



Information Visualization Tool for Academic Institutions: Imam University as a Case Study

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Abstract

Educational data has become prime focus of researchers in the past recent years. The emergence of academic disciplines like Learning Analytic (LA) and Educational Data Mining (EDM) has declared that universities and educational institutes have entered the era of Big-data. Academic administrators (like deans/directors) are keen to have greater level of visibility of their educational processes so as to be able to manage their performance records. This article proposes an interactive information visualization tool that displays students and university records, and analyse them against a set of performance indicators. This article is part of intended future research of developing a performance management system that integrates LA techniques and balanced scorecards concept to monitor the performance of educational institutes against the attainment of business strategies.

Keywords: Information Visualization; Learning Analytic; EDM.

1. Introduction

Today's world is driven by data. Organizations success and global competitiveness are highly reliant on their ability to analyse and visualize performance data. The term Big-data refers to a complex form of data that are too large to be analysed using the conventional processing applications [1] [2]. Advanced technology turn masses of data into meaningful patterns suitable for statistics, graph analysis and provide valuable information. Sources of Big-data range from banks transactions, trading invoices and on-line payments, to CCTV cameras, wireless sensors, speed tickets, etc. Given such plethora of data, organizations have implemented initiatives to analyse their business data to assist them in making informed business decisions [3] [4] [5]. These initiatives may be stand-alone Big-data strategies or part of business process management procedures [6]. One apparent example of Big-data is data generated within educational institutions where thousands of students are enrolled and hundreds of programs are offered. Systems like registration, attendance, learning management, library, etc., produce terabytes of data on a daily bases. Such data has recently increased especially with the growing number of on-line courses, and hence has become difficult to aggregate or analyse consistently to provide informative educational information. It has been argued that businesses where ways ahead in embracing Big-data technology in achieving their ultimate goals, compared to educational institutes [7] [8] [9]. Recently, key areas of research related to data analytics in education have been introduced, which are Learning Analytics (LA) and Educational Data Mining (EDM). LA is known as the measurement, collection, analysis and reporting of data about learners and their contexts, for purposes of understanding and optimizing learning and the environments in which it occurs [10]. In other words LA can be thought of as a tool to augment management understanding on learning performance and make predictions with a remarkable degree of accuracy. EDM, on other hand, is defined as "developing, researching, and applying computerized methods to detect patterns in large collections of educational data that would otherwise be hard or impossible to analyse due to the enormous volume of data within which they exist"[11]. The context of this research is to provide performance management reporting tool rather than predictive analytic using LA or EDM techniques which may be of interest in future research.

2. Academic Institutions and Performance Management

Academic institutions like any other organization have specific business goals and objectives towards the financial and operational efficiency and the desired annual growth. Universities executives require timely and accurate business data to assist them in making critical business decisions such as programs and courses offering, staffing, resources, etc. [12]. Such data would also enable them to become more responsive towards pressing needs of the universities multiple stakeholders like students, staff, employees, funding agencies, accreditation bodies and many other more [13]. Therefore, having efficient performance management tools will foster such data-driven decisions and hence help the management in their performance assessment plans. Every university business function like a department or a college has its unique Key Performance Indicators (KPIs) of business performance measure. Such KPIs require an efficient visualization tool so as to be well measured and monitored against its attainment. Doing so will enable universities and academic institutions to improve and maintain high quality and consistent teaching process, reduce the management overload and proactively take actions on issues [12][14]. Moreover, applying intelligent data analysis techniques for students data help capture their learning behaviour and therefore provide pre-emptive actions for their student coaching and Mentoring [21].

Many universities and academic institutions applied Balanced Score Card (BSC) to manage their overall business strategy [13] [15]. A learning analytic-based system called Signals was developed in Purdue University to track student performance [16]. University of Michigan has developed e-Coach system to monitor the performance of their students in math and science courses. A detailed literature review of the application of LA and performance dashboards in academic institutions is discussed in [17] [18] [7].

The most commonly applied technique for monitoring business performance is performance management systems [21]. Such systems are usually accompanied with a dynamic dashboard, which is a business tool for measuring and monitoring the performance of a business. According to [19] a dashboard is defined as "a multilayer application built on a business intelligence and data integration infrastructure that enables organizations to measure, monitor, and manage business performance more effectively. In the following section, we will propose our performance management reporting tool which were applied recently at the College of Computer Science and Information (CCIS) in Imam University.

3. Imam University Dashboard

Imam University is the largest university in Saudi Arabia with three overseas branches. The estimated number of enrolled students in the academic year 2015/2016 for both regular and eLearning modes reached 165,000 students. For the sake of simplicity, the data scope of this research is limited to selected colleges, and for the undergraduate levels. In our proposed tool, three authorization groups belong to three layers of the university administration were defined: (1) department chair, (2) college dean and (3) university rector. Also, four main data categories of critical educational data were identified: (1) students population, (2) drop-out rate, (3) failure rate and (4) Denial rate. Students' number is an important indicator for any administration like department chairs or college dean to enable them plan for the allocation of classrooms, faculties and educational resources. Drop rate is also a very important KPI for any institution to maintain a drop rate thresholds and act on proactively. The dashboard development and testing activities were carried on the Quality & Development Unit in the College of Computer Science and Information (CCIS) in Imam Mohammed bin Saud University.

The dashboard was built using Power Pivot and Power Query plug-ins in Microsoft Excel 2013. It was deployed in a SharePoint server 2010 with the underlying data warehouse retrieved from the university registration system on Spring 2016, and uploaded into the tool manually. The retrieval process was a simple export from the system back-end SQL server database. In case data imported was unstructured or fuzzy, mining and cleansing activities are required prior to its export into the tool [20]. For optimum result and real-time analysis, the tool should be integrated with the main university registration system and deployed in the main university portal for easy access. The dashboard was tested for full functionality on one selected college which is the College of Computer Science and Information (CCIS), and on one selected department which is the department of Information Systems (IS). In the following, snapshots of the tool output are demonstrated for the three authorization groups. The university level data were shortened for the sake of simplicity.

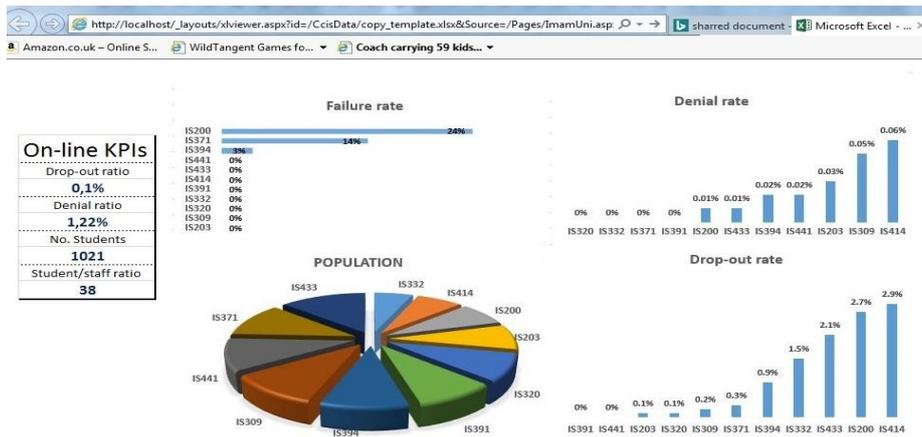


Fig 1: Department Level Interface

Figure 1 shows a snapshot of the department level of the tool which includes four graphical charts summarizing the data of the 4 main categories in the department level broken by the courses offered by the department. Further slicing to the data may include ethnicity, gender, prior education status, etc. On the left part of the tool, there is the run-time performance indicators pane which displays the current status of the performance KPIs and any other academic parameters. As far as the department is concerned in this case, drop rate and denial rate are shown with real-time data indicator. Some non-real-time metrics like failure rate which can only be identified at the end of the semester, were not included in this part. Figure 2 shows the college level of the tool where the data of different department is visualized. In Figure 3, the university level interface of the tool for which is viewed by the university administrator. As can be noticed, the set of the KPIs for every may include different measures according to the need of the level of authority this. In the university level, other aspects related to the Human Resource (HR), finance, funding, staff and classrooms utilization, etc. Other metrics can also be incorporated in such tool concerning the alumni, % of graduates employed, % of students carried on their post graduate study.

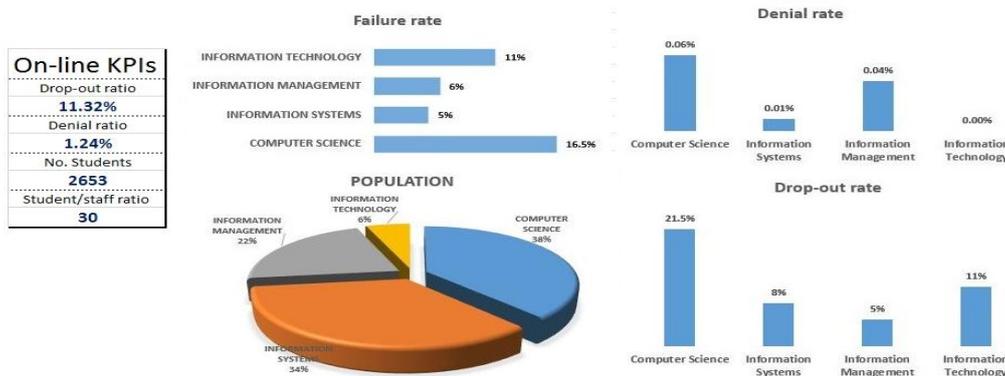


Fig 2: College Level Interface

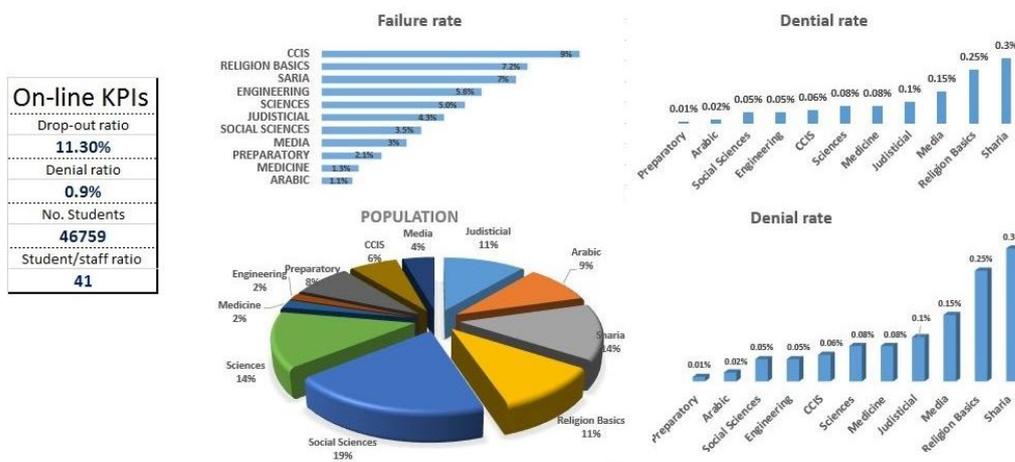


Fig 3: University Level Interface

4. Conclusion

This article proposed a dynamic visualization tool for academic institutions to monitor the performance of their educational process against a set of predefined KPIs. It is assumed that such tool will assist academic institutions for the prioritization of their goals and to proactively act on issues related to their educational process. The data warehouse of the proposed tool and the scope of implementation were exclusive to the student registration system of Imam University in Riyadh. Future research would include integrating various transactional-based systems of the university like eLearning, learning management systems, payroll, HR, library, into one pool of voluminous data warehouse. This data will be used with intelligent data-mining algorithms to generate valuable information related to learning analytic of the students. Such information would be able to predict when student are likely to drop out or transfer, what courses representing bottlenecks in the curriculum and many useful patterns of information.

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