

Substation Transformer Failure Analysis Through Text Mining

Nanthiine Nair Ravi
Universiti Tenaga Nasional
43000 Kajang, Selangor, Malaysia
nanthiinenair@gmail.com

Sulfeeza Mohd Drus
Universiti Tenaga Nasional
43000 Kajang, Selangor, Malaysia
sulfeeza@uniten.edu.my

Prajindra Sankar Krishnan
Universiti Tenaga Nasional
43000 Kajang, Selangor, Malaysia
sankar@uniten.edu.my

Nur Laila Abdul Ghani
Universiti Tenaga Nasional
43000 Kajang, Selangor, Malaysia
laila@uniten.edu.my

Abstract— Transformer failure could occur in terms of tripping that results in an unplanned or unseen outage. A good maintenance strategy is therefore an essential component in a power system to prevent unexpected failures. In this paper, the causes of transformer failure within the power transformer systems have been reviewed. Data is obtained from the transmission substation assets from the whole of Peninsular Malaysia for the past 5 years. However, the challenge is that the problem descriptions of the datasets are all in text formats. Thus, text mining approach is chosen for the data analysis using R. This paper covers the most common steps in R, from data preparation to analysis, and visualization through wordcloud generation. This study mainly focuses on bag-of-word text analysis approaches, which means that only word frequencies per text are used and word positions are ignored. Although this simplifies text content dramatically, research and many applications in the real world show that word frequencies alone contain adequate information for many types of analysis. As a result of analysis, keywords like “leak”, “lightning”, “animal”, “cable” and “temperature” are identified as the main causes of transformer failures based on the number of word frequency in the tripping dataset. Further enhancement could be made in the future to predict the failure beforehand using predictive analytics approaches.

Keywords— power transformer, text mining, trip, R language, failure analysis

I. INTRODUCTION

Over the years, disruptions in the power system has been a major concern to industrial and commercial customers in Malaysia [3]. The tripping incidents in Malaysia has been rapidly increasing for the past 5 years and the amount of unsupplied energy (MWh) has also increased consequently [22]. According to the Energy Commission, the major cause of the dips are transformers tripping and [3] says that total of 21.3% of power failure incidents happened at the utilities substation alone. Thus, utilities are persistently looking for ways to effectively overcome these industry challenges and remain relevant in the changing energy marketplace [2]. Navigant Research estimates that utilities will spend almost \$50 billion on asset management and grid monitoring technology by 2023 [1]. Routine preventive maintenance programs have traditionally been used in combination with regular tests [7,23,24]. However, in recent years, predictive maintenance has become popular due to the demanding industrial needs. While power failure brings a huge financial impact to the business in terms of revenue loss, increased repair and maintenance costs, it also severely impacts the consumers on the other side. Unexpected outages paralyse consumers' daily routines which then only leads to dissatisfaction. Hence, it is very vital for the utilities to study on the faults and failures of the equipment [8] and thus,

being able to predict the possible failures that could occur in near future. Extensive research needs to be done in order to realize this dream as the amount of data available today is providing utilities with the information needed to operate more efficiently, effectively and safely, thus allowing them to overcome some of these disruptive obstacles.

Thus, this paper focuses on analyzing the tripping data and analyze possible causes of transformer failures. Data is obtained from the transmission substation assets from the whole of Peninsular Malaysia for the past 5 years. These data need to be processed to evaluate and analyze the causes of tripping on substation assets. One of the challenges with these datasets is that the problem descriptions are in textual format which makes it quite challenging to identify the possible causes of tripping. Therefore, text mining approach is chosen to analyze these data. The remainder of the paper is organized as follows:

Section II discusses on the literature review which encompasses the overview of transformer failure analysis, applications of text mining in various sectors and text mining tools comparison. Research methodology on text mining approaches is discussed in Section III whereas section IV focuses on results and discussion based on data visualization via frequency barplot and wordcloud generation. Finally, conclusion is done in section V.

II. LITERATURE REVIEW

A. Overview of Transformer Failure Analysis

Transformer, the costliest and strategic component is an electrical device used to transfer energy between two or more circuits by electromagnetic induction [30]. It plays a major role by interconnecting at each stage of the power transmission and distribution system [23]. An electrical utility comprises a large number of transformers in different sizes ranging from a few kVA to more than a few hundred MVA capacities throughout the electrical network. Power transformers are very reliable for functioning up to 30-40 years ideally [23], [31-33]. However, there are some transformers that are in use for more than 50 years. Due to their long-term operating condition, critical elements like on load tap changer, insulation (oil and paper), active part (winding and core), bushing and tank are recurrently subjected to various operational pressures that cause the degradation. These condition then results in an unexpected power transformer failure [34].

Studies reported large number of transformer failure incidents at various electric utilities across the globe. CIGRÉ working group [12] conducted an analysis on the large power transformers failure and found that about 41%