

Implementing Classification Techniques in Predicting Incidents in a Higher Education Institution in the Philippines



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Abstract: *The holistic success of the student in the university heavily relies on the curricula and student development programs. In this milieu, the increasing demand for designing, implementing, monitoring and controlling of major and minor violations of the students' demands formative, reformatory, rehabilitative, and restorative remediation programs. This paper presents the implementation of classification technique in predicting incidents, develop a predictive model, and implement the model in a recommender system. The researchers utilized a Descriptive Developmental research design. During the development, business rules, use cases and processes of an HEI were used in developing the recommender system and evaluated using ISO 9126 for Software Quality. The developed predictive model was tested using Classification and Regression (C&R) Tree, C5.0, Quest Tree, Logistic Regression, random tree and Classification technique. On the basis of the findings, the Classification Technique was adopted since it had a higher accuracy rate. The recommender system helped improve employees in incident resolutions, productivity and efficiency, and have provided a significant reduction of students' major and minor offences based on the classifiers using the CHAID Algorithm. The researchers recommend that further studies and empirical investigation be conducted on the analytical reports, and other data mining techniques may be applied to further improve the system, processes, and student services.*

Keywords: *Classification techniques, Predictive Analytics, Incident Management, CHAID*

I. INTRODUCTION

In this milieu, the increasing demand for designing, implementing, monitoring and controlling of major and minor violations of the students'

demands formative, reformatory, rehabilitative, and restorative remediation programs. The university offers numerous opportunities and success space plays a vital role in shaping the lives and future of the students.

The educational institution as the mother of all sectors, thence, the academic success of the students is deeply associated with the university support services. According to the study of [1, 2, 3] the university as the mother of all sector, and service provider of educational services, it facilitates onboarding to graduation career in the university.

Student-related services of the university are assigned under the tutelage of the Student Development Office (SDO) with focus on student activities as well as student discipline to guide students' behaviors or limit students' actions to become responsible of their actions. Student discipline helps students to look into their disruptive activities against a teacher, a student or group of students or against the university system. The work of [4, 5, and 6] upkeep and supported that the many lenses of the university should advocate virtuous studentry, and instills students holistic development. Student Development is defined as the integrated academic learning programs and learning activities which progressively drive student's individual growth and personal development. As a support activity of the university, it is aligned with the university's mission, vision and objectives. In most universities, Student Development Office is a dynamic support unit intended to develop and implement student-centered and holistic focus of experience to develop the demonstrating values and strength of character, nurturing skills, life skills and other university provisions towards becoming young and competitive graduates. Student development initiatives should conform to be of student-centered nature, its impacts on students and school as well its alignment to education [7].

Over the past 45 years, research has positively shown effects of student discipline to student's success in urban schools, although some cited it disproportionately [8]. In most universities, discipline problems are rampant, and because of this environment, it becomes disruptive to a student, a teacher, a classroom, or to the university itself such as vandalism, violence and bullying [9] reported in their study. In order to establish effective discipline practices, the university shall impose policies and regulations on Student Discipline and Student Development Office services. In some schools, it was observed that transition from one school or curriculum to the next level faced many students to be difficult.

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The authors [10] associated that discipline problem from transition is yet to be validated as to frequencies of disciplines problems committed by the student.

Also [11] regretfully reported that most public school teachers left teaching because of student discipline problems. In the work of [12], they even examined that there have been noteworthy relationship between student misbehavior and the performance of the students on the academic sense.

The student academic success heavily lies on the university support system by providing student learning activities, a handful of student-centered activities, retention programs, student services and student discipline. The social environment and the academic rigor always make the student more interesting and the vigor of university support office such as Student Development Office. The academic and student affairs related undertaking of the student form part of student university holistic formation. During these formative years in the university, the student is likely to engage in unbecoming violations set forth by the discipline committee. With this, however, Student Development and Discipline Office shall hold the common authority in the administration of student discipline locally adapted by the college or university [13]. The work of [14] highlighted that teacher also can decode issues of student's character and discipline. Thence, as part of Discipline Management Plan of the university, teachers should accord authority and seat during the investigation or any pastoral program. Scholars [15] posited that implementation and institutionalization of chastisement management strategy can provide positive effect and behavior as well as academic achievement. Innovative and transformative discipline program also tussle those who view student discipline as everyone's responsibility, and conduct ethos changed. It exemplified that criminalization of student discipline program changed school views on student conduct ethos as well [16].

II. BACKGROUND OF THE STUDY

The Student Development Office (SDO) of Jose Rizal University (JRU) is an academic unit which is responsible for management of Student Development, Student Affairs, Student Organizations, student conduct and discipline [17]. Under this office, JRU has imposed the rules of student conduct from both within and outside of the university. The same office monitors Student Development related activities, including academics and non-academics. Significantly, the SDO also spearheads and supervises student affairs which are likely to develop the students academically and non-academically, encourage and foster community-related engagement. The university student population is increasing at par and, in every year, the university encourages student participation in community activities for social responsibility, monitors and oversees university accredited student organizations, approves resource and activity request, etc.

More importantly, SDO provides support for Student Affairs. The Student Affairs promotes and allows student to advance into the many spaces of development, instills and deploys promotional activities form becoming multi-diverse individual, immerse students with the space of inclusivity and respectful institutions, and develop student to understand and

recognize building strong institutions as well as empower to thrive for more without losing the JRU Core Values. Ideally, Student Affairs help the student to achieve their personal and educational goals while within the university premises.

Also, SDO promotes student development in leadership and management. Thence, it overseas and supervises Student Organization Accreditations, Renewal of Accreditations, students' organizations activities, amongst others. Significantly, SDO imposed the rules of student conduct and discipline inside and even outside of the university. The students are given the corresponding disciplinary actions based on the gravity of their violation and offences listed and elaborated in the JRU Student Handbook [18, 19].

With these services of SDO, or Portfolio, SDO performs functional routinary works tediously because of the absence of any information system as their tool aside from using the Microsoft Office Productivity Tools. In order to keep safe documents, it required the university to provide compartmentalized cabinets and larger storage areas. On the basis of documentation, SDO requires the university to procure office supplies more often as documentations requires for free reports, standard and management reporting which can be reduced when using an information system [19].

To an increasing extent, documents collected in the storage is vulnerable to any natural calamities and catastrophes and even physical security, employee mistake, malicious conduct or by any other unbecoming conduct. However, SDO is connected to the university computer network and has an internet provider with workstations for the employees. Inherent to sharing of files and resources, the employees are using third party email providers as an exchange medium which puts information into the internet and cloud, exposed to high vulnerability to information security risks [19, 20].

A. Service and Portfolio Management System

Service is defined by [21] as a type of product provided by the service industry to the general consumers. He furthered that product is generally anything which is offered to a marketing order to satisfy the customers want or need. A collection of services is referred to as Portfolio or Service Portfolio. A collection of services is documented and stored in a repository of services called service portfolio [21].

In managing services portfolio, an information system can be used which is also known as Portfolio Management System. The system includes all services, process for each service with multi-dimensional analysis [22] and [23]. It is a set of graphical and electronic representation of service features and attributes and involves system and methods comprising those that cater all services of the organization [24, 25, 26, 27 and 28].

B. Data Mining and Predictive Analytics

Data mining is a knowledge discovery approach by applying scientific practices [29] in examining big data, large databases using quantitative tools and techniques for better decision making and produce as well as generate new information as exemplified in the study of [30, 31].

Data mining was used by [32] in developing state-of-the-art data mining applications for Customer Relationship Management while [33] posited data mining as application of concepts and techniques in processing the gathered data.

Accordingly, data mining refers to the method or process of examining enormous and large amount of data [1, 34] with myriad opportunities to investigate and provide informed decision and better the organizational performance.

Researches of [1,34] implemented data mining on its exploratory study to enhance the crime prevention program in the Philippines, while [35] used data mining in measuring the performance and productivity of selected BPO companies in the Philippines. Both of these studies employed Data Envelopment Analysis and Clustering Techniques.

The emergence of technological shift has also improved data mining techniques because of emerging tools and software applications capable to process big data analytics. These analytical applications support the Descriptive Analytics, Predictive Analytics and Prescriptive Analytics that can be integrated in the information system [36, 37, 38] Predictive Analytics is a lens of business analytics in which tools or system provides prediction and forecasted results [39, 37] and [40]. Although there are tough challenges and repercussions in implementing these processes and information management innovation [21] it improved businesses and organizations as to the forecasting factors considered such as operations, budgets, supplies and product or services demands [61].

These forecasting and predictive models can be implemented in an information system commonly known as Recommender System. They [42] developed a Recommender System using collaborative filtering technique, while [43] used dimensionality reduction in developing data analysis software which was used as recommender system in product development. Also, [44] used information retrieval and filtering research, and Lu [45] who developed personalized e-learning material recommender system using the data mining and knowledge discovery techniques. Further, [1, 34] used decision tree in identifying patterns and developed a recommender system to enhance the university services portfolio and portfolio management for student welfare and formation program.

C. Objectives of the study

The study aims to develop an information management system for the Student Development Office of Jose Rizal University. Specifically, the study aimed at identifying and classifying the types of student issues being encountered at the Student Development Office of Jose Rizal University, determine the Data Mining Techniques and strategy will be used in the study, determine the Recommender System that will solve the student discipline issues in the Student Development Office of Jose Rizal University, and develop and application system with Recommender module to help the SDO improve its administrative and operational activities.

III. METHODOLOGY

This section presents the research design, research approach, tools and analyses conducted by the researchers.

A. Research Design

The researchers employed a Descriptive-Developmental Research Design. Descriptive research design examines the current system of the organization by conducting environment scanning, documentary analysis (on business processes), secondary data analysis and semi-structured interview [47, 48]. During the development stage, the Cross-industry standard process for data mining, Recommender System techniques and Agile- Unified Process (RUP) methodologies were used.

In this study, the Cross-industry Standard Process for Data Mining or commonly known as CRISP-DM was used to define knowledge discovery methodologies with an interdependent phase [48, 49, and 50]. It was also discussed by [51] that CRISP-DM was used as data mining technique to evaluate level of the organizational success based on the phases and tasks as well deliverables for each task listed by [52].

B. Predictive Model for Recommender System

The Recommender system will be using the following phases adapted from the study of [53]. It recommends or predicts what kind of items the user may prefer. This can be done either directly hooked on the dataset gathered in data gathering stage which could be memory based or model based or through the framework's and activities of the client or system user as illustrated in Figure 1.

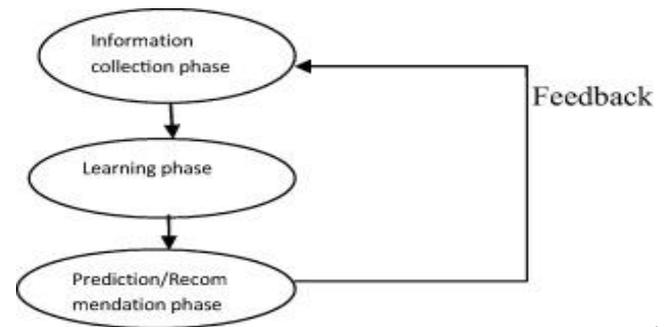


Fig 1. The Phases of Recommender System [53]

C. Agile- Unified Process

Agile Unified Process (AUP) is a simplified version of the Rational Unified Process (RUP) describes a simple, easy to understand approach to developing business application technologies that utilizes agile methodologies yet remaining true to the RUP it also quickly and clearly describes the concepts, structure, and content [54]. Agile-RUP is a software development methodology from Rational. Based on UML, RUP organizes the development of software into four phases, each consisting of one or more executable iterations of the software at that stage of development. The Rational Unified Process is a powerful tool for improving software development [55] while Agile Modeling can also be used to improve and often simplify your modeling efforts on projects [56, 57].

D. Locale, Sampling and Instrument

The operational and administrative processes to be used in this study are taken from the Student Development Office of Jose Rizal University.

There are two Data Gathering Instruments to be used by the proponent. The first instrument details the Guide Questions for Semi-Structured Interview.

The Guide Questions has three parts, each part consists of five questions which are categorized into current problems encountered by the SDO, technologies used in the current operational,

Administrative and other reporting functions as well as the processes which could be improved or integrated into the technology improvement. For the purpose of getting the Recommender System's predictive function, the dataset was the two-year records (SY 2016-2017 and 2017-2018) of Minor and Major Offenses from the SDO will be used for Data Analysis.

IV. RESULTS AND DISCUSSION

This section presents the results and discussion of the results based on the research activities conducted.

A. Data Mining Techniques and Strategy

Classification and regression trees are becoming increasingly popular for partitioning data and identifying local structure in small and large datasets.

The Classification and regression trees getting progressively well known for partitioning information and recognizing local structure in a small and enormous datasets based on the work of [58] on Tree structured data analysis. Amongst those tools for managing large datasets is the CHAID, a method developed by [59]. The CHAID is a decision tree method grounded on the adjusted significance testing of a certain variable. It is a tool used to discover whether there exists an association amongst variables considered in the data. Data analysis using CHAID also helps build an analytical model, or tree, to identify how these variables can be best combined in order to elucidate the results in the given dependent variable. To some extent [60] used the CHAID to assess the performance of higher secondary school education in India using a predictive model for student performance.

Applying CHAID in this particular study, CHAID was used to classify student offenses using as predictors the category of offense, date and college to which the offender belongs, and the Year Level of the offenders. Figure 2 depicts the CHAID Diagram; a remodel was generated using Python, while figure 3 depicts the CHAID Predictors.

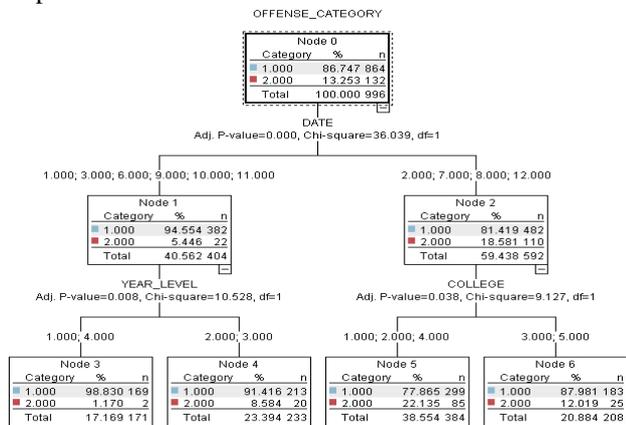


Fig 2. The Generated CHAID Diagram

Rule set

DATE = January or DATE = March or DATE = June or DATE = September or DATE = October or DATE = November => Minor
 YEAR_LEVEL = 1 or YEAR_LEVEL = 4 => Minor
 YEAR_LEVEL = 2 or YEAR_LEVEL = 3 => Minor
 DATE = February or DATE = July or DATE = August or DATE = December => Minor
 COLLEGE = BAA or COLLEGE = ACE or COLLEGE = HTM => Minor
 COLLEGE = CSE or COLLEGE = NHS => Minor

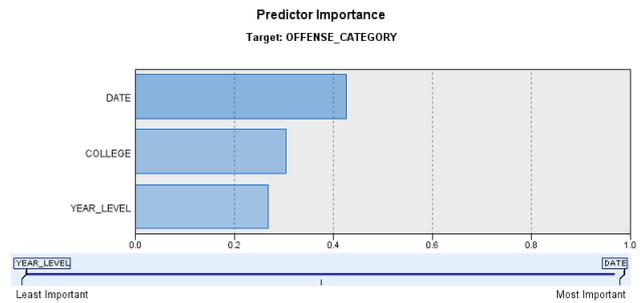


Figure 3. Chi-square Automatic Interaction Detector (CHAID) Classification Predictor

Discussion:

Node 0 considers the Category of Offense as the predictor. It presents that minor offense is 86.747 percent and the major offense is 13.253 percent.

Node 1 considers the Date attribute as the predictor. The offense committed during the months of January, March, June, September, October or November resulted to 94.554 percent as a minor offense and 5.446 percent as a major offense.

Node 2 also considers the Date attribute as the predictor. The offense committed during the months of February, July, August, or December resulted in 84.419 percent as a minor offense and 18.581 as a major offense.

Node 3 considers the Year Level as the predictor. The offense committed by students in the first-year level (1) or fourth year level (4) resulted to 98.830 percent as a minor offense and 1.170 as a major offense.

Node 4 likewise considers the Year Level as the predictor. The offense committed by students in the second-year (2) or third year levels (3) resulted in 91.416 percent as a minor offense and 8.584 as a major offense.

Node 5 considers the College as the predictor. The offense committed by students of BAA, ACE or HTM resulted in 77.965 percent as a minor offense and 22.135 as a major offense.

Node 6 considers the College as the predictor. The offense committed by students of CSE or NHS resulted in 87.981 percent as a minor offense and 12.019 as a major offense.

B. Evaluating the CHAID Model

The Confusion Matrix was used to evaluate the accuracy of the classification. Also, the Confusion Matrix is valuable in scheming the accuracy and memory of the given forecasted labels from a certain model. In this study, the confusion matrix for binary classifications was utilized with four different outcomes, true positive, false positive, true negative, and false negative.

```
In [20]: category_classifier = DecisionTreeClassifier(max_leaf_nodes=10, random_state=0)
category_classifier.fit(x_train, y_train)

Out[20]: DecisionTreeClassifier(class_weight=None, criterion='gini', max_depth=None,
max_features=None, max_leaf_nodes=10,
min_impurity_decrease=0.0, min_impurity_split=None,
min_samples_leaf=1, min_samples_split=2,
min_weight_fraction=0.0, presort=False, random_state=0,
splitter='best')

In [21]: predictions = category_classifier.predict(x_test)

In [22]: predictions[:10]

Out[22]: array([1., 1., 1., 1., 1., 1., 1., 1., 1., 1.])

In [23]: accuracy_score(y_true = y_test, y_pred = predictions)

Out[23]: 0.8875379939209727
```

Fig 4. The Confusion Matrix using Python

Before the *DecisionTreeClassifiers* were built data were normalized using a utility function in the preprocessing package in Python. The same data were fragmented into a train set and other part is the test set. The accuracy if the model was 88% as described in the Figure 4. It can be gleaned that the classifier are performing.

```
y_pred = predictions
print (confusion_matrix (y_test, y_pred))

[[292  2]
 [ 35  0]]

print (classification_report (y_test, y_pred))
```

	precision	recall	f1-score	support
1.0	0.89	0.99	0.94	294
2.0	0.00	0.00	0.00	35
avg / total	0.80	0.89	0.84	329

Fig 5. Confusion Matrix- Classification of Data

Based on the confusion matrix, there was a total of 37 (35 + 2) misclassified data out of the 329 test data as depicted in figure 5.

V. CONCLUSION AND RECOMMENDATION

On the basis of the results and the summary of findings, the researchers concur that, with the number of student issues and violations recorded by the Student Development Office of Jose Rizal University, and the increasing population of the university enrolment, there was a need for process improvement and system development intended for SDO.

In order to classify the minor and major offenses by the college or courses, a CHAID algorithm was employed and the model was evaluated using Confusion matrix with 88% accuracy, hence, it can be gleaned that the classifiers are performing. Also, an Online Portfolio Management System was developed with Recommender Module to help the SDO on providing its services to its clientele specifically on Student Discipline Services. Empirical investigation could be done by using other forecasting models and machine learning techniques to help the universities improve their services and develop a fully service-oriented culture and data driven decisions.

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