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Predicting the intention to adopt e-zakat payment services: a machine learning approach

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ABSTRACT

The technology evolution in the zakat collection and payment services has brought about a profound transformation in the global processes of gathering and distributing charitable contributions. Despite witnessing a positive trend in annual zakat collection in Malaysia, it has yet to reach its optimal level. Therefore, predictions regarding performance and comparisons across multiple models for online zakat collection hold crucial significance in improving the overall collection rate. This paper, utilizing data from 230 zakat payers, presents an empirical assessment of various machine learning algorithms aimed at predicting zakat payer intentions when utilizing online platforms for zakat payments. Additionally, this paper presents the analysis of machine learning features importance to justify the effect of technology acceptance model (TAM) and theory of technology readiness (TR) attributes in the machine learning algorithms for predicting e-zakat payment service adoption intention. The findings show that many of the machine learning models are able to perform for highly accurate results, with most achieving over 80% accuracy. The most crucial attribute influencing these predictions was found to be the TAM. This study's methodology is designed to be easily replicable, allowing for further detailed exploration of both the influencing factors and the machine learning algorithms used.

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1. INTRODUCTION

Advancements in zakat collection and payment services, encompassing technologies such as mobile applications, online payment gateways, and blockchain [1]-[3], have sparked a profound evolution in the way charitable contributions are gathered and distributed globally. These transformative technologies have not only modernized zakat collection and payment services but have also increased their accessibility, security, and adaptability to the changing needs of zakat payers and beneficiaries on a global scale [4]. For instance, according to [5], mobile banking apps have streamlined the zakat payment process, making it exceptionally convenient for contributors to fulfill their obligations through secure and hassle-free transactions.

In Islam, zakat operates as a sustainable force for social and economic upliftment, aligning with Islamic principles of social justice and equity. Zakat is a form of compulsory charity that aims to purify wealth and redistribute it among those in need [6]. Indeed, Zauro *et al.* [7] stress that zakat, a fundamental aspect of Islamic financial and social responsibility, serves as a pivotal force in alleviating poverty and bolstering economic stability. Mandated as a charitable obligation, zakat involves the systematic giving of a portion of one's wealth to assist the less fortunate. Through systematic wealth redistribution within the Muslim community, zakat channels resources into essential social welfare programs such as healthcare, education, and financial aid for the less fortunate. This targeted assistance not only directly aids those in need but also fosters economic stability by stimulating activity within the community. As zakat circulates within society, it stimulates economic activity, promotes entrepreneurship among the less privileged, and enhances overall financial well-being.

In Malaysia, the introduction of online zakat services has ushered in a more efficient, flexible, and user-friendly system, resulting in notable enhancements in the collection and distribution of zakat funds. For instance, the annual report of zakat collection centre-Federal Territory Islamic Religious Council (PPZ-MAIWP) documents that the adoption of digital zakat solutions contributed to a 9% surge in zakat collection for the MAIWP, amounting to RM816.48 million, and a 10% increase, reaching RM12.19 million in 2021, encompassing both zakat harta and zakat fitrah. Despite the growing popularity and transformative potential of online zakat payment services, there exists a discernible gap between this potential and actual collection rates. Previous research indicates that some zakat contributors exhibit reluctance towards adopting online platforms [8]-[11].

Hence, it is crucial for zakat institutions, policymakers, and government agencies to anticipate the inclination of zakat contributors towards embracing alternative payment methods, such as online zakat payment services. Recently, machine learning has emerged as a critical predictive tool across various domains, including education [12], agriculture [13], and medical applications [14], [15]. Moreover, numerous studies have demonstrated the effectiveness of machine learning in achieving more precise outcomes when predicting online donation intentions [16]-[18]. For example, Alazazi *et al.* [16] predict the determinants of crowdfunding campaign success on GoFundMe and compare the performance of six different machine learning algorithms including linear regression (LR), classification and regression tree (CART), k-nearest neighbor (KNN), support vector machine (SVM), neural networks, and random forest (RF). The results show that SVM performs the best and is able to predict the average daily amount received with a high degree of accuracy. Meanwhile, Peng *et al.* [17] formulated predictive models for medical crowdfunding employing five machine-learning algorithms, namely KNN, LR, artificial neural network (ANN), CART, and extreme gradient boosting (XGBoost). Utilizing data from 11,771 medical crowdfunding campaigns sourced from the prominent donation-based platform Weibo Philanthropy, the findings indicate that XGBoost, constructed through ensemble techniques, outperformed all other algorithms, exhibiting the lowest mean-squared error and the highest R-squared. Further, the investigation conducted by [18] seeks to explore the factors influencing customers' voluntary donations to content contributors on social websites. Using machine learning classifiers, namely SVM, ANN, decision tree (DT), RF, and considering both content and creator-related features, the study concludes that the random classifier, surpassed other constructed models, exhibiting excellent predictive performance. This outcome underscores the significance of these factors in forecasting donations. Additionally, the study reveals that the predictability of content-related features is relatively superior compared to those associated with creators.

While machine learning is commonly applied to forecast online donations, there is a notable gap as no previous studies have specifically concentrated on predicting the adoption intention of online zakat payment services. Consequently, the aim of this study is to enhance the current understanding by employing a machine learning classification approach to anticipate the inclination of Muslim zakat contributors to utilize online platforms for fulfilling their zakat obligations. The prediction models are formulated based on two dimensions of the technology acceptance model (TAM): perceived usefulness and perceived ease of use, along with attributes from the theory of technology readiness (TTR), including innovativeness, and optimism.

2. METHOD

2.1. Data collection and dataset

This study employed a questionnaire instrument to collect the dataset for constructing the prediction model with different machine learning algorithms. The survey was distributed to Muslim zakat contributors in Malaysia. The questionnaire consists of two sections that was designed to acquire information on the contributors' demographic and their intention to adopt e-zakat payment platform as well as of the TAM; perceived usefulness and perceived ease of use, and the technology readiness (TR); innovativeness and optimism. The TAM, proposed by [19], is a system-specific model that adopts two fundamental cognitive attributes; perceived usefulness and perceived ease of use for studying an individual's attitude/intention in accepting or adopting a new technology. Perceived usefulness is defined as the extent to which an individual believes that using a specific system will increase his or her job performance [20]. Perceived ease of use, on the other hand, is an individual's belief that using a particular system will be free of effort [20]. Meanwhile, the TR proposes two positive personality traits; optimism, innovativeness [21]. The positive traits are perceived as favorable factors that stimulate individuals to accept the novel technology. Indeed, Parasuraman [22] argue that if an individual has a higher level of positive TR attributes, then his or her adoption rate of new technologies is higher.

The data collected for the independent and dependent variables were measured using a seven-point Likert scale, with a range from 1 ("strongly disagree") to 7 ("strongly agree"). The optimism and innovativeness construct comprised four indicators each, all adapted from [23]. The perceived usefulness and perceived ease of use were assessed using a three-item and four-item questionnaire, respectively, adapted from [24]. The dependent variable, online zakat payment service adoption intention, was measured using three items adapted from [25]. Out of 350 questionnaires distributed, 230 valid responses were used for the analysis, representing a 66% response rate.

2.2. The machine learning algorithms

Six machine learning techniques were proposed using AutoModel RapidMiner for the dataset, including generalized linear model, SVM, deep learning, DT, RF, and gradient boosted trees (GBT). However, only the three most accurate algorithms were chosen. GBT, RF, and DT are the three methods that were chosen. For three methods, the hyper-parameters early analysis is crucial. Maximal depth is a frequent hyper-parameter for tree-based algorithms. While learning rate is exclusively utilized in GBT, Number of trees is an extra hyper-parameter for both RF and GBT. The optimal hyper-parameter configuration is listed in Table 1.

Table 1. The optimal hyper-parameters for the machine learning algorithms

Machine learning algorithm	Hyper-parameters	Best error rate (%)	Hyper-parameters	Worst error rate (%)
DT	Maximal depth=4	8.9	Maximal depth=2	13.1
RF	Number of trees=140 Maximal depth=7	8.4	Number of trees=60 Maximal depth=2	12.8
GBT	Number of trees =150 Maximal depth=4 Learning rate=0.100	7.1	Number of trees=30 Maximal depth=4 Learning rate=0.01	15.4

The worst error rates for the three algorithms were 13.1%, 12.8%, and 15.4%, respectively, as shown in Table 1. With four maximum depths, the best error rate for DT was 8.9%, while with seven maximum depths, the best error rate for RF was 8.4%. Number of trees is an additional hyper-parameter for RF and GBT. While GBT requires 150 trees, RF can achieve the greatest performance with 140 trees. In addition to the two hyper-parameters, GBT has a learning rate, of which 0.1 was the ideal value. The study employed a split training strategy with a 70:30 percentage ratio to separate the training and testing datasets. Consequently, 69 of the 230 data were used for machine learning testing, while 161 were used for machine learning training. As shown in Table 2, the features selection was split into two groups.

Table 2. Features selection

Features selection	Attributes/IVs
ALL	Gender, occupation, age, qualification, Zakat_literacy, experience, TAM (ease of use, usefulness), and TR (optimism, innovativeness)
TAM and TR	TAM (ease of use, usefulness), TR (optimism, innovativeness)

3. RESULTS AND DISCUSSION

The study's findings are reported in two sets. First, two feature selection groups indicated in Table 3 will be evaluated based on performance outcomes in terms of root mean square error (RMSE) and R squared (R^2). Second, each algorithm's recall and precision will be shown. Thirdly, the differences between each machine learning characteristic will be discussed.

Table 3 indicates that DT and RF present better performance in terms of RMSE and R^2 when using all attributes. For GBT, there's a slight improvement in RMSE with the reduced feature set (TAM and TR only), while R^2 stays the same, suggesting a potentially more efficient model with fewer features. This might be due to GBT's capability to handle feature interactions more effectively, reducing the need for a larger feature set. Furthermore, it is interesting to get insight into the influences of each attribute based on the two groups of feature selection. Figure 1 depicts the feature importance of machine learning algorithms that use all attributes.

Table 3. The performances result

Algorithm	RMSE (+-Std.Dev)	R^2 (+-Std.Dev)
ALL		
Algorithm	RMSE (+-Std.Dev)	R^2 (+-Std.Dev)
DT	0.62 (0.12)	0.79 (0.12)
RF	0.50 (0.10)	0.87 (0.04)
GBT	0.45 (0.11)	0.88 (0.06)
TAM and TTR		
Algorithm	RMSE (+-Std.Dev)	R^2 (+-Std.Dev)
DT	0.69 (0.11)	0.68 (0.12)
RF	0.57 (0.10)	0.80 (0.05)
GBT	0.42 (0.10)	0.88 (0.06)

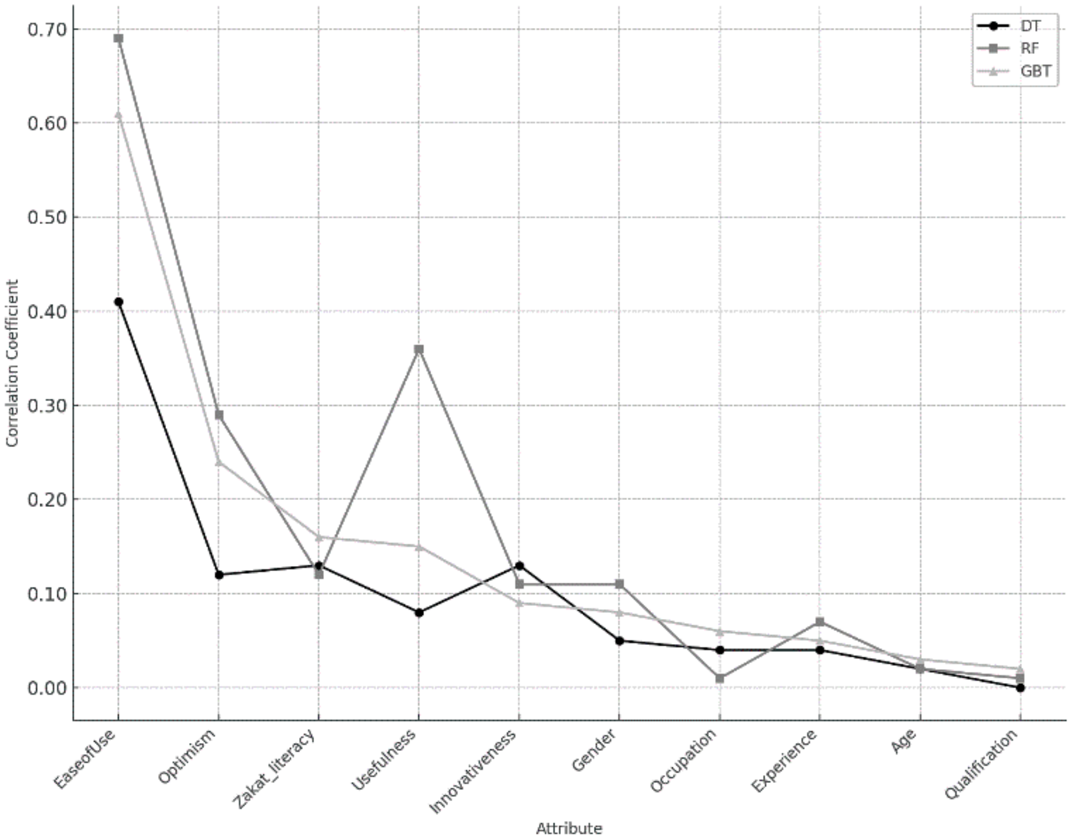

Figure 1. Feature importance from features selection that used all attributes

Each attribute that influenced the machine learning algorithms was varying across the prediction models, which may be due to the different ways these algorithms handle feature selection and interactions. DT and RF appear to be sensitive to *Ease of Use* while other attributes influenced at the moderate to low levels, while other attributes had a moderate to minimal effect, yet still contributed to enhancing algorithm performance (refer Table 3). The attributes associated with the TAM (*Ease of Use* and *Usefulness*) demonstrated a significant influence in the GBT. Figure 2 explores the impact on machine learning algorithms when only attributes from the TAM and trust (TR) were utilized.

All three algorithms assign the highest importance to this *Ease of Use*, with RF assigning it the greatest importance, followed by DT and then GBT. This indicates that *Ease of Use* is a critical predictor for these models when the attribute set is limited. The importance of usefulness drops significantly across all models compared to *Ease of Use*, especially for DT and GBT. RF shows a less pronounced decline, suggesting Usefulness retains more importance in this model than in the others when fewer attributes are considered.

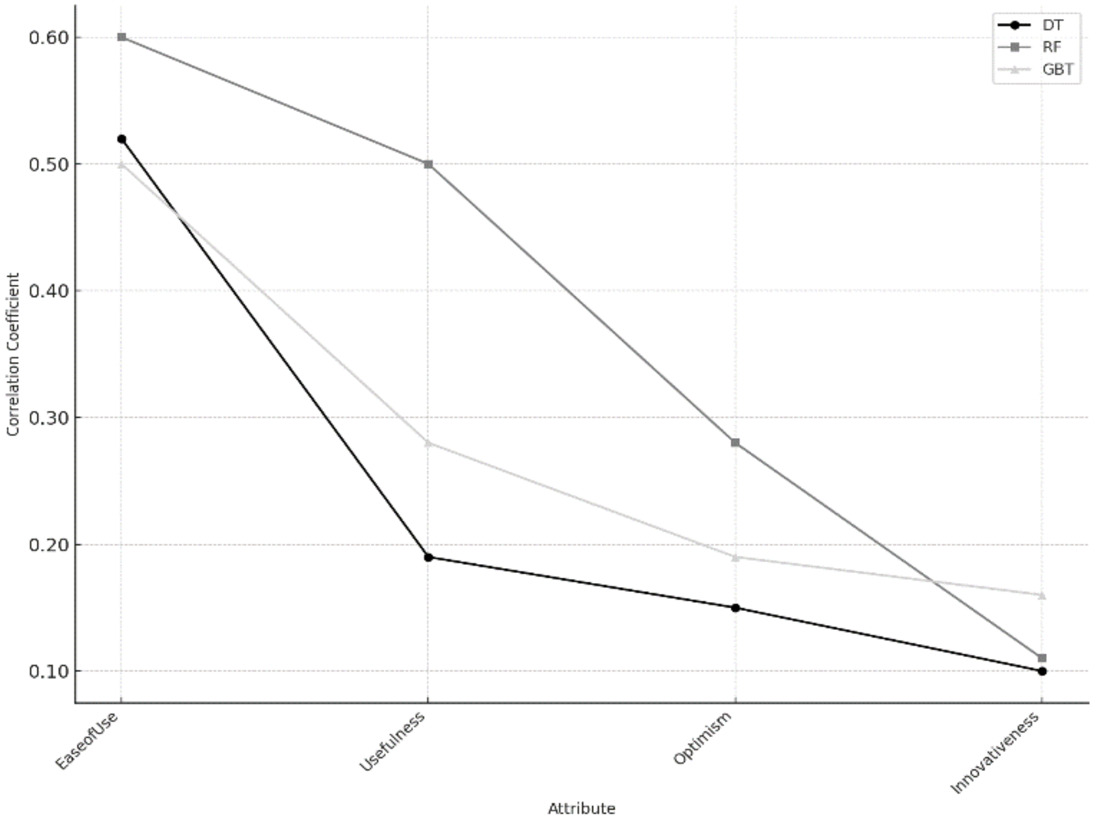

Figure 2. Feature importance from features selection that used TAM and TTR attributes

4. CONCLUSION

This study offers important research results on the role of TAM and TR elements in determining donors' intentions while making online zakat payments. It is a worthwhile research endeavor to recognize that machine learning approaches can be utilized to support quick and dependable prediction jobs, to determine which algorithms are appropriate, and how significant aspects can be observed from the prediction model. This will allow for more thorough examination. Attributes from the TAM, mainly ease of use consistently exhibit a stronger influence on model predictions across the different groups of features selection. This could suggest that these constructs capture key factors that are more directly correlated with the outcome variable, and thus, they are weighted more heavily by the algorithms. The findings of this study not only highlight the predominant role of TAM but also underscore the value of a comprehensive feature set for certain algorithms, thereby offering a multifaceted view of feature relevance in machine learning model performance. In future works, deeper investigation on extended TAM constructs can be conducted to evaluate the impact of additional factors such as perceived risk, system accessibility, and user satisfaction on the predictive performance of machine learning models.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest regarding the publication of this paper.

INFORMED CONSENT

Informed consent was obtained from all participants involved in the study.

ETHICAL APPROVAL

Ethical approval for this research was obtained from the Committee of Research UiTM Perak (Approval No: REC/02/2024 (ST/MR/22)).

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author.

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