Dashboards for Decision Making in Higher Education

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Dashboards are used as a graphical user interface that provides at-a-glance views into key measures and trends to assist decision makers in the Singapore University of Social Sciences (SUSS) to enhance learning support for students.

A student's first contact with SUSS often starts at the point of application (i.e., applying for places in the University). Hence, the process of application, selection and offer has been identified as the business problem in this project. An effective dashboard will empower users to make more informed decisions with a visibility to data and ease in generating insights, ultimately streamlining the selection and offer process. The users in this project are the stakeholders who deploy the dashboard in the process of and decision making related to selection and offer.

Quality of information on the dashboard is highly dependent on the state of data, including their completeness and accuracy. Quality of a dashboard can be measured by how much impact it can make, which is directly related to actions taken by users with information extracted from the dashboard. With the right knowledge and skills in developing an effective dashboard, business objectives can be met and user requirements can be catered for. If every decision maker is able to customise his/her own dashboards that meet business objectives and user requirements, the University will be empowered at a functional level, with various departments supporting students through their respective roles and functions. Challenges in data and people issues will be discussed in this paper alongside the future directions in overcoming these issues.

Keywords: data-driven decision making, streamlining of the application and selection process, dashboards, enhanced learning support

Introduction

The Singapore University of Social Sciences (SUSS), a university dedicated to provide lifelong education and to equip learners to serve society, was established in April 2005 (then known as SIM University). It offers part-time and full-time degree programmes and courses to both working adults and fresh school leavers. Applicants who meet the specified minimum admission criteria are enrolled into SUSS's part-time programmes, with little need for shortlisting and selection. The degree programmes for working adults are offered on a part-time mode with blended learning, where classes are held in the evenings and on weekends. Currently, SUSS has about 13,000 part-time students.

In 2014, three full-time degree programmes were launched in SUSS for fresh school leavers, namely, Accountancy, Finance and Marketing. New programmes in Human Resource Management, Social Work, Business Analytics and Early Childhood Education were subsequently launched in later years. Applicants are shortlisted based on their performance in prior education. As programmes are oversubscribed with more applicants than the number of available places, SUSS puts in place a series of selection tests for shortlisted applicants. The selection tests comprised a computerised cognitive test, an individual interview, a group interview, and an essay. There are also specific additional requirements for various programmes.

Qualified applicants are usually offered a place if they exceed the threshold of the selection test scores. However, the number of qualified applicants frequently exceeds the number of university places for the choice of programme. Further assessments then have to be made, to decide which applicants to offer which programme. To make such decisions, the decision maker needs information. But to make efficient and effective decisions, the decision maker needs more than just information; he/she needs information that is easy to find, complete, up-to-date, and consistent in presentation and format (for ease of use).

In SUSS, the Business Intelligence & Analytics (BI&A) department was set up to provide such a platform for decision making. Its mission is to provide information for data-driven and evidence-based decision making and planning in SUSS. This covers not only the digital warehousing of critical data, but also the twin functions of reporting and analytics. BI&A also provides training to faculty and staff to build up the University's capability in dashboard development and in data mining/analytics.

From the collaboration between BI&A and the Office of Admissions (OA), a dashboard that presents data from the point of application to the point of offer (including applicants' demographics and prior academic performance) is deployed to aid decision making. In addition, applicants' predicted cumulative grade point average (CGPA), an output of predictive analytics, is also reflected in the dashboard. Hence, the dashboard contains not only information of the applicants but also additional information generated with predictive analytics.

This paper discusses the conceptualisation of the dashboard along with an overview of the dashboard. It also illustrates the use of the dashboard by both OA and the faculty. Finally, the last section discusses the challenges and future directions.

Background information

Dashboards, known for their use to manage the performance of organisations more effectively, have recently been employed by SUSS to support decision making. The use of dashboards to support decision making in higher education is not new (Harel 2003, Muntean 2010), and there has been success stories in some of these educational institutions (UC 2000, Harel 2003, NTU 2019). Harel (2003) reported that close to 200 campus administrative system users began using their dashboard within 90 days of their rollout, and he attributed this success to the dashboard's ease of use and holistic support given. Locally, there has been a lack of studies on institutional dashboards in Asian higher education, with most focusing on learning analytics (Tan 2017, Corrin 2014, Ochoa 2014), and NTU announced that it was the first University in Asia to implement a cloud-based enterprise technology focused on improving administrative processes, which allowed users to turn the University's data into 'quickly accessible, executive level reports', poising them to be ready for the next stage of growth in the higher education landscape (NTU 2019).

Other studies have also reviewed the institutional use of dashboards. Wolf (2016), for example, reported that George Washington University (GWU) had a data warehouse and enterprise BI services in place. Before delivering dashboards to their deans for decision making, GWU implemented a data governance process with a centralised repository of data definitions and business terms, and established a BI Community of Practice. Also, GWU identified and prioritised strategic information to be presented. Using Scrum's iterative method of developing dashboards, they spent less time gathering data and more on analysing them. A strong community was also established to share skills, information and mutual support, and information demo session were held to share ready dashboards. Wolf (2016) concluded that dashboards had to be well-summarised to meet specific needs for them to be well-utilised.

In the other three universities reviewed by Wolf (2016) (namely, New York, Purdue and Rochester), the infrastructures needed were largely similar to that of GWU. Crucial stakeholders who worked with their division's data frequently had to be identified and tasked as a core group in developing dashboards. Sharing of information and skills had to be done frequently to ensure cohesion among departments, and to push the transition from manual to automated reporting of data. Dashboard prototypes were designed using short iterative phases and were launched as early as possible. Dashboards had minimal visualisations, yet were effective and had sufficient information for the different scopes of operations used for making academic and administrative decisions. The challenges were to simplify visualisations but at the same time carry important metrics for them to be useful and relevant. Also, merging multiple sources of data to concisely display 'cleaned' data on the dashboard needed meticulous and diligent planning, validation and verification. Data dictionaries should be openly and readily available, which was crucial to the success of collaborations.

This paper reports the development of dashboards that help decision makers in the selection of prospective students who have a better chance of doing well in and graduating from their programmes. In particular, dashboards can provide historical academic results and student profiles, enhanced with charts that provide insights on expected student performance. For example, results generated from prediction models can be incorporated into the dashboard to further differentiate applicants with similar application scores. Data on performance of graduates can be used to predict how well a student may perform after enrolment. Through this paper, we also hope to address the lack of studies regarding dashboards used for decision making in shortlisting applicants and offering university placements, especially in an Asian context.

Dashboard Implementation in the Application and Selection Process

Since the launch of the University's full-time programmes (in 2014) and the government's announcement of SUSS as the sixth autonomous university in Singapore (in 2017), SUSS has been managing a rapidly increasing number of applications for its full-time undergraduate programmes. The University wants to be efficient and effective in its processes and make data-driven and evidence-based decisions. In selecting full-time students, the University has much information to assess before making timely decisions on which applicants to offer a place.

Such decisions can be facilitated by a well-designed dashboard that provides a central location for users to access, interact and analyse up-to-date data. A dashboard gives an easy-to-read summary of information and has many important benefits. In particular, it is customisable according to business objectives and user requirements; its intuitive data presentation allows easy and smooth navigation to get the required information; its all-in-one ability replaces the conventional way where users spend a large amount of time reviewing and analysing different reports to get to a conclusion; and its dynamic feature allows drilling into detail, enabling user to get deeper into information by simply selecting or filtering variables. An effective dashboard will improve the efficiency and effectiveness of processes through empowering users and facilitating data-driven decision making.

The iterative approach of business understanding, data understanding, data preparation, modeling, evaluation and deployment is used in this dashboard project. It is adopted from the Cross-Industry Standard Process for Data Mining (CRISP-DM), as illustrated in Figure 1. This approach is modified slightly to tailor to this project.
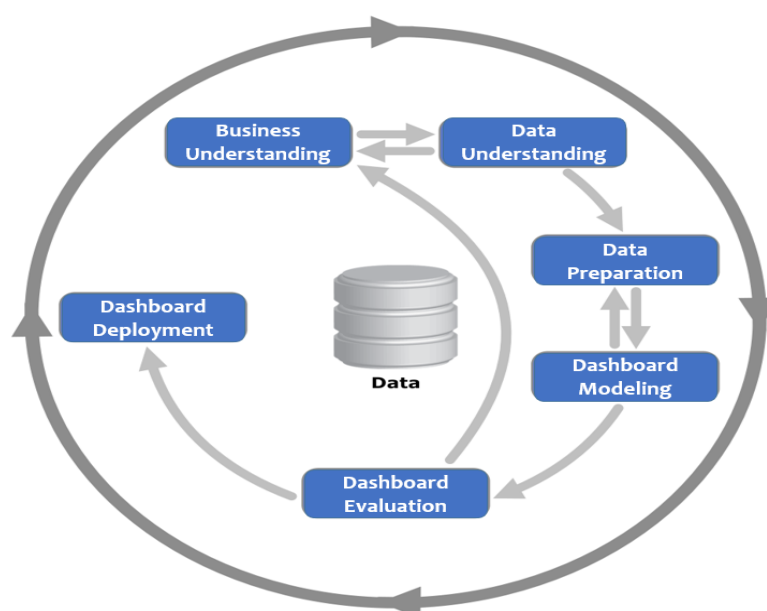

Figure 1: Adopted from CRISP-DM
Extracted from https://en.wikipedia.org/wiki/Cross-industry_standard_process_for_data_mining

Business Understanding

Understanding the current application and selection process is necessary before developing the dashboard. The process is managed by OA who presents related information to the schools so that they can decide whether to accept or reject an applicant. The application and selection process of a full-time student is depicted in Figure 2. There are four stages in the selection process for SUSS full-time students, comprising a 30-minute essay, a 12-minute cognitive test, a group discussion, and an individual or cluster interview. This paper focuses on the internal process of selection.

extracted from https://www.suss.edu.sg/full-time-undergraduate/how-to-apply

Figure 2: SUSS Application and Selection Process for Full-Time Undergraduate Programmes

The Stakeholders

OA and faculty are stakeholders and users of the dashboard. During the application and selection period, as frequent as daily meetings are held, in which OA presents information required for decision making in the form of excel spreadsheets and other files. The required information is extracted with assistance from Campus IT Services (CITS) that manages the University's operational database, the Student Management Information System (SIMS). Periodically, data generated from the decisions made are input into SIMS.

Data Understanding and Preparation

For decisions to be made in this context, the University assesses the applicants' scores for all the selection tests (i.e., 30-minute essay, 12-minute cognitive test, group discussion, and individual or cluster interview) in addition to programme choices and records of prior education. During the application and selection period, these data are stored in different sources. Data generated from the selection tests are stored independently by OA, while data relating to application, prior education and demographics are stored in SIMS. There are also variables derived by OA that do not flow back to SIMS as the database's current structure does not cater for them. For example, the computed final university score that is derived to standardise applicants' academic performance of their prior education and the start dates and dates of subsequent weeks of each application period are recorded separately outside SIMS.

After identifying the required information for decision making and tracking the data sources, the relevant data are extracted and verified. During verification, data cleaning is conducted, and various data derivation are performed to prepare the data to be stored in the Data Warehouse, a data repository for the purpose of supporting decision making.

Dashboard Modeling

A well-designed dashboard can meet business objectives, cater to user requirements, empower users, and ultimately facilitate data-driven decision making. The dashboard is structured according to the workflow in the application, selection and offer process. Hence, it contains three sheets, with the first sheet presenting information at the point of application (Application-data), second sheet information at point of shortlisting (Shortlist-data) and the third sheet information at point of offer (Offer-data). The structure, layout and design are developed in collaboration with the stakeholders, ensuring that it is intuitive and informative, and yet not overwhelming. Only information relevant to decision making in the selection process is incorporated into the dashboard, and this information relates to Application-data, Shortlist-data and Offer-data.

Shortlisting

Application-data and Shortlist-data provide information to make decisions in shortlisting applicants. Application-data include information provided by applicants, from their demographics and prior education to what they are applying for in SUSS; as well as other data generated at point of application such as application ID and payment status. Shortlist-data are generated when decisions are made for shortlisting, for example the shortlist status and the programme an applicant is shortlisted for.

Offering

Application-data, Shortlist-data and Offer-data provide information to make decisions in offering places. Offer-data (which document decisions regarding offers) include the offer status and programme offered to applicants.

Dashboard Evaluation and Deployment

Modelled after the process flow of application and selection, the dashboard is evaluated by the stakeholders and enhanced by the developer according to stakeholders' feedback and input. The evaluation is conducted with formal documentation through a User Acceptance Test (UAT). Evaluation and maintenance of the dashboard is an ongoing process, so that customisation and improvement are implemented as requirements change or objectives refined.

The dashboard that is evaluated and accepted by users consists of the following three sheets.

Dashboard: First sheet (Application-data)

Application-data are captured on the first sheet of the dashboard (see Figure 3). This sheet contains information on demographics like race and gender, information on prior education such as the awarding institution and final university score, and information on application details like payment status and programme applied for.

Other relevant information shown includes total number of applications, application intake and joined intake. These visual representations of Application-data will enable stakeholders to easily access and assess the overall profile of applicants.

Figure 3: Dashboard on Application-

Dashboard: Second sheet (Shortlist-data)

Shortlist-data are represented on the second sheet of the dashboard (see Figure 4). This sheet presents information relating to data generated at point of shortlisting, such as applicants who are shortlisted by week or by programme, and the total number of applicants who are shortlisted as compared with the total number of applicants. It demonstrates the integration of reporting and analytics as it also presents the predicted CGPA of the shortlisted applicants. These value-adding results from predictive analytics provide additional information to facilitate data-driven decision making in the shortlisting process.

Figure 4: Dashboard on Shortlist-data

Dashboard: Third sheet (Offer-data)

Offer-data are shown on the third sheet of the dashboard (see Figure 5), where information and patterns related to offers are generated at the point of offer. Such data include the number of applicants who are offered by week or by programme, the total number of applicants who are offered against that of applicants who are shortlisted. They provide necessary information for users to make decisions in offering places. This sheet also demonstrates the integration of reporting and analytics as it also presents the predicted CGPA of the offered applicants. These value-adding output from predictive analytics provide additional information to facilitate data-driven decision making in the offer process.
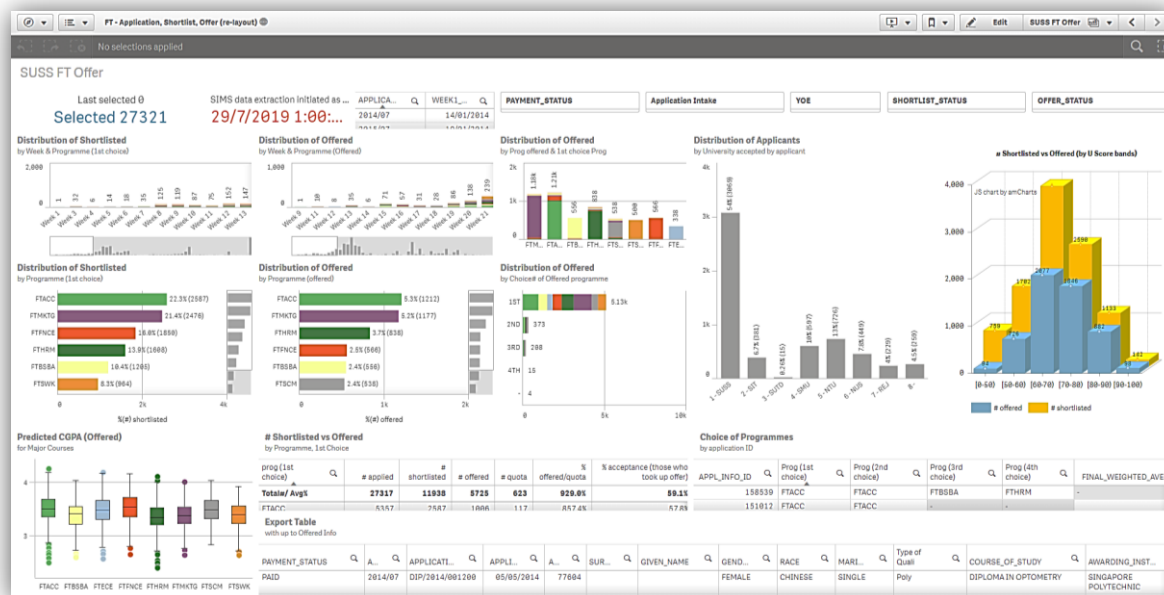

Figure 5: Dashboard on Offer-data

The dashboard is deployed in a secured environment through the campus server, with each account tagged to an individual staff's login credential. Access to it can only be made on campus intranet. The deployed dashboard is made accessible to OA, and to the schools offering full-time programmes. In deployment, training is also conducted for stakeholders, to equip them with the skills and knowledge in developing customised dashboards, and interpreting and creating visualisations.

Uses of the Dashboard

By using the dashboard, it is easier to compare the application statistics across the years, or even Year-on-Year (YOY). Before the dashboard, OA would have to extract data from SIMS based on the data criteria (for example, Application Intake and Paid Status) and then do the necessary data cleaning before presenting the statistics in a report format. The dashboard allows users to select the criteria filters and then use the visualisation features for presentation and reporting, which is much simpler.

The benefit for the Heads of Programmes (HoPs) in each school is the accessibility of data. In the traditional format, the HoPs needing statistics and will require more time to seek OA's help to prepare the data. With the dashboard, they can view the statistics and have a more real-time update of their programme applications or offers at any point of time.

For all SUSS full-time programme applications, OA processes and shortlists the applicants. It also tracks the volume of applications on a weekly basis. This is easily mapped out on the dashboard based on the programme, and status of payment on a week-on-week basis. This helps OA and HoPs understand the application trend for each programme and they can tweak the marketing messaging or advertising feature for the programmes with weaker application numbers over the marketing campaign period.

In addition to this, OA is able to track the number of applications, and those who are shortlisted, and/or offered by their prior education institutions. It helps the recruitment team understand the impact of the effort put into

outreach activities at the various education institutions. If the number of applications is relatively high from a certain institution but the number of offers does not commensurate, the team will be able to deep-dive into the details to analyse if the unsuccessful applicants from that particular institution did not do as well for the 4-stage admission process. With the relevant information, it can better guide the Education and Career Guidance (ECG) counsellors and teachers to better prepare the next intake of students applying for SUSS full-time programmes. If the scenario is instead high applications and high offer rates, then the statistics will be useful for the team to present to the education institution to collaborate more in the ECG approach.

Shortlisting

OA shortlists applications on a daily basis. The trending of this will aid the team in planning their resources and faculty interviewers for the admissions interview process. Certain weeks will have fewer applications being processed and shortlisted while the volume of applications will usually increase nearer to the end of application period.

Offering

The predicted CGPA, an output from predictive analytics, is incorporated and value-adds to the dashboard. It is a forecast that will help HoPs and schools predict the academic performance of students, and identify students who may need more learning support after enrolling into SUSS. This becomes a trigger for schools to be more proactive in supporting students who potentially may have difficulties in their study.

Challenges and Future Directions

Data Issues and Future Directions

Data are streamed into the dashboard server from the data warehouse, which in turn goes through an ETL process to extract, transform and load the data from the main sources of data, i.e. the operational databases. Hence, data accuracy and completeness on the dashboard is dependent on the main sources, as well as the ETL process. It is also dependent on the stability and performance of the servers.

Consistent maintenance of the dashboard is required, not only for review and evaluation against changing business objectives and user requirements, but also in detecting data inaccuracy and incompleteness. When any data issues are detected in the dashboard, it is necessary to go through a series of investigations before the root causes of the data issue can be identified, whether it is the data warehouse, ETL process, servers, etc.

By integrating business processes with data and analytics in an effective and timely way, the University can make more informed decisions and enhance effectiveness to better support students and improve their learning outcomes. Data visualisation through dashboards has great potential to empower decision makers in different roles. In empowering users, the functionalities in the dashboard will reduce reliance on IT or external help for customising reports.

To exploit data fully and to drive efficiency and effectiveness, datasets across different functions of the University have to be integrated. The University has commissioned CITS to develop a new Student Information Management System that will cater for an integrated database.

People Issues and Future Directions

Because a dashboard can be used for different purposes by different people, it should be highly customisable for different users with different objectives. It should display only the appropriate information required by decision makers to do their job. A dashboard should not be overloaded with information as it will look cluttered and be distracting to users. The user interface should be designed such that it is easy for users to navigate through the dashboard. Equipping users with the relevant skills and knowledge will empower them to develop customised dashboards that are effective for their respective functions.

As part of its role, the Business Intelligence & Analytics (BI&A) department provides training for staff to build up the University's capability in analytics and dashboard development. BI&A was setup in August 2016 to provide information for data-driven and evidence-based decision making and planning in SUSS. This covers not only the digital warehousing of critical data, but also the twin functions of reporting and analytics.

It is hoped that this paper provides information for readers to generate ideas and insights in developing and implementing dashboards that can facilitate in decision making in shortlisting applicants and offering university placements.

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