

TOWARDS THE DEVELOPMENT OF TRANSITION
PROBABILITY MATRICES IN THE MARKOVIAN
MODEL FOR THE PREDICTED SERVICE LIFE OF
BUILDINGS

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THESIS SUMMARY

TOWARDS THE DEVELOPMENT OF TRANSITION PROBABILITY MATRICES IN THE MARKOVIAN MODEL FOR THE PREDICTED SERVICE LIFE OF BUILDINGS

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The global importance of and need for sustainable development demand an informed decision-making process from the built environment to ensure optimum service life, which depends on the ability to quantify changes in condition of building materials over time. The objective of this thesis is to develop a model, which translates expert knowledge and reasoning into probability values through the application of Fuzzy Logic Artificial Intelligence to supplement limited historical performance data on degradation of building materials for the development of Markov Chain transitional probability matrices to predict service life, condition changes over time, and consequences of maintenance levels on service life of buildings. The Markov Chain methodology, a stochastic approach used for simulating the transition from one condition to another over time, has been identified as the preferred method for service life prediction by a number of studies. Limited availability of historic performance data on degradation and durability of building materials, required to populate the Markovian transition probability matrices, however restricts the application of the Markov Chain methodology.

The durability and degradation factors, defined as design and maintenance levels, material and workmanship quality, external and internal climate, and operational environment, similar to the factors identified in the state-of-the-art 'Factor Method' for service life prediction, and current

condition are rated on a uniform colour-coded five-point rating system and used to develop “IF-THEN” rules based on expert knowledge and reasoning. Fuzzy logic artificial intelligence is then used to translate these rules into crisp probability values to populate the Markovian transitional probability matrices.

Historic performance data from previous condition assessments of six academic hospitals are used to calibrate and test the model. There is good correlation between the transitional probability matrices developed for the proposed model and other Markov applications in concrete bridge deck deterioration and roof maintenance models, based on historic performance data collected over extended periods, which makes the correlation more significant.

Proof is presented that the Markov Chain can be used to calculate the estimated service life of a building or component, quantify changes in condition over time and determine the effect of maintenance levels on service life. It is also illustrated that the limited availability of historic performance data on degradation of building materials can be supplemented with expert knowledge, translated into probability values through the application of Fuzzy Logic Artificial Intelligence, to develop transition probability matrices for the Markov Chain. The proposed model can also be used to determine the estimated loss of or gain in service life of a building or component for various levels of maintenance.

Key words: building maintenance, condition changes, fuzzy logic, Markov Chain, service life prediction, transitional probability matrices.

ABSTRACT

- Title:** Towards the Development of Transition Probability Matrices in the Markovian Model for the Predicted Service Life of Buildings
- Author:** J.J. Mc Duling
- Supervisor:** Professor Doctor E Horak
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