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Data Analytics Tool (DAT): A Data-Driven Decision-Making Tool for Business and Data Analytics Courses

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Abstract

Data Analytics Tool (DAT) is an application that collects and analyzes data in order to improve business processes and aid in discovering hidden trends and patterns thereby uncovering insights to make future data-driven and intelligent decisions. This project, which is aligned with the business and data analytic course contents of the University of the East, Caloocan, is intended for particular users, such as the faculty members and students enrolled in these courses, so as to uniformly use the application in simulating business analytics cases with the given data set in their respective classes. The application development was based on the principles of lean methodology since the model eliminates waste and improves efficiency for the team, thus maximizing the time for development. Various technologies in analyzing data were incorporated in the application such as data mining techniques, statistical measures, forecasting algorithms and decision analysis methods. These technologies were implemented using Visual Studio and was coded using C# programming language. DAT was evaluated for its effectiveness and efficiency as a data analytics tool by several faculty members and students in the classes of business and analytic courses using the ISO/IEC 20510 software quality assurance standard with the following criteria: functional suitability, performance efficiency, compatibility, usability, and reliability. The general weighted mean of 3.96 and 3.49 were gained from the faculty members and students respectively. Hence, the respondents "strongly agree" with the applicability and acceptability of the proposed application as a tool that can be used in analytic courses.

Keywords: decision-making tools, data mining, business analytics, data analytics, agile, prediction, visualization

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INTRODUCTION

Data analytics is a method of analyzing data to come up with valuable information that can be used for smart decision-making. This method employs techniques and algorithms to determine patterns, trends, and insights to improve business operations. Optimizing business performance could help identify ways to reduce costs, analyze customer satisfaction, and provide better products and services. Currently, the analytic courses are offered in several programs of the University of the East and various tools are being used by the faculty member and students depending on its availability and user's confidence on the tool usage which lead to different results and interpretation.

Whenever an analytical tool is available, this tool is either outsourced which is an additional cost to the students or non-customized where the off-the-shelf software cannot provide features required for covering the content of the course. These issues motivated the researchers, to develop a data analytics tool specifically designed for use in the business and data analytics courses offered by the University of the East – Caloocan. The proposed tool will be uniformly used by faculty members and students as a standard application in simulating business analytics problems during their classes. This will provide a more reliable basis for the faculty and students to have the same expectation and output which makes the

studying process quicker, easier, and more understandable to the students.
In addition, the proposed tool will provide students with the basic techniques of data science which includes data mining algorithms and statistical models. Basically, the tool represents a confluence of analytics, statistics, data mining, and information technology. Utilization of the tool will expose the learners to the practices in data analytics discipline and the potential application of this discipline for a fact-based business decision-making.

Objectives of the study. The goal of this research is to develop a data analytics tool which is a software application for the University of the East, Caloocan that will aid faculty members and students perform statistical/data analytics operations for basic statistic, data analytics, or business intelligence courses offered in the Colleges of Engineering and Business Administration. The following were the specific objectives of the study:

1. To create an appropriate raw data distribution.
2. To visually analyze test and train data sets.
3. To implement pivot tables and charts in the tool for easy understanding.
4. To construct a dashboard to show comprehensive illustrations of data from different sources.
5. To integrate and apply statistical formulas and methods in a data set.
6. To use a regression model, data mining algorithms, and decision analysis methods in a data set for forecasting.
7. To perform linear optimization or sensitivity analysis in a particular data set.

Scope and limitations of the study. The study was limited to the following factors:

1. Importation of file. Pre-defined and limited sample data sets were provided in the tool for class discussion and simulation. User-defined data sets must be written in plain text format that can be used as either training or test data. Moreover, the file to be imported was limited to CSV (Comma-Separated Values) or TAB (Tab-delimited) formats.

2. Presentation of data in visualize format. Initial or analyzed data sets can be presented in an illustration or graphs that can easily be interpreted. However, graph representations were limited only to line, bar, pie and columns.

3. Implementation of data mining algorithms. Clustering algorithm and prediction model were used in the study. However, these data mining algorithms were limited only to K-means, Naïve Bayes and Linear regression.

4. Application of statistical methods and analysis. Several statistical methods and techniques which are part of the course content were used in the study. However, these methods were limited to measures of central tendency, measures of variance, measure of skewness and Pearson' mode, correlation coefficient, hypothesis testing, point interval, and chi-square testing.

5. Integration of forecasting techniques. The prediction methods that were included in the tool are the coefficient of determination and normalization method.

6. Performing decision analysis. Decision analysis was implemented through the computational techniques of linear optimization model, sensitivity analysis, expected value of perfect information (EVPI), and expected value of sample information (EVSI).

The study was conducted in school year 2021-2022 referencing to the course syllabus of business analytic courses offered in the College of Business Administration, University of the East - Caloocan.

The evaluation instrument was based on ISO 25010 Software Quality Assurance which is a cornerstone of a product quality evaluation system. Respondents of the study were the students enrolled in statistics, data and business analytic courses as well as the professors handling the courses for school year 2022-2023.

LITERATURES

Data analytics is one of the technical aspects currently in demand to explore raw data and elicit useful information from voluminous data. It is used in analyzing data through uncovering patterns, discovering hidden data, identifying trends, and determining future insights. Some of these techniques were statistical analysis, machine learning, data mining, intelligent analysis, cloud computing, and data stream processing. This is the solution to the issue of determining the difference between the domain of need to the domain of knowledge wherein data must be identified and purpose of using this data determined. It is known that big data analytics is a trending method to obtain information from big data where it is considered an essential part of a business workflow whether in the industry or in the academe concerning issues influencing decision-making in higher education. Several tools are available both in research and in practice to assist in identifying, integrating, and applying data analytics in various applications. (Bonthu, 2017; Sahu, 2017; Acharjya, 2016; Dwivedi, 2016; Janardhanan, 2020; Khalajzadeh, 2022; Ed, 2020; Devi, 2023; Al-Shiakhli, 2019; Alblawi, 2017; Abualganam, 2022; Putra, 2017; Devarakonda, 2020; Rahman, 2022; Ngo, 2020; Brown, 2019; Apraksin, 2018; Machii, 2023; Hasanah, 2020).

Several data analytical tools are used to collect, interpret and present data visually for a wide range of applications in various organizations even in the educational sector. These tools are used to support data-driven decision making in the academe for operational improvement and optimization. (Doneva, et al., 2021), In addition, the use of these tools form part of the instructional method of teachers in teaching data analysis and data science even in the middle and high school (Pimentel, et al., 2022). Even in the height of pandemic where learning was done virtually, it results to the generation of big data because of the computer applications usage. This big data architecture is used to gain knowledge about the learners and improve the educational processes. Furthermore, the analysis of this educational data through the use of data analysis tool will generate information based on the learning needs of the students (Villegas, et al., (2020)).

Statistical methods incorporated into the tool are the most common and helpful techniques used in data analytics. Measuring central tendency, variation, skewness, hypothesis testing, correlation analysis, chi-square, confidence interval, coefficient of determination, normalization, linear optimization, sensitivity analysis, EVPI (American Board.org; Voxco.com; CQE Academy.com, StatisticsHowTo.com; O Reilly.com; Vskills.in; Wisdomjobs.com; Cherney, 2017; Chen, 2024; Mackenzie, 2021; Hessing, 2020; Hayes,2022; Keshav, 2022).

There are available tools in the market such as Rapidminer, PowerBI and Tableau. However, these tools are costly and most of the application capability does not fit the analytic course content of the University and are not made according to the specific needs and specifications of the teacher and students. Dashboards of these tools appeared too complex to the users since a lot of information are displayed for which are not sometimes necessary especially when the students are analyzing data (Data Camp, 2024). A comparative study of data analytics tools for effective business decision was conducted and these tools were evaluated based on the following parameters: primary use case, data sources, visualization option, integration, machine learning capabilities, ease of use and basic pricing (Tripahi, 2023). In relation to DAT, most of the tools' characteristics are somewhat the same. However, the only factor that differs DAT from these tools is that the proposed tool is tailor-made from the requirements of the business and analytic courses of the University and specifically designed to meet the learning outcomes of the course. DAT application was developed in the platform of Visual Studio (VS) because of its comprehensive IDE (learn.microsoft.com). The advantages of using VS were considered in developing the tool (Cangemi, 2020). C# is a high-level programming language that is easy to learn (Mkhitaryan, 2017). With the capabilities and features of C# as a development tool, it would

be easy to create an application suited to the users' needs. (Castro, 2020).

Evaluation criteria were based on the ISO/IEC 20510 standard which is noted to be the appropriate software quality assurance model to be used in determining the degree to which the system satisfies the stated and implied needs of the stakeholders. These criteria were used in several works relating to software development (Cruz, et al., 2020; Wibawa, et al., 2019; Hasanah, 2022; Hasanah, et al., 2020; Yuniasri, et al., 2020). Additionally, the criteria of the model were used as factors in computing for the acceptability rate of the software, and then were referenced through the Likert scale model (Mcskimming, et al., 2021; Kuiper, et al., 2019).

Conceptual Framework. The illustration shown in Figure 1 explains the overall picture of project DAT where combining the data mining algorithms and the statistical techniques will result into a data-driven application that can be used for data analysis simulation in several courses for students' learning. The development of the tool is a collaboration of the faculty members teaching data analytics, business intelligence, and business analytics courses at the University of the East, Caloocan. In addition, the validation of the tool's effectiveness and efficiency were done through the specific and intended users' interaction and participation.

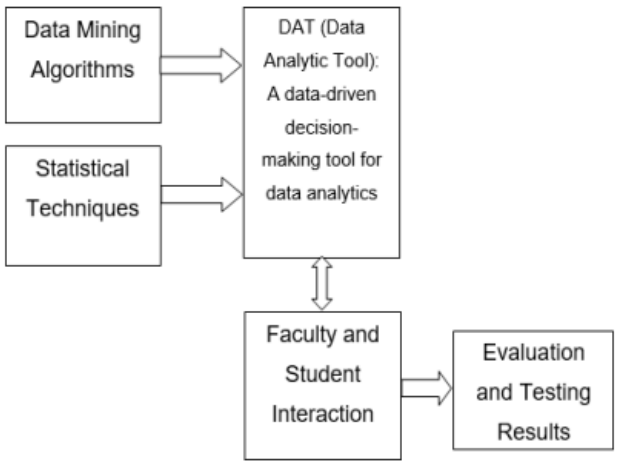

Figure 1
DAT Framework

METHODS

The model used in this project is the "Lean Development Methodology" which gives emphasis on the 7 principles of software development (as seen in Figure 2) and was used as the guiding principles of the researchers.

Figure 2
Principles of Lean Technology

These principles were applied in the following steps of the Lean Development Methodology as reflected in Figure 3, where waste elimination and quality output were evident in the first step because the problem and requirements were thoroughly identified by the users as well as removing the unnecessary factors not to be included in the research project. Along with this phase, the scope and limitations of the project were also determined. The development of the application was motivated by the instructional issue of the author while teaching business analytics to the Business Administration students. Students are having difficulty in simulating sample data set because of the inability of a standard data analytics tool. Though the students were instructed to use spreadsheet application for simulation purposes, limited access to some students is also visible. Another issue is the students' coding of the statistical formula to come up with a certain result, which in turn is a tedious and difficult task since most of the students are not mathematically inclined.

Figure 3
Lean Methodological Steps

Defer commitment principle comes in when requirements are changing based on the needs and wants of the users which happened in the design stage. During the design stage, the framework of the research was developed with the identification of the methods, techniques and statistical measures to be included in the project. With the course syllabus as the basis of the project scope, the appropriate computational models were clearly defined. In the third step of development and testing, developers performed repetitive tasks that entailed skill improvement, eliminating errors, boosting the morale of developers, building quality products, and on-time product delivery. Coding happened in the Visual Studio platform with C# as the programming language. Alongside with coding is testing the software. Testing procedures starting from development plan assessment, software requirements and design testing up to the building phase testing were rigorously done. Lastly, launching the tool and making it available to the users requires feedback where product performance, product reactions, and users' evaluation are needed for future product improvement. This phase was toughly implemented from the installation of the application, correcting some software changes after its installation to the new environment up to the evaluation of the application to determine its effectiveness and efficiency.

Testing and evaluation procedure. To determine the justifiable aspect of developing the tool for business analytic related courses offered in the University, the measurable objectives presented on Table 1 have been considered.

Table 1
Testing Procedure List

Problem Statements	Procedure
What are the following statistical or mining topics that would be included in the proposed software tool?	Review of course syllabi
What are the methodologies and techniques that would be considered to develop the tool?	Application of Lean Methodology
How will the entire software tool be tested for quality assurance?	Evaluation using ISO 25010 criteria
Does the proposed analytics tool be accepted for academic use?	Acceptability testing
What are the subjects to be considered to incorporate this proposed tool into their laboratory?	Student recommendation

Focusing on the software quality of DAT, the ISO25010 standard for software quality assurance was used and measured using the following parameters:

1. Functional suitability. This characteristic represents the degree to which a product or system provides functions that meet stated and implied needs when used under specified conditions. This characteristic is composed of the following sub-characteristics: Functional completeness, functional correctness, and functional appropriateness.

2. Performance efficiency. This characteristic represents the performance relative to the number of resources used under stated conditions. This characteristic is composed of the following sub-characteristics: Time behavior, resource utilization, and capacity.

3. Compatibility. The degree to which a product, system or component can exchange information with other products, systems or components, and/or perform its required functions while sharing the same hardware or software environment. This characteristic is composed of the following sub-characteristics: Co-existence and interoperability.

4. Usability. The degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use. This characteristic is

composed of the following sub-characteristics: appropriateness, recognizability, learnability, operability, user error protection, user interface aesthetics, and accessibility.

5. Reliability. The degree to which a system, product, or component performs specified functions under specified conditions for a specified period of time. This characteristic is composed of the following sub-characteristics: Maturity, availability, fault tolerance and recoverability.

In school year 2021-2022, the two offered classes in statistics with 49 and 47 students respectively were chosen as the respondents in the evaluation of DAT to determine the tool's effectiveness and acceptability. Proper communication with the concerned faculty members was done and permission to conduct the assessment of the tool to their classes was granted. Since the study was conducted during pandemic and physical interaction was impossible, the whole process of evaluation was done online. Teachers and students were provided a soft copy of the tool, had it installed on their machines and used the application during their online and offline classes. Then, Google Forms with the ISO25010 parameters were disseminated to the students and faculty members to assess the effectiveness and efficiency of the tool.

The weighted mean of the evaluation was computed using the formula below:

$$W = \frac{\sum_{i=1}^{n} w_i X_i}{\sum_{i=1}^{n} w_i}$$

The weighted mean results were interpreted using the 4-point Likert scale model

Table 2
Likert Scale

Response Rating	Description	Rating Range
4	Strongly agree	3.26-4.00
3	Agree	2.51-3.25
2	Disagree	1.76-2.50
1	Strongly disagree	1.00-1.75

RESULTS

Data analytics tool (DAT) is specifically designed to be of future use in the data and business analytics courses offered in the University of the East, Caloocan. It is an application used with reference to the syllabus content of the business and data analytic courses that faculty members and students can uniformly use in simulating data and business analytics during class discussion. Technologies incorporated in the application are machine learning, data management, data mining, and predictive analysis which are some of the technological techniques and innovation used in data analysis. The tool allows importation of files containing the data set to be analyzed and interpreted. The dashboard of the tool is also provided for visualization of the test and training data set using graphs and charts for easy understanding and interpretation. One of the benefits of data analytics is to discover hidden trends and patterns from a huge pool of data and provide insights for future opportunities. Thus, data mining is one of the technical concepts currently in demand where these undiscovered data are revealed to come up with meaningful and useful business information and this technology is also provided in the DAT tool. The statistical methods and techniques are also accessible in the project since these capabilities allow for managing the data set and are essential in making the data processing convenient and timely. DAT statistical procedures are used to analyze the given data set to determine whether the predictor variables are correlated or have significant relationships and effects among the data.

The initial screen will be displayed allowing the user to import a file or a data set to be analyzed (as seen in Figure 4) which allows a CSV or Tab delimited file format shown in Figure 5. Pre-defined files having test data are also available on the application which is presented in Figure 6.

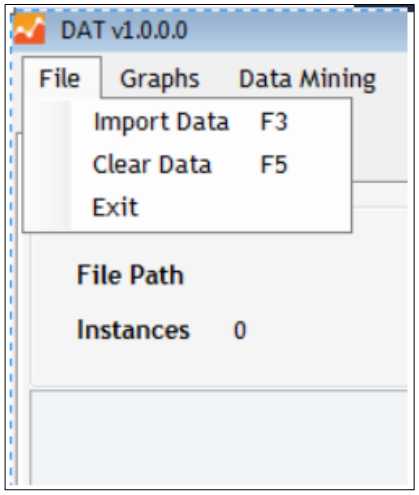

Figure 4
Importing File

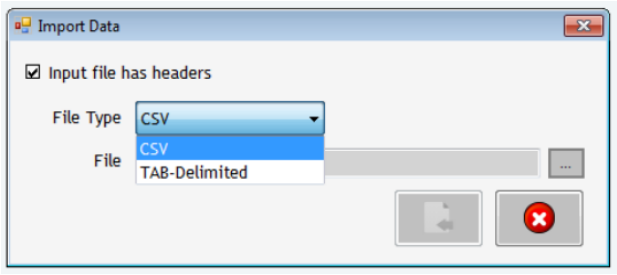

Figure 5
Valid File Types

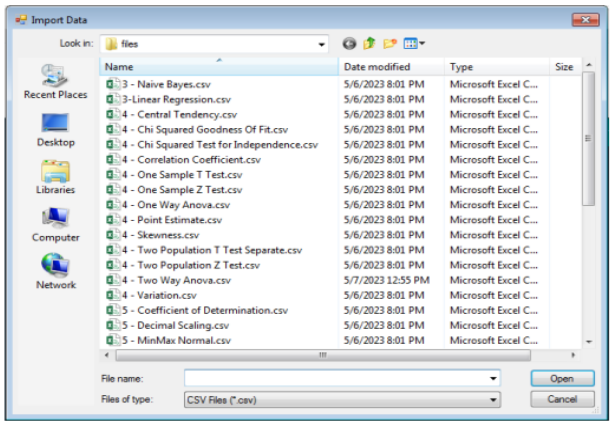

Figure 6
Sample Test Files

Data sets are uploaded on the dashboard presented in Figure 7 and are ready to be analyzed. Attributes which are the variables used in the data set are also presented with their corresponding data type as well as the number of instances available in the data set.

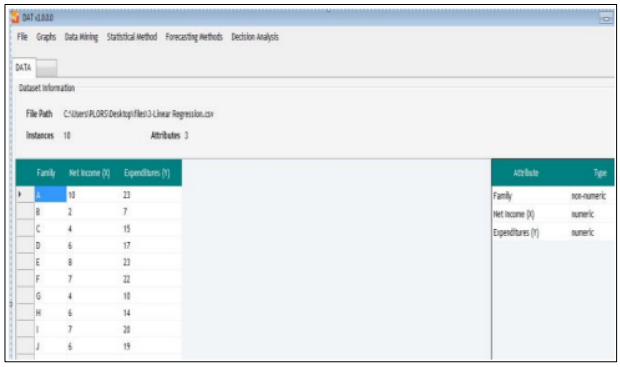

Figure 7
Imported Dataset

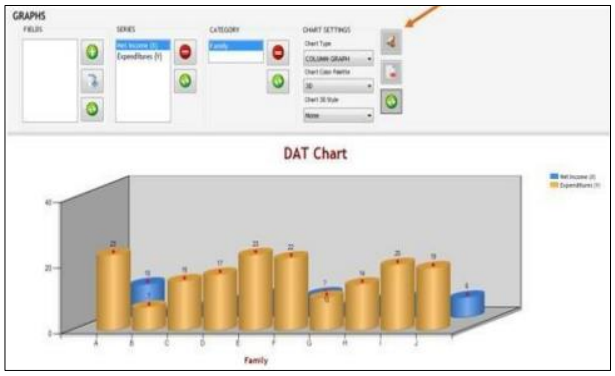

Figure 8
Graph of Family Data Set

Figure 8 shows the sample graph output of the data set generated. The succeeding illustrations are sample outputs computed depending on the methods used: data mining applying linear regression in Figure 9, statistical method implementing variation in Figure 10, and forecasting method computing using coefficient of determination in Figure 11.

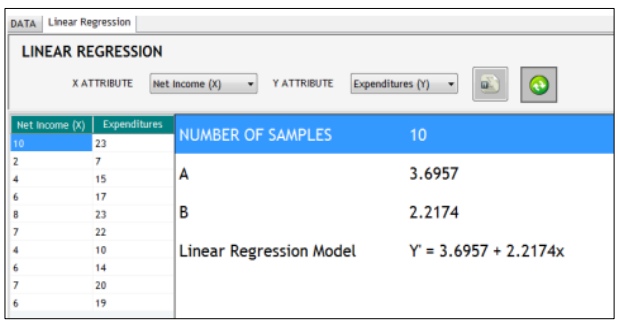

Figure 9
Linear Regression Result

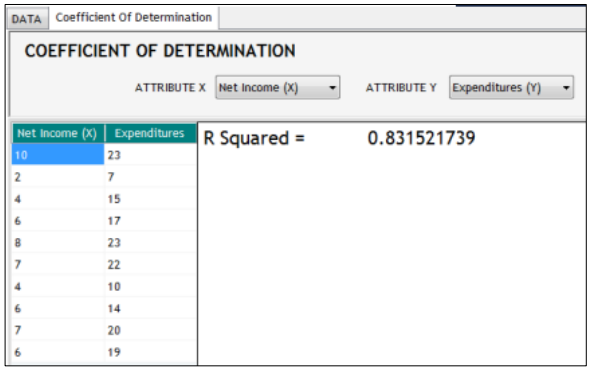

Figure 10
Variation Result

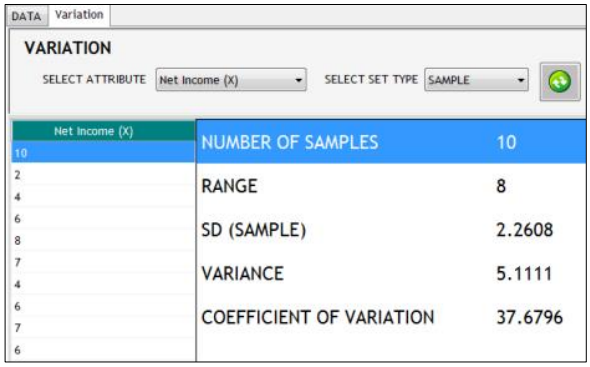

Figure 11
Coefficient of Determination Result

Presented in Table 3 is the summary rating from the evaluation conducted by the respondents. The general weighted mean of 3.96 and 3.49 were gained from the faculty members and students respectively. This is with respect to the parameters on software assessment of ISO 25010. Hence, the respondents "strongly agree" with the applicability and acceptability of the proposed application as a tool that can be used in analytic courses. The resulting rates are qualitatively explained as, in terms of functionality, DAT met the stated and implied needs of the users. Moreover, the functionalities are appropriate and aligned with the syllabus content of the course making it more convenient and effective for the users during analytics simulation. The efficient performance of the tool allowed the users to analyze multiple and increased data sets without compromising user experience. Interoperability of the proposed tool is also an advantage making it adaptable to any platform or system environment without issues or conflicts. The learnability, accessibility and manipulation of DAT app allowed its users the easy use of the different analytical techniques and methods during their class session. With reliability, DAT is described as trustworthy and performed consistently well in terms of generating accurate measurements and calculations. The tool was able to yield the computational and illustrative results in a specific time in a given environment. In brief, Table 4 shows the overall rating computed from the assessment conducted which described DAT as generally accepted by its prospective users.

Table 3
Summary of Findings

	Faculty		Students	
Functional Suitability	4.00	Strongly Agree	3.52	Strongly Agree
Performance Efficiency	3.94	Strongly Agree	3.51	Strongly Agree
Compatibility	4.00	Strongly Agree	3.51	Strongly Agree
Usability	3.97	Strongly Agree	3.45	Strongly Agree
Reliability	3.88	Strongly Agree	3.47	Strongly Agree
Average	3.96	Strongly Agree	3.49	Strongly Agree

Table 4
General Average

	Ratings	
Faculty	3.96	Strongly Agree
Student	3.49	Strongly Agree
General Average	3.72	Strongly Agree

DISCUSSION

Conclusion. With the development of a data analytics tool intended to be used in the different related data analysis, statistics and business intelligence courses in the university, it is said that the proposed tool will definitely be of assistance to both faculty members and students in simulating business data sets and will help the students to clearly understand the lecture and discussion. The dashboard of the tool provides a comprehensive illustration of data from raw facts to meaningful information. It allows appropriate use of data distribution which can be visually viewed as a test or a train data set through charts and graphs for easy understanding and interpretation. Various statistical formulas and models were integrated and applied in the tool to help analyze and extract hidden information from a certain data set. Additional techniques in regression and

data mining were also implemented which can be used for prediction and insight creation. Through the possible utilization of the proposed tool, students and faculty members will be able to execute summarized data computation for productive and worthwhile interpretation of data. This can be achieved because of the execution of statistical measures aligned with the course content of the university. Thus, delivery of the content to the students will be more convenient and easier. A "one-software" concept in business and data analytic courses in the institution provides a standard way to effectively carry out the learning outcomes of the program, thus, promoting uniformity in the course content delivery.

Recommendation. However, while this research has shown positive results in delivering the data analytic objectives, some mathematical principles and methods that such integration entails were not dealt with. This requires further investigation in which emphasis must be taken into consideration on the following issues:

1. Improve data collection. Validation of file whether binary or not is needed. If binary, the tool must not accept the file or reject the file. A technical technique of identifying valid file format must also be a feature of the tool to avoid wrong analysis of data set.

2. Methods. Additional statistical measures which were not included in the tool are recommended.

3. Drag and drop functionality. For more intuitive use, it is suggested that this functionality be part of the tool so that file transfer within or between applications will be much easier.

4. Files from cloud. Files can be imported from the cloud to the tool. It is proposed that additional data sets can be retrieved from the server off-site locations, thus, providing the user with more options for data set analysis.

5. Mobile version. It is advised that the DAT version can be implemented through mobile phones or tablets for more tool accessibility and portability.

6. Command line functionality. Dump the output computation to an external file so that the analyzed results can be converted and migrated into files that can be managed and maintained.

The force of computing power and blow up of data acquisition techniques led to the creation of voluminous data in several organizations which calls for a big demand for professionals with data analytical skills. With the development of DAT as a scientific tool serving as a supplemental instrument in analytical courses will prepare the students to adapt to the big data era, facilitate the students in conducting research in data science and be able to apply the algorithms in these researches.

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