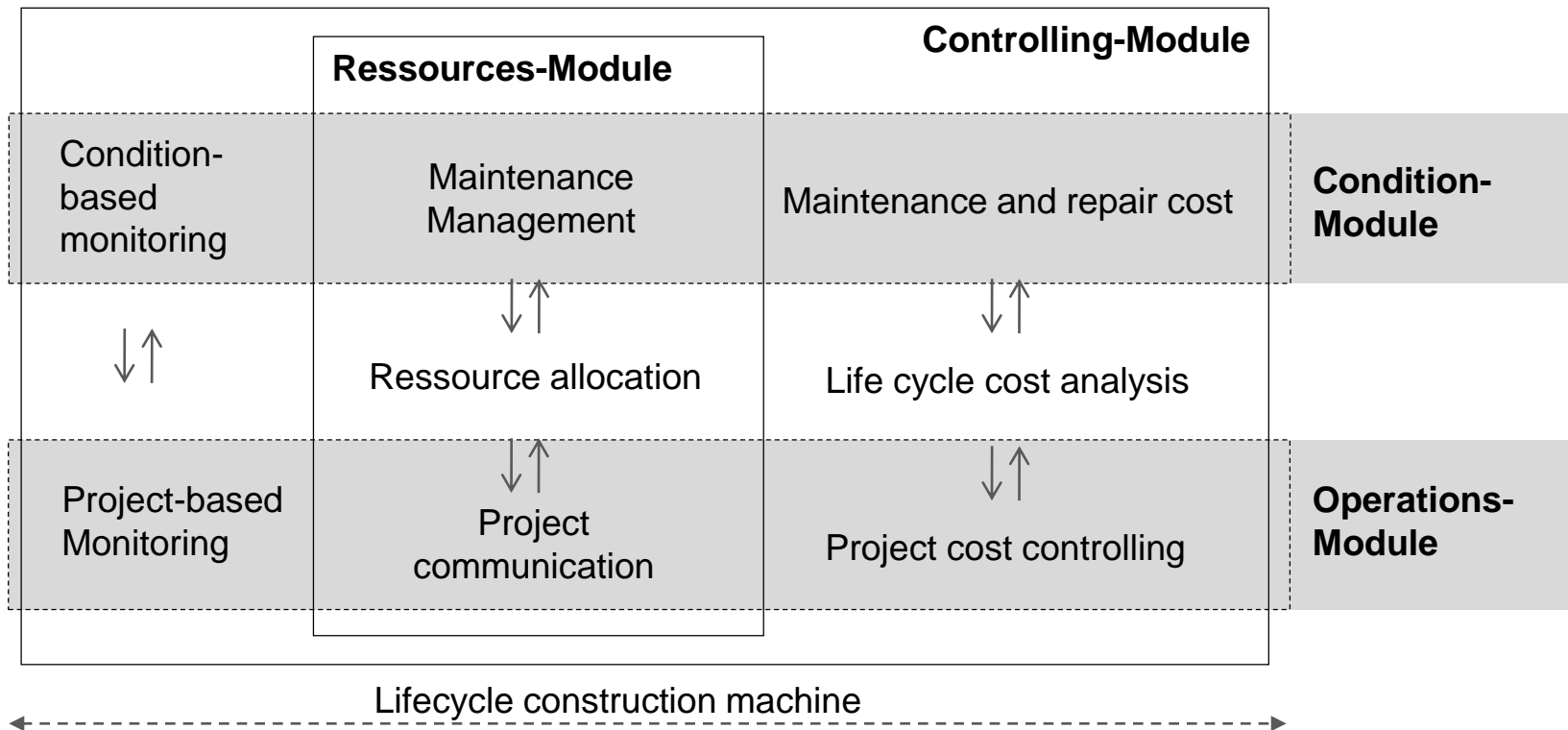
Introduction

Strategic Construction Equipment Management

Demand Prediction Approach

Strategic Construction Equipment Management

Holistic approach for planning, monitoring and controlling construction machines over their lifecycle



Holistic approach for planning, monitoring and controlling construction machines over their lifecycle

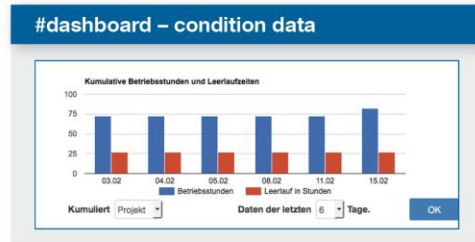
#project management

Project Name: Altkasse Kottensleben, Beginn: 24.10.2015, Ende: 01.09.2016

Aktuelles Wetter: 15.5°

Wettervorhersage: Mo 04.04, Di 05.04, Mi 06.04, Do 07.04, Fr 08.04

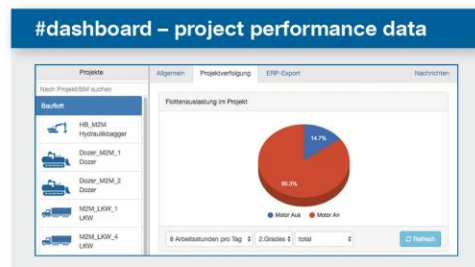
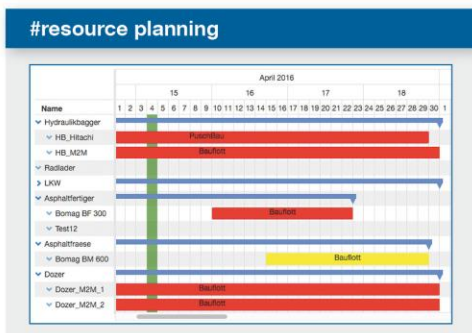
Temperatur und Messwertverläufe: Temperatur (°C), Regen (mm)



#hours export

Maschinen-Mitarbeiter	Datum	Von	Bis	Platzzeit [h]
Müllerfrau Miriam	01.04.2016	07:30	21:00	2
Müllerfrau Max	04.04.2016	08:00	17:00	0
Margu Armin	04.04.2016	08:00	18:00	1
Müllerfrau Annett	04.04.2016	08:00	18:00	1

April 2016



#newsfeed

Show All, DTC Messages, Current Process, Display Message, Last Communication

HB_M2M sent a message to Dozer_M2M_2
15.3.2016 07:49:17 Uhr Message: 202

HB_M2M has an error: hydraulic oil pressure
15.3.2016 07:49:17 Uhr
Source: ECU
Temperature: 20.00 Celcius
Alert Source: ECU
Component Group: Motor

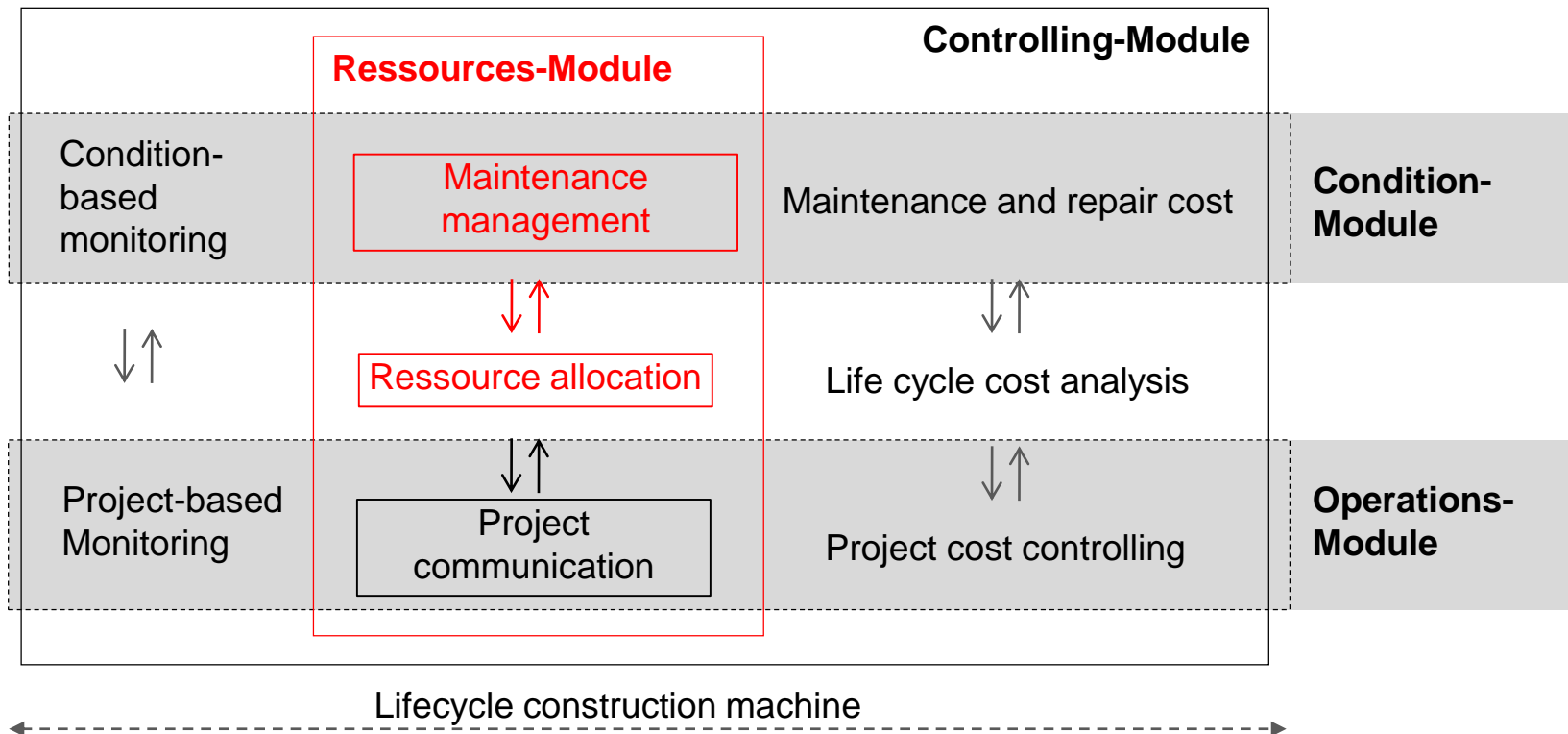
Strategic Construction Equipment Management

Demand Prediction Approach

Results and Discussion

Demand Prediction Approach

Focus today



Demand Prediction Approach

Key requirement for strategic equipment management is the knowledge of construction machine demand for future construction projects

- **Forecast** of monthly utilization rates for specific construction machine groups
- **Data-driven support** for construction machine owners regarding resource planning
- **Current construction machine stock:** Increasing planning safety and transparency of entire machine owner's fleet for utilization on projects respectively for maintenance management
- Prerequisite for **short term** (rent needed machine for a short time period) and **long term procurement strategy** (buying / leasing)

Monthly utilization rate for machine groups (excavator, dozer, wheel loader, ...) :

used workdays per month of construction machine

possible workdays per month of construction machine



used workdays per month of construction machine group

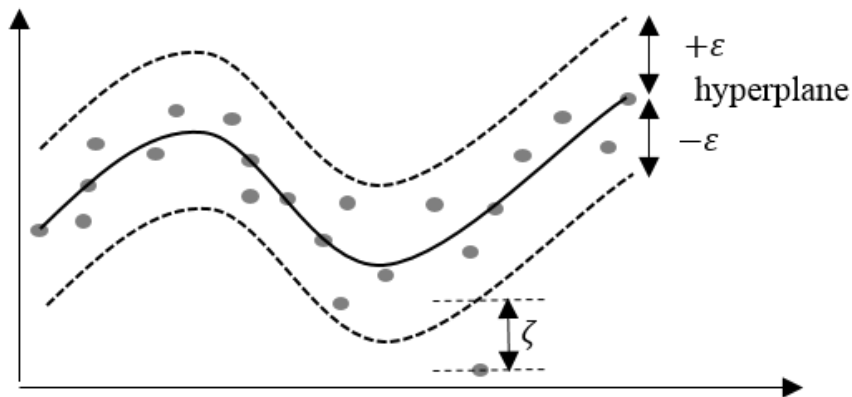
possible workdays per month of construction machine group

Demand Prediction Approach

Support Vector Machines

Support Vector Machines (SVM) are a supervised machine learning algorithm for classification and regression through pattern recognition.

Core idea of SVM is to map a training data set (input space) into a higher dimensional feature space by applying a kernel function and construct a hyperplane with maximum margin in the feature space.

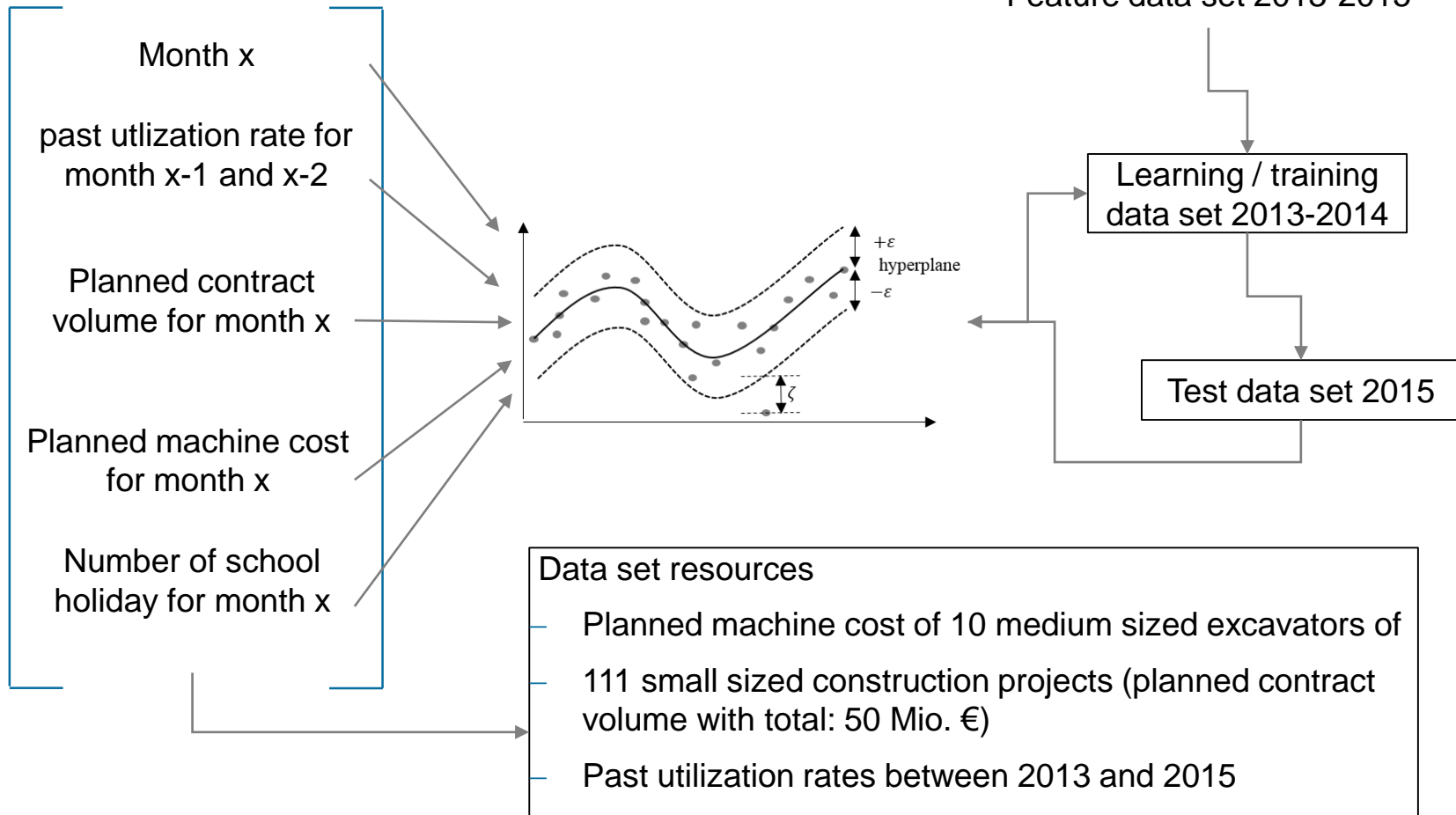


SVM Regression fits a nonlinear function (e.g. construction machine demand) with an n-dimensional hyperplane within plus/minus Epsilons as maximum margins and slack variables for outcloding training data outliers

Demand Prediction Approach

Support Vector Machine Regression

SVMR features for month x to be predicted

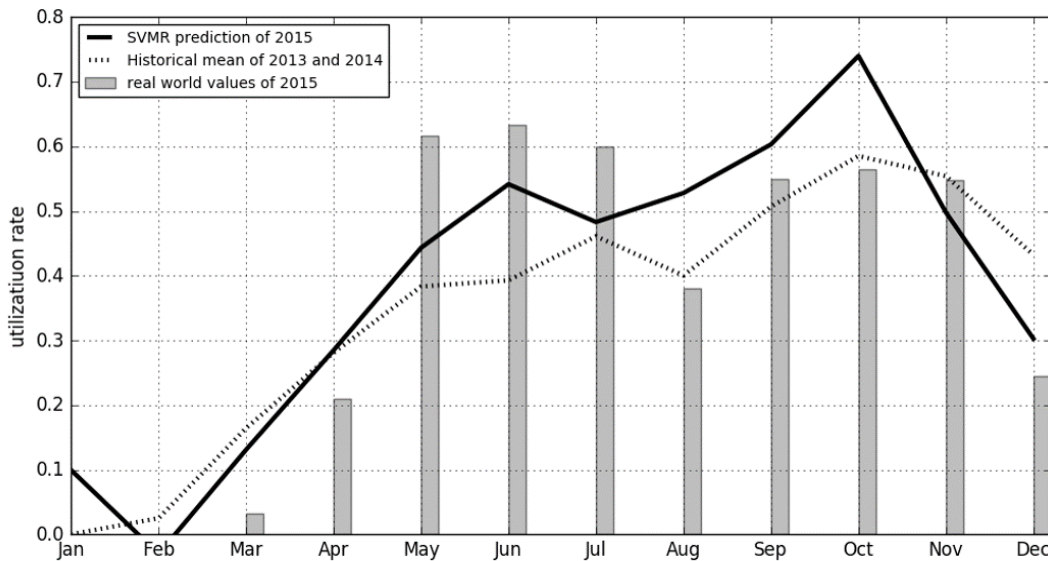


Demand Prediction Approach

Results and Discussion

High prediction rate enabled

SVMR utilization rates prediction of the construction machine group hydraulic excavator (weight class: 6 - 12 tons) for the year 2015 in relation to the real world values



Goodness-of-fit with over 80 percent shows a proper value for R-squared. Mean squared error and the root mean squared error show a less prone to error prediction compared with the historical mean approach.

The SVMR prediction shows a good approximation of the real world utilization rates.

Compared to the historical mean, it can be stated that the deviation between real world utilization rate and historical mean value is higher over the entire year.

	SVMR	Historical mean
MSE	0.012	0.016
RMSE	0.108	0.127
R-square	0.804	0.730

Results and Discussion

Further things to do

Demand prediction approach:

- More features for improving prediction rate respectively enabling an automated feature selection and testing

General strategic equipment approach:

- Development and linkage of all presented fleet management modules for a holistic construction equipment management

Summary

- Introduction presents the general shortcomings and future challenges of construction equipment management
- Presentation of the general research approach regarding a strategic construction equipment management
- Demand prediction approach of heavy equipped construction machines as key task of resources module
- Discussion of results and further research steps

Thank you!

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