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Open Source Dashboard Technology and IEDSS for Higher Education Institutions

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Abstract: ***Open Source Dashboard Technology plays an imperative role to integrate IEDSS (Intelligent Decision Support System) in the establishment of the higher education in technology for revolutionized decision making. Because of modern factors, decision making has become complex requiring knowledge of business, data, and data representation; hence an intelligent computerized system is required. "An IEDSS is an intelligent information system that reduces the time in which decisions are made in an environmental domain and improves the consistency and quality of those decisions [Haagsma & Johanns, 1994]". Decision-makers try to apply new strategies and use new tools to convert data into useful information that would contribute to managerial problem-solving. Decision makers require reports that are accurate, timely, and which give the whole "business picture". Dashboard Technology and Intelligent Decision Support System (IEDSS) systems come to the rescue of decision makers. This paper proposes the integration of Open Source Dashboard Technology and IEDSS to improve the quality and efficiency of higher education's systems. The dashboard enables executives to measure, monitor and manage organizational performance more effectively. If Dashboard Technology and IEDSS are applied to higher education processes, it would help to improve students' performance, their life cycle management, selection of prospective students, course design, selection of courses to measure their retention rate, infrastructure, and development and the grant fund management of an institution. This is an approach to examine the effect of using open source dashboard technology and IEDSS for Higher Education Institution in strategic planning. Finally, an IEDSS system for higher education planning is introduced to illustrate and evaluate the use of dashboard technologies as intelligent decision-making tools.***

Keywords: Open Source, Dashboard Technology, IEDSS, Data Mining, Data Warehouse, OLAP, OLTP, Cloudera, Hadoop, R Analysis, and Higher Education

1. Introduction

Currently, higher education institutes are in an extremely weak position compared to their competitors in the education sector and the commercial world in terms of understanding where they are, how they got here and the impact of where they want to go in the future.

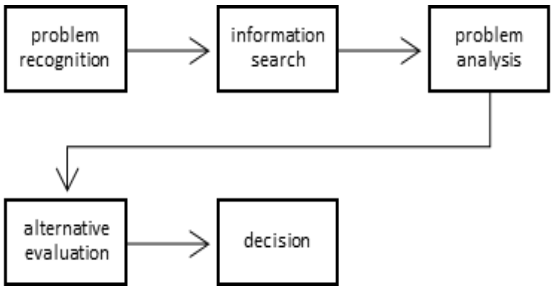

Figure 1: Major Activities in Decision Making Process

The decision-making process in an organization or business should be planned and resolved in a comprehensive, reliable, and transparent manner. Managers equipped with information about their relevant organizational cultures, interconnected with the knowledge transfer, can alter their knowledge management strategies to make their organizations more efficient and to evaluate and manipulate ICT (Information and Communication Technologies) ineffective strategies. Quality and well-timed decision-making are fundamental to the success of any organization.

Most of higher education institutes have become more and more dependent on the collection, storage, and processing of educational data. The dynamics and transformation of higher education, characterized by complex processes and statuses, generate an immense volume of data, and their acquisition and storage require the use of the innovation in the Information Technology. Decision-makers try to apply new strategies and use new tools to convert data in useful information that would contribute to managerial problem-solving. Decision makers require reports that are accurate, timely, and giving whole "business picture". Because of the modern factors, decision making has become complex requiring knowledge of business, data, and data representation; hence an intelligent computerized system is required. Intelligent Decision Support System (IEDSS) come to the rescue of decision makers.

Intelligent Decision-making can be applied to the following purposes:

- Measurement – creating a hierarchy of KPIs;
- Benchmarking both within and out with organizations;
- Analytics that enable optimal decision making and business knowledge discovery including data mining, statistical analysis, and predictive analytics and modelling;
- Data Visualization – presenting the data to the full range of staff in a clear and effective manner, enhancing data quality, decision making, and knowledge.

The problems faced by the Higher Education Institutes with regard to access to valuable, correct, timely, and actionable information is depicting the whole "business picture" for effective decision making. University decision makers needed information from multiple disconnected data across all departments or units of the University. The "complete business picture" of the organization was prevented due to lack of consolidated data. Complexity to generate reports was due to

the consolidation of data from sources like accounting, student MIS, student's portals, and e-learning portals, Human Resource (HR) /Payroll, Social Media Insights, and Websites. Due to incomplete data for making important decisions; missing data prevented seeing a complete view of the organization', analytics were incomplete and could not show an accurate representation of top issues and users were often unaware that certain data is missing and assumed it was not present. It is observed that once a report is generated, people have to use it as is so that in the case of further inquiries another report had to be generated.

Higher education institutions are under pressure - to increase enrollment, ensure students graduate, Increase tuition fees and reduce resources costs, consistently improve the learning experience, and be accountable and transparent - among many others. These pressures are pushing higher education institutions to evolve and re-think the "way things have always been done" and to drive towards new solutions to solve their business challenges.

Many Institutes of higher education leaders are using data analysis and visualization to question the status quo and develop effective solutions. Achieving these insights and information requires not a single report from a single system, but rather the ability to access, share, and explore institution-wide centralized/ decentralized structured and unstructured, offline/online data that can be transformed into meaningful insights at every level of the institution.

Higher education institutions are interested in predicting the paths of students, alumni, research, and funding agency, thus identifying which students will join particular course programs and which students will require a large number of debates. Today, one of the prime challenges the educational institutions face is the exponential growth of educational data and it's usage to adjust the quality of managerial decisions.

This research contributes to getting an overview of intelligent decision support systems (IEDSS), and also the conceptual model in designing a higher education IEDSS to design the data warehouse model using cluster integrated with a Statistical Software, dashboard technology as data visualization analytical tool and data mining technique for higher education institutions.

The research method began with designing the knowledge needs; designing and developing transformation model to the data warehouse; using data mining techniques and designing the dashboard for the analytical tool by using CLOUDERA is the most popular distribution of Hadoop and related projects in the world.

Apache Hadoop is a Platform for all kinds of Data, to Store, Process and Analyze Data in any Format, Quantity, Quickly and Free from RIGID Schemas.

Cloudera is the leader in Open, Hadoop-Based Big Data Systems, Solutions, helping to gain Profit from all kinds of Data by Understanding targeted Audience, Markets, Products, and Operations strategies. Cloudera gives access to all data in a single platform to optimize the business and delight the customers. With Cloudera, we can efficiently capture, store, process and analyze vast amounts of data in order to solve the most challenging business problems quickly, securely and at a lower cost. The world's leading organizations trust Cloudera to help them improve experiences, improve businesses, improve lives, and advance human achievement. When we ask bigger questions, we get bigger answers which make anything possible.

For problem-solving and decision-making tasks, human beings are the ones who explore the sea of data during problem-solving processes. Thus, dashboard technology faces challenges in dealing with non-geometric data and incorporating human problem-solving processes.

The obtained result was to understand the dashboard technology and integrates IEDSS for a higher education institution that will improve institution's performance, and help them to improve analytical and decision making process. And to transform the data warehouse in centralized resources form and analysis achieved using a query language and open source statistical software through data visualization and dashboards. Comparison with the good open source intelligent tools was conducted.

For any institutes of Higher Education subsystems consist of:

a. Academic subsystem
b. Research subsystem
c. Community Service subsystem
d. Personnel subsystem
e. Library subsystem
f. Infrastructure subsystem
g. Financial subsystem
h. Cooperation subsystem
i. Student and Alumni subsystem
j. Management subsystem and many others.

1.1 Research Objectives

To enhance the use of Open source Dashboard Technology and implement IEDSS that matched to provide optimum decision support in the higher education institutes/ universities, by generating and presenting relevant information and knowledge which are helpful in taking the decisions at all administrative and managerial levels in the higher education technical institutes/universities.

2. Literature Study

This section provides the need to research in this domain, a background study DSS, use of data dashboards, the importance of data visualization, and best practices in IEDSS implementation. Most research efforts reported in the last decade tried to fill the gap of developing IEDSS for a variety of domains by using a single intelligent tool and addressed a significant class of decision situations.

Information systems applications that support decision-making processes and problem-solving activities have evolved over the past decades. In the 1970s, these applications were simple and based on spreadsheet technology. During the 1980s, decision-support systems incorporated optimization models, which originated in the operations research and management science. Numerous technological and organizational developments have applied an impact on its evolution. The Web has empowered inter-organizational DSS and has given rise to countless new applications of existing technology. Contemporary decision support systems (DSS) offer their users with a broad range of capabilities. Current DSS facilitate a widespread variety of decision tasks including information congregation and analysis, model building, sensitivity investigation, collaboration, substitute evaluation, and decision implementation. There are many uses for a dashboard to include support of monitoring

capabilities, reporting/ analysis, and management dashboards "monitor critical business processes and activities using metrics of business performance that trigger alerts when potential problems arise" The importance of the monitoring purpose is to track performance in various strategic, operational, and financial areas. This is tremendously significant for decision-making at managerial levels but has a trickle-down effect to executives and then responsibility in man. DSS are designed for unstructured and semi-structured activities. The decision process is not a single task rather it can be defined as a collection of correlated tasks that include: gathering, interpreting and exchanging information; creating and identifying scenarios choosing among alternatives, and implementing and monitoring a choice [20]. But implementing DSS is a challenging activity. Some of the disadvantages of DSS are:

1. Implementing DSS may reinforce the rational perspective and overemphasize decision processes and decision making. Customary DSS are ineffective in expressing and amalgamating the knowledge. Therefore there is a difficulty in solving complex unstructured and semi-structured activities, and this is a limitation for taking the better decision.
2. The primary components of a decision support system are a database management system, a model base management system, and a generation and management system. An appropriate database management system must be able to work with both data that are internal to the organization and data that are external to it. The deficiency of integration data also leads to ineffective applications of traditional DSS.

A dashboard's strength is also its limitation: it provides only a high-level business overview measured against predefined metrics. This prevents users from asking and answering new questions and experiencing new relationships between different types of information. Often, users cannot drill down into data to see what is causing the top-line results. Additionally, decisions based on real time dashboard information often exist in a black hole: they are made and executed, but the decision-making process is never passed down through the organization. The result is a need for something beyond the standard dashboard [13]. In order to get an accurate, effective and better decision making, the data must be comprehensive, accurate and up-to-date. These properties require that not only data from other enterprise but also from external sources. In order to use the data from existing systems to support decision making, some kind of intelligence is required.

An IEDSS has been defined as 'a computer-based information system that provides knowledge using analytical decision models and providing access to data and knowledge bases to support effective decision making in complex problem domains' [1]. The basic concept of an IEDSS is the integration of classical decision support including information access and analytical decision models with those of knowledge-based systems including reasoning and inference An IEDSS may use models, is built by an interactive process, supports all phases of decision-making, and may include a knowledge component [3]. Knowledge-based systems (KBS) embody the knowledge of experts and manipulate this expertise to solve problems at an expert level of performance [2].While Business Intelligence helps in gathering, management, and analysis of large amounts of data [7]-[8], knowledge discovery in Database (KDD) attempts to extract relevant and interesting hidden relationships that exist among variables or between causes and effects [9]. An ideal visualization would provide a set of views [3] using many of knowledge discovery [4] approaches. The search and extraction can be a difficult and exhaustive process [5]. DM remains poorly integrated with the decision support [10] Visual data mining is a step forward [6].

Driven analysis of the decision-making systems displays a rate of the variables that can complement to productive decisions [Shimizu et al, 2006]:

I. Accountability and Transparency – there are laws and disciplines to be respected by the individuals or relationship in decision-making philosophies.
II. Proficiency – each decision should be created in the noteworthy data/knowledge of an expert.
III. Organization – the best decision options are lacking if there is no synchronization to transmit the solicitations that should be taken after and to manage the decision-making process.
IV. Economy Factor – a decision can have a negative result or a singular battle can be lost, however broad a conventional sense in decision making can help to make up for the passing of a couple of encounters.
V.Time – a wealth of time acts as an influence like the economy component, allowing decision components to sit tight for perfect open entryways.
VI. Consensus or negotiation – when there is a brain boggling level of an issue, a more created examination of the issue and game plan among the get-togethers concerned is mandatory.

A decision is defined as a process of choosing among alternative courses of action for the purpose of attaining a goal or goals according to Simon (Simon, 1977).

The decision-making process consists of four main stages:

1. Intelligence: Fact finding, problem and opportunity sensing, data collection, analysis, and exploration
2. Design: Formulate a model, Set criteria for choice, Search for alternatives, modelling, and simulation
3. Choice: Evaluation of alternative, Sensitivity analysis, Selection of best alternative and plan for implementation
4. Implementation: Final implementation of the chosen alternative.

2.1 Dashboard Technology

Dashboards theoretically resemble dashboards incorporated in automobiles by simplistically representing the existing and past key performance metrics of a company in forms, e.g., gauges, tables, and charts. They are typically showed on one screen, in a web browser, use colors (like traffic light colors) to indicate the progress towards the goal, and use a high data-to-ink ratio (meaning that the pixels incorporated for representing pertinent information outweigh the pixels used for decorative purposes). They are not a static representation of information but are updated regularly, for example, hourly, weekly, monthly, quarterly etc., depending on end-user needs and/or capabilities of a system. They are powerful tools that rely on human cognition principles to improve comprehension with the help of visualization [15]-[16]-[17]. When referring to the visual features of the dashboards, the main point of reference is - Few. Few (2006, p.26) [14] emphasizes the importance of visualization that dashboards provide:

"A dashboard is a visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen, so the information can be monitored at a glance." Performance dashboard is an umbrella term that holds various types of dashboards like drill-down reports, drillable charts, graphs, and gauge like dashboards. Eckerson (2011, p.11) [12] defines

performance dashboard as "a layered information delivery system that parcels out information, insights, and alerts to users on demand so they can measure, monitor, and manage business performance more effectively". This definition recognizes the interactive nature of modern dashboards as the tools powered by business intelligence, their functionality as an information system and the performance management principles they represent. [18]. There is an abundance of vendors that supply businesses with business intelligence based dashboards, to name a few, IBM Cognos, Cloudera, Oracle BI Foundation Suite, SAS Enterprise Intelligence Platform, SAP Business Object BI Platform, MicroStrategy, QlikView and Web Focus. Furthermore, Eckerson (2011) [12] states that on previously mentioned hierarchical level dashboards are incorporated for monitoring, analysis, and management. He discusses that monitoring as succeeding the strategy by comparing the desired with the actual performance and occasionally utilizing alert systems for signaling performance deficiencies. Dashboards are then used for analysis to identify causing an unacceptable performance. Finally, dashboards are used to communicate information transversely the entire organization for collaboration and decision making.

The literature on performance dashboards mentions monitoring as the most fundamental feature (e.g., Rasmussen et al., 2009; Few, 2006; Yigitbasioglu and Velcu-Laitinen, 2012) [15]-[19]. Monitoring means following KPIs and other performance metrics to spot when a corrective action is needed, how good a performance was against a target or/and a benchmark and what can be learned from this. A consistency in measures is necessary to be able to measure and compare the performance across the organization and its business units. Planning is setting the goals and strategies for the future. Dashboards are incorporated for planning, for example, by performing numerous scenarios, and for sharing the observations, results, and strategy with others.

3. Discussion

3.1 Dashboard Framework for Higher Education

Dashboard framework are concerned with strategic planning management of university resources and the objectives. Decision-makers are able to evaluate various strategies and generate forecasts by means of simulating with the input data. To keep the model manageable and intuitive and to avoid functional explosion we opted for a single bottleneck resource of the educational capacity, which is the teaching staff. From experience, staff availability is by far the most crucial resource constraint, expensive and hardly adjustable in the short-term compared to other resources involved, such as facilities, budget, appliances, materials etc.

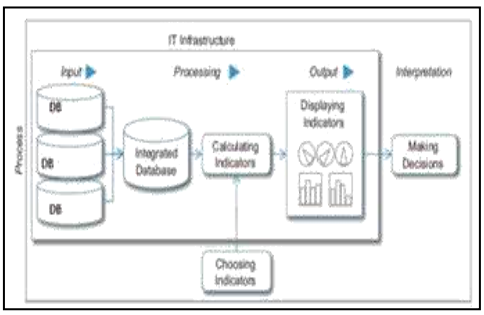

Figure 2: Dashboard Framework

Based on the evaluation results and discussion with the subjects afterwards, this research has summarized the following comments: A dashboard is very necessary and helpful to be able to guide decision maker to make a decision; Dashboard and IEDSS are very flexible. Users can join a decision-making process anytime, at any location and on any type of computer.

The Dashboard and IEDSS have the powerful functionality to match the requirement of decision maker for solving multiple goal decision problems. The development of an integrated IT system that will assist the decision makers from the academic field in making the right decisions at the right time constitutes an important step in the implementation of the new educational policies. The IEDSS system will assure the requirements on Standards and Guidelines for Quality Assurance in the Higher Education Area", as follows: student progression and success rates, employability of graduates, students' satisfaction with their programs, effectiveness of teachers, profile of the student population, learning resources available and their costs, the institution's own key performance indicators. In addition to organization requirements, we need to ensure that standards/goals are achieved.

3.2 Intelligent Decision Support System: A Framework

There are four main components of an Intelligent Decision Support System (IEDSS).

3.2.1 The Database Management Subsystem: It includes a database which contains data that are relevant to the class of problems for which the DSS has been designed and Database Management System (DBMS) which is a software that manages the database. A DBMS can be interconnected with data warehouse and/or data marts of the organization. A DBMS separates the users from the physical aspects of the database structure and processing. It should also be capable of informing the user of the types of data that are available and how to gain access to them. The DMS subsystem allows access to the data stored in IEDSS own database with reference to the organizational structure, types of relations and work fluxes, the allocation of teaching and auxiliary training personnel, effort and communication procedures between the system and the beneficiaries. The database will contain the following entities:

ALUMNI: described by attributes: name of employer, activity field (the position requirements are in accordance with the training and specialization level), wages etc.

STUDENTS: described by two types of attributes: attributes describing the personal data of each student; attribute describing the educational activity.

EMPLOYERS: described by attributes: name of the company, dimension, field of activity etc.

TEACHERS: described by three types of attributes: attributes describing the personal data of each teacher: name, surname, date of birth, address, sex, marital status, education, date of employment, academic title etc.; attributes describing the teaching activities: diversity and quality of educational materials, taught subjects, number of hours allocated to each subject, number of resulting conventional hours and their quota, number of allocated credits etc.; attributes describing the research activity (publication of books / articles: title, authors, abstract, name of the publication, index, the web address where the article can be found; participation in projects: name of the project, value, position within the project (director/member)).

FACULTIES: described by the attributes: name of study program, level (degree, master, doctoral), specialization etc.

FINANCIAL RESOURCES: state budget, own income, personnel expenditure, the cost of utilities, investments etc.

3.2.2 Model Management Subsystem

The role of MMS is analogous to that of a DBMS. It includes a model base which contains financial, statistical, management science and other models that provide DSS with analytical capabilities. The purpose of an MMS is to convert the data from the DBMS into information by applying models to it. Since many problems that the user of a DSS will cope with may be unstructured, the MMS should also be capable of assisting the user in model building. These methods allow the extraction of information from the IEDSS database system through the descriptive modelling of data, exploratory analysis, predictive modelling, anomaly detection, the discovery of association patterns and rules.

3.2.3 The User Interface Subsystem

Here the all aspects of communication amid a user and diverse components of DSS. As their users are often managers who are not computer-trained, DSSs need to be equipped with intuitive and easy-to-use interfaces. These interfaces assist in model building as well as interaction with the model, such as gaining insight and endorsements from it. The primary responsibility of a user interface is to enhance the ability of the system user to utilize and benefit from the DSS.

3.2.4 Knowledge Management Subsystem

Once the information is well-known, composed, and managed, it must be transformed into knowledge. This requires sorting, analysis, and synthesis which require human intervention. Knowledge cannot be created by technology. Only a human being can render information into a format that causes it to be easily transformed into knowledge by another human being upon retrieval. Since all knowledge is not relevant to the business projects at hand, some mechanism must exist to filter the unnecessary and non-relevant knowledge (Lubit, 2001). Various tools and technologies that transform and filter the information/ knowledge for this phase of the knowledge management process include Data Mining, OLAP, Machine Learning, and Artificial Intelligence.

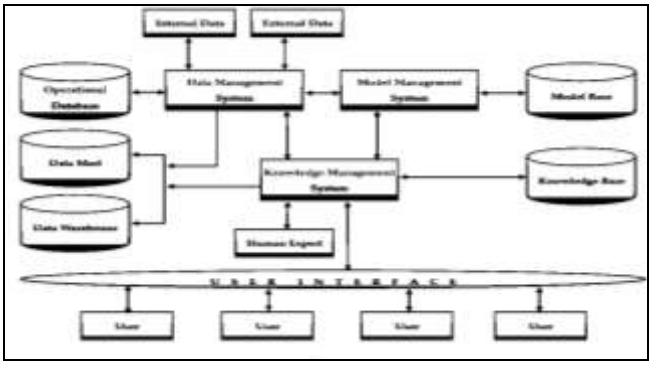

Figure 3: User Interface Subsystem

There are different sources of information/knowledge which can be broadly classified as internal and external in figure 3. Internal sources include the operational database, data warehouse, data marts and humans working in an organization. While as external sources include prospective students and their parents, market competitors, markets trends, endowment, funding, industrial and government agencies, etc.

Tools and Technologies: Various tools and technologies that can help in the capture, transformation, storage and dissemination of information/knowledge are discussed below.

Document Management System: Documents are a vital part of any organization. It has been estimated that 94 percent of all business information is stored on paper (Ziming & Stork, 2000). Tidd suggests that successful knowledge management is critically dependent on successful document management since a significant amount of the information captured and shared is in some form of text-based document (Tidd, 2000). Locating and updating information in that format is a great source of organizational inefficiency.

Internet: As on today, it is estimated that there are over 8 billion indexed web pages, and thousands of newsgroups and forums, on the Internet - covering virtually every topic. To take advantage of the potential opportunities of the Internet, both Web site developers and users need to be aware of the tools and techniques for managing and retrieving online knowledge. This has driven the development of improved search and information retrieval systems. However, there is a need for sophisticated information extraction capabilities to present the user only with the information they require, rather than a large set of documents to read. A popular method for finding Internet resources is through directories, search engines, and web mining. Directories consent a user to manually browse a hierarchy of categories to find appropriate Web sites. Search engines take a user's query and automatically search their database to return matching results. Web mining is the request of data mining techniques to discover patterns from the Web. Web mining can be divided into three different types, which are Web usage mining, Web content mining and Web structure mining.

Operational Database: Operational database is the main source of data/information. A database is the collection of related files. Database Management System (DBMS) is software that manages data in a database.

Data Warehouse: Due to globalization and rapid technological advancement, competition among companies is becoming more intensified. The key to success in this competitive environment is quick and effective decision making. This fast growing demand for analyses business information has quickly led to the emergence of data warehousing (Finnegan, et al., 1999). A data warehouse is a copy of transaction data specifically structured for query and analysis and is informational, analysis and decision support oriented, not operational or transaction processing oriented (Kimball, 1996). The data warehousing technologies, if implemented properly can assist organizations in reducing business complexity, discovering ways to leverage information for new sources of competitive advantage, realizing business opportunities, and providing a high level of information readiness to respond quickly and decisively under conditions of uncertainty (Love, 1996) (Park, 1997). Data in a data warehouse is subject-oriented, integrated, time-variant, and non-volatile. Populating a data warehouse from internal sources like operational database and external sources requires transformations of the data before it can be loaded into the data warehouse. This transformation process is called ETL and performs the following functions:

Extraction: During extraction, the data is acquired from multiple sources including the operational systems well as from external sources. The selected data is merged and filtered out from non-relevant data.

Transform: It validates and scours up the extracted data to correct inconsistent, missing, or invalid values. Data transformation integrates data into normal formats and applies business rubrics that map data to the warehouse schema.

Load: It loads the cleaned data into the data warehouse/data mart.

Data Mart: These are small localized data warehouses, created by different departments or divisions to provide their own decision support activities. To avoid the risk of failure, huge investment, certain companies invest in data marts for a few functional areas like marketing or finance instead of a full-fledged data warehouse. There are some companies that select both data warehouse as well as specialized data marts which significantly reduce the query complexity and query response time.

Multidimensional Data Analysis: Also called Online Analytical Processing (OLAP), which is a function of business intelligence software that enables a user to easily and selectively extract and view data from different points of view. OLAP is software for manipulating multidimensional data from a variety of sources stored in data warehouse/data marts. The software can generate various views and representations of the data. It also allows business analysts to rotate that data, changing the relationships to get the more detailed understanding of company information. Many of intelligent decision support systems depend on different types of information technologies, including model-driven DSS, expert systems, multidimensional analysis, query and reporting tools, OLAP (Online Analytical Processing), and Business Intelligence. A dashboard is a visual presentation of the most vital information needed to achieve one or more objectives, combined and organized on a solitary screen so that information can be monitored at a glance. Dashboards are aimed at helping to visualize large amounts of data in a condensed representation in a user interface which puts together and shows information in an easy and intuitive manner. They provide a quick overview of organizational processes and support managers in their decision-making tasks. Designing of Dashboards in different features offered by each platform is explained in below table:

Table 1: Comparison between Open Source and Commercial

	Open source				Commercial			
Features	JasperSoft	Pentaho	SpagoBI	Vanilla	IBM	Microsoft	MicroStrategy	Oracle
Reports	✓	✓	✓	✓	✓	✓	✓	✓
Dashboards	✓	✓	✓	✓	✓	✓	✓	✓
OLAP	✓	✓	✓	✓	✓	✓	✓	✓
ETL	✓	✓	✓	✓	✓	✓	✓	✓
Data mining		✓	✓	✓	✓	✓	✓	✓
KPIs		✓	✓	✓	✓	✓	✓	✓
Data export	✓	✓	✓	✓	✓	✓	✓	✓
GEO/GIS	✓	✓	✓		✓	✓	✓	✓
Ad-hoc queries	✓	✓	✓	✓	✓	✓	✓	✓
Linux	✓	✓	✓	✓	✓		✓	✓
Windows	✓	✓	✓	✓	✓	✓	✓	✓
Unix		✓	✓	✓	✓		✓	
Mobile	✓	✓	✓	✓	✓	✓	✓	✓

The Information elements such as information tables and several charts are considered in reports. Dashboards are graphical elements that allow view the data in graphical mode. The visualization of information in data cubes is allowed by the On-Line Analytical Processing (OLAP). The process in charge of data extract, data transformation and data load is ETL. Data mining is a complex process of extract information by data sequences. The KPIs are the key performance indicators that usually arise associated with the data represented. The data export allows export data to Excel, CSV files etc. Any information system that displays geographic information for informing decision-making is described by GEO/GIS. Ad-hoc queries are the typical queries made by decision makers where any field can be queried at any time.

IEDSS can be used to deliver accurate and reliable decisions, besides to improve the effectiveness of decision-making processes. IEDSS use a number of approaches and techniques from simple data reporting tools, statistical software for decision support tasks. They assist decision makers in high levels phases of decision making by integrating human knowledge with modelling tools. Dashboard and IEDSS remain a tool that can provide higher education institutes/universities with a sustainable competitive advantage.

4. Conclusion

The study illuminates the Complete Summary of Student Performance at a glance using Dashboard Concept and integrating Key Performance Indicator. The current system is just a normal reporting without integrating the Key Performance Indicators and display details without summary for the University. The study integrates Data Mining engine to cluster the Student's Result for knowledge exploration. While in the current system does not integrate Data Mining process. The results only go through normal information retrieval with predefined requirements. The study combines forecasting engine to forecast the Future Student Performance when the current system does not combine forecasting engine. It only displays the current status and history. The study joins opinions from Education Experts on the student performance and suggestion for improvement as part of the knowledge management mechanism. In the current system, the report does not include expert opinion. Opinions are recorded as part of meeting minutes without proper documentation – no knowledge management mechanism. The study includes related publications such as the article, conference proceeding, paperwork and technical report which relates to the student performance. While the current system no sufficient research being done to improve student performance. The outcomes are not attached to the academic system for review or to help in decision making. The study integrating Drill-down features to zoom into Cluster's Behavior and Analysis by Faculty, time and competition. The current system Drill-down is only for faculty, time, competition etc., but not to detail student's behavior. Student behavior is not taken in any application. The study combining data management elements to process the open information such as Data Clustering of Student's Result, Detail Student Behavior and Analysis of Results; and very limited knowledge management for explicit knowledge. The current system just displays result without exploring the vision of the information. The study incorporating information management elements to process the hidden information such as expert opinion and skill and experience through publications such as knowledge bank in the terms of Technical Report,

Article, Journal, Paperwork and etc. The current systems display only the result of explicit knowledge without implicit knowledge. The methods used in the study are found to be efficient, accurate and graphically represents all the insights required for dynamic decision-making strategies. This is achieved using various dashboards, using which, decision makers can now easily predict the next steps to achieve the University goal.

In the research work, it has been found that Hadoop provides a great opportunity to developers who aspire to implement solutions dealing with large amounts of data typically termed as "Big Data", using data mining techniques. Also, it revealed that R is also powerful and can work well with Hadoop to analyze data for further insights. The work revealed great opportunities for open source tools in data analytics for Universities. Universities can take a lead to incorporate this low-cost technology into their information systems so as to able to take advantage of IEDSS. Also, the study recommended and gives leads for future research in direction of exploring the development of a real-time IEDSS system that would relay the live status of events for effective decision-making and also an incorporation of unstructured data from social media in improving the University analytics. These study key features are intelligent tools to be used to assist decision-makers answer 'what if', questions examine numerous alternatives very quickly and find the value of the inputs to achieve a desired level of output. It would be motivating to the prospective researcher to explore what type of decision purposes dashboards are used for, assess the effects of using dashboard technology in decision making, how dashboards are used in organizations to deal with unstructured information sources. Even though the context of this study is limited to higher education, the results of this study could be generalized for other areas.

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