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A Framework Of Procurement Analytics For Fraud Coalition Prediction

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Abstract*— The field of data analytics has become a significant catalyst for change in government operations, presenting unique possibilities for enhancing governance efficiency. The availability of vast amounts of data accessible to individuals responsible for making decisions presents an opportunity for extracting valuable insights. However, effectively harnessing this potential requires the utilisation of advanced methodologies. Data analytics has the potential to greatly benefit procurement, which is a crucial aspect of government operations. By utilising data analytics, procurement can improve its efficiency, mitigate disputes, prevent instances of fraud and corruption, enhance transparency and accountability, and reduce both time and cost burdens. The significance of effective procurement management is underscored by Malaysia's budget allocation of RM388.1 billion for the year 2023. Insufficient monitoring of procurement procedures can give rise to fraudulent activities, corrupt practises, and suboptimal tenderer choices, thereby causing significant financial losses to government funds. A misdemeanor arrest of the government procurement cartel coalition in 2021, which involved a monopoly of 345 tenders in government ministries and agencies across the nation and a project value of RM3.8 billion is one illustration of the insufficient monitoring of the fraudulent cartel and coalition activities in government procurement process. In order to tackle these issues, this study introduces a novel framework that employs a machine learning model specifically developed to assist evaluation committees and tender board in detecting fraudulent company in the tenders and quotations. The framework demonstrates the capability to predict tenderers who possess a likelihood of engaging in fraudulent activities and forming cartel coalition with other tenderers. Comprehensive information pertaining to tenderers can be discerned, hence bolstering the evidentiary support for the presence of fraudulent alliances and cartels among tenderers. This framework additionally offers visual analytics that facilitates the awareness of committee members and tender boards regarding the potential danger of fraudulent activities by tenderers during the procurement process. The framework described in this study utilises historical and current datasets derived from Malaysia's eProcurement system that is known as ePerolehan that was exist since 1999. This framework effectively extracts patterns, identifies trends, and generates forecasts pertaining to fraudulent coalition and cartel activities among tenderers. To date, there is an absence of technologies available for the detection of fraudulent coalitions and cartels in the procurement process. By implementing this framework, it has the potential to mitigate financial losses and corrupt practises, hence fostering economic growth and enhancing transparency within a nation.

Keywords—Procurement, Cartel, Fraudulent, Coalition, Machine Learning, Analytics

I. INTRODUCTION

The management of procurement processes is crucial for organizations worldwide, as it significantly impacts their financial operations. Efficient procurement management can successfully tackle challenges such as operational inefficiencies, conflicts, fraudulent activities, and corruption (Gunasegaran et al. 2023). Collusion and bid-rigging are concealed behaviours that create substantial barriers in procurement, compromising fairness and competitiveness. These behaviours entail covert cooperation

among potential purchasers to influence prices or damage the quality of products and services, so undermining the integrity of the procurement system (Barajei 2023; Rendon & Rendon 2016; Soylu et al. 2022).

The research project aims to improve procurement analytics by specifically targeting the detection and prevention of collusion fraud in e-procurement. The project aims to create highly efficient Machine Learning models to detect coalition fraud. It also aims to determine the key components of a comprehensive fraud detection framework and evaluate the efficacy of these approaches using case study data (Gunasegaran et al. 2023; Rendon & Rendon 2016). The study centres on the ePerolehan system in Malaysia, which is an electronic procurement system that accumulates significant untapped data. The existing parameters in the system are not fully optimised, namely in effectively tackling comprehensive fraud coalition detection.

The lack of recorded efforts by the Malaysian Competition Commission (MyCC) to tackle fraudulent alliances and cartels employing advanced strategies worsens the issue. The current methodology used by MyCC does not use Machine Learning techniques for the automated identification and detection of fraudulent coalitions and cartels. This highlights a significant gap in the existing literature and official publications. Hence, the objective of the study is to present an all-encompassing framework and models that employ sophisticated data analytics and Machine Learning techniques to proactively detect and deter fraudulent collaborations in the e-procurement sector.

The research holds importance in its ability to improve scholarly understanding of procurement analytics and offer practical advice to policymakers and organisations for reinforcing their procurement processes against collusion and bid-rigging (Barajei 2023; Gunasegaran et al. 2023). The study aims to fill the existing gap in the literature and utilise sophisticated data analytics and Machine Learning techniques to actively avoid fraudulent practices in e-procurement. The ultimate goal is to enhance fairness and integrity in procurement procedures.

II. METHODOLOGY

This study employs a systematic approach to create and verify a framework for procurement analytics that specifically targets the prediction of fraud coalitions. The technique is divided into four clearly defined phases: Preliminary Phase, Data Preparation Phase, Modelling & Verification Phase, and Visualisation Phase. Every phase is crucial in guaranteeing the thoroughness and efficiency of the framework as shown in Figure 1

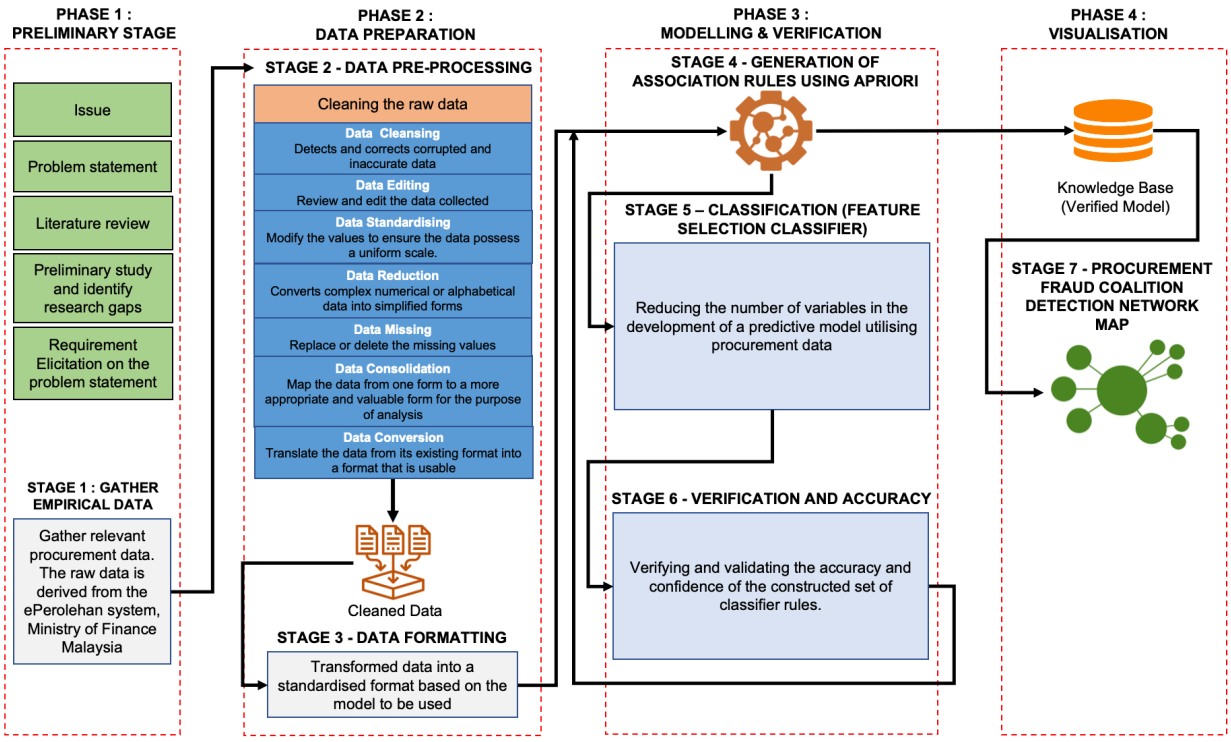

Fig. 1. Procurement Fraud Coalition Analytic Framework (PFCAF)

The preliminary part of the project include doing a comprehensive literature research and consulting with experts to identify common fraud patterns and key variables in procurement data. This phase lays the foundation for the model by developing a theoretical and empirical basis for the types of fraud commonly encountered in procurement processes. The first stage entails the identification and procurement of unprocessed data from the ePerolehan system, which is a database overseen by the Ministry of

Finance, Malaysia. The dataset covers the time period from 2015 to 2020, offering a comprehensive temporal viewpoint that is essential for understanding the changing patterns of fraudulent coalition activity.

The Data Preparation Phase involves the collection and preprocessing of procurement data. Data collecting entails gathering data from several procurement systems to ensure a comprehensive and inclusive dataset. Preprocessing encompasses the activities of cleansing, editing, standardising, and converting data, thereby making it suitable for efficient analysis. Stage 2 comprises Data pre-processing is an essential step that improves the quality and efficiency of subsequent data mining procedures. During this step, meticulous cleaning, editing, reduction, and merging actions are carried out. Erroneous, absent, and disruptive data are corrected or eliminated, and tables are combined to enhance the dataset (Malik et al. 2010) . The objective is to generate a polished dataset that is suitable to precise and enlightening data mining. In order to enable insightful analysis, Stage 3 processed and convert the raw data into a structured and standardised format. This guarantees that every category of data conforms to a uniform structure, hence enhancing the overall calibre and relevance of the collection. The prepared data is used as input to execute the Association Rule algorithm in later stages.

The Modelling & Verification Phase is the fundamental component of the methodology, in which the association rules technique is utilized. Association rules are employed to detect and analyse trends in the data that could potentially signify fraudulent activities. This step include the development of regulations, the examination of their soundness, and the enhancement of their effectiveness through evaluating their ability to identify established instances of fraud. The predictive capability of the model is thoroughly assessed using rigorous validation approaches, such as cross-validation and sensitivity analysis, to ensure its robustness and reliability. In Stage 4, The Apriori algorithm, known for its high efficiency in extracting frequent itemsets, is utilised for the purpose of extracting Association Rules (Agrawal et al. 1993; Agrawal & Srikant 1994). These principles elucidate patterns and trends in the data by finding elements that occur frequently and are connected. The algorithm iterates through the information, tallying the frequencies of each item, and identifies the initial set of frequently occurring elements. This serves as the foundation for detecting correlations that may suggest the presence of potential fraudulent coalition actions.

Feature selection as in Stage 5 performed categorization to reduce irrelevant or redundant features, keeping just those important to predicting fraud collusion (Kuhn & Johnson 2013) . The objective is to entails finding the most pertinent attributes that contribute to predicting fraud and improve the interpretability and performance of the model by eliminating irrelevant features. This phase aims to enhance the accuracy and efficiency of predictions without compromising learning performance by ensuring that the model focuses solely on important aspects.

Stage 6 comprises the verification and evaluation of the constructed framework's validity and precision. Results undergo rigorous evaluation by a panel of specialists from both the educational and industrial sectors. The goal is to validate the identified sets of rules related to fraud collusion and evaluate the precision of predictions. This collaborative validation guarantees that the framework is effective in practical applications and is aligned with real-world conditions.

The visualisation phase in Stage 7 is the last stage of the process, which is dedicated to displaying the results. The model utilises effective visualisation methods to depict the discovered patterns and connections. This phase is designed to offer procurement managers with intuitive and actionable insights, enabling them to make well-informed decisions in order to prevent fraud.

III. RESULTS AND FINDINGS

During the data analysis process using the model in the framework, a clear correlation between two firms was discovered by a targeted investigation of a particular subset of the data using Association Rules and Feature Selection model as in the framework depicted in Stage 4 and Stage 5 of PFCAF. This initial finding prompted a comprehensive investigation into the company's available information, which uncovered that both entities had registered using the same field code. This uncommon event suggested a possible collaboration or shared ownership.

Upon further investigation of their bidding history, it was discovered that both companies had taken part in an identical series of eight tenders. This occurrence is statistically unlikely, which prompts inquiries about the randomness of their involvement in the tender process. Notably, not only did they participate, but they also achieved a high success rate. Each business was granted contracts for two out of the eight tenders they competed for. This consistent pattern of jointly submitted bids and corresponding rates of success may indicate a deliberate division of victories in order to evade detection of any collusive behaviour.

The examination extended beyond their bidding behaviour. Upon closer analysis of their company identities, notable resemblances were observed. Both organisations displayed a name system that adhered to a noticeable pattern, indicating a shared origin or an intentional effort to create an illusion of rivalry when it may not exist. Furthermore, the fact that both firms share identical physical addresses strengthens the assumption that they have a closer connection than what is expected of two separate companies.

The convergence of these characteristics, including the same field codes, the intersection of involvement in tenders and awards, and the replication of corporate names and locations, establishes a discernible pattern that cannot be easily disregarded as mere happenstance. It portrays a relationship that extends beyond harmless professional rivalry, indicating a purposeful plan to bypass procurement restrictions and maybe participate in anti-competitive behaviour. Considering the significance of these relationships, there is a strong case for maintaining a heightened level of surveillance over the activity of these corporations. A thorough inquiry must be done to fully understand the nature of their relationship. An inquiry of this nature would probably entail cross-referencing supplementary databases, interviewing crucial stakeholders, and potentially performing on-site audits of the

corporate premises. The true extent of the link between these companies can only be determined through thorough investigative efforts, which are essential to uphold the integrity of the procurement process.

IV. CONCLUSIONS

Incorporating a machine learning system that is particularly made to identify fraudulent coalitions can greatly improve the procurement evaluation process. This novel methodology enables decision-makers to discern and scrutinise patterns of risk within the substantial amounts of money involved in public expenditure. The core of this system revolves around the utilisation of a Feature Selection Classifier. The Procurement Fraud Coalition Analysis Framework (PFCAF) is a suggested framework that combines the association rules technique, an effective algorithm for identifying connections, alliances, and potential collusive or cartel behaviours among organisations. Using a feature selection classifier not only improves the accuracy of the algorithm but also significantly reduces the number of features in the dataset. As a result, the system experiences increased efficiency and enhanced overall performance. However, in order to completely confirm these first discoveries, additional empirical research are required. Furthermore, prior to its implementation, the framework should undergo thorough evaluation by specialists in the field to guarantee its efficacy and dependability in real-life situations.

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