Modelling Lifetimes of Switches and Crossings

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Introduction

Switches and crossings (S&C) are critical assets of railway infrastructure. Understanding the failure process and being able to predict the likelihood of faults of S&C components is essential for developing effective asset management strategies in support of proactive fault prevention and sustainable operation of S&C units. This research was focused on developing **probabilistic models** for forecasting lifetimes of individual S&C components.

Data

- **Fault Management System** (FMS) – historical failure records for components of 652 S&C units over the period from 2002 to 2012 obtained.
- A list of point operating equipment (POE) matched with a set of switches - components belonging to the same S&C unit identified.
- **Intelligent Infrastructure** (II) - utilisation levels of S&C units estimated.

Analysis Results

Weibull distribution shape parameter, β, values are consistently less than 1 in all models indicating a decreasing hazard rate.

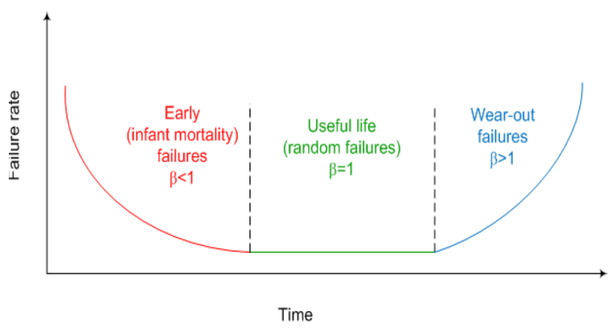


Figure 1. Reliability bathtub curve with β value interpretations

Component	Time	Utilisation
Clamp lock	0.48	0.52
Point machine	0.38	0.50
Supp. drive sets	0.42	0.50
Point heater	0.55	N/A
Stretcher bar set	0.43	0.55
Fastening set	0.42	0.56
Slide chair set	0.47	0.63

Table 1. Weibull distribution shape parameter β values

The outputs of the Weibull analysis, e.g. reliability estimates as presented in Figures 2 and 3, can be used to implement cost-effective and efficient maintenance strategies.

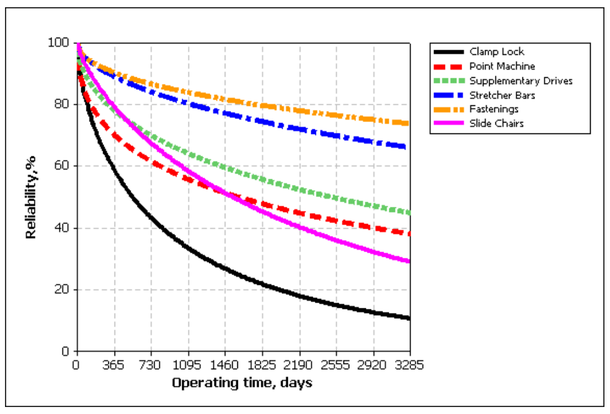


Figure 2. Reliability of S&C components

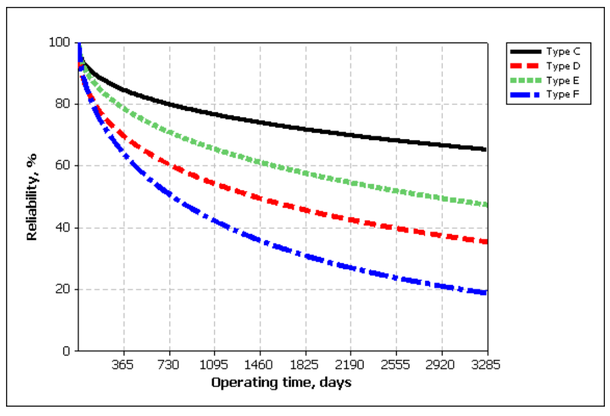
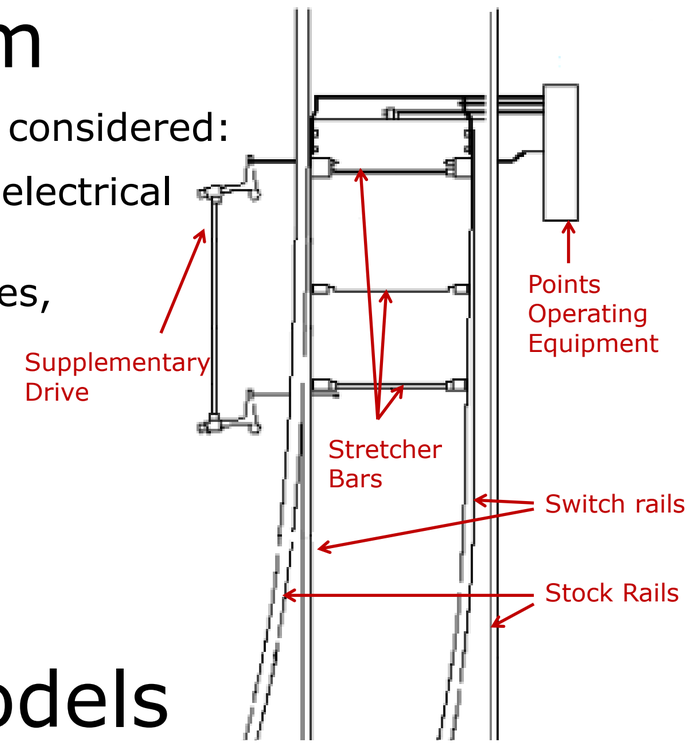


Figure 3. Reliability of supplementary drives in different type S&C units

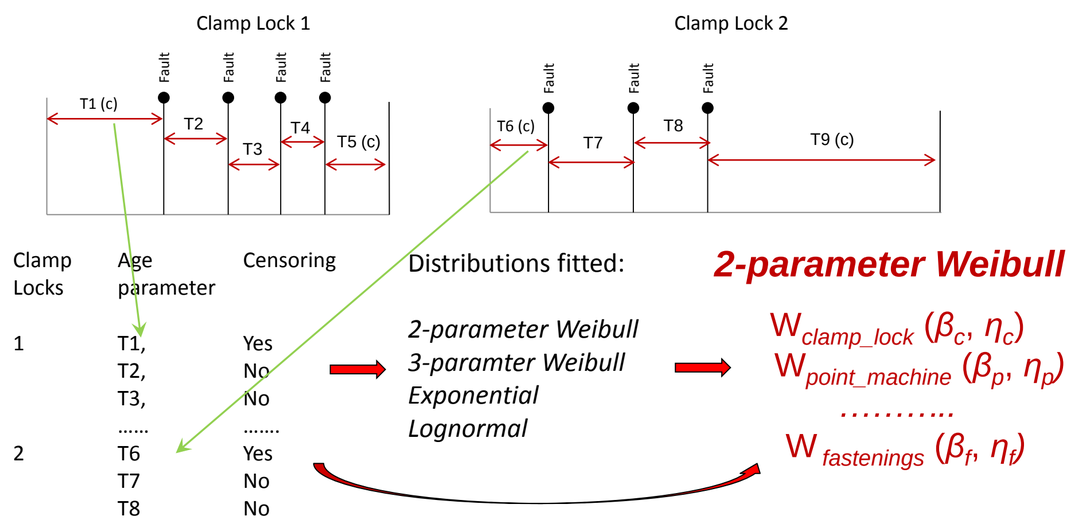
S&C System

Individual components considered:

- POE (clamp lock or electrical point machine),
- supplementary drives,
- point heater,
- stretcher bars,
- fastenings,
- slide chairs.



Lifetime Models



- **Time based** lifetime model: $\mathbf{T_i}$ is time to failure, e.g. number of days between failures.
- **Utilisation based** lifetime model: $\mathbf{T_i}$ is number of switch movements between failures.

Summary

The main outcomes of the study are:

- The two-parameter Weibull distribution was identified as the most appropriate.
- The shape parameter of the distributions was consistently less than unity.
- Ineffective maintenance was considered to be a strong influence on these possible early life failures although analysis showed that this alone could not explain the phenomenon.
- The reliability of components varies among different types of S&C units and this should be considered when developing asset management tools.
- Obtained approximate constant failure rates can be used to predict component failures past their burn-in period.