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A Business Intelligence Based Framework to Align Higher Education Output with Labor Market in Sudan

إطار مبني على ذكاء الأعمال لمواءمة مخرجات التعليم العالي مع سوق العمل في السودان

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Dedication

I dedicate this dissertation to the memory of my late mother Safia (may Allah grant her the best of Heavens, the Firdous), father Ali, wife Sara, and lovely kids Ahmed, Ali and Aya. Also, to my brother, sisters, and all their gorgeous children, and to my family at large, and friends, for their care, unwavering support and love.

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I am very fortunate and grateful to my dad who has helped me in all things great and small.

Abstract

The global expansion of Higher Education (HE), socioeconomic changes and technology advancements exert tremendous pressures on HE including its alignment with labor market. In Sudan, HE has seen unprecedented growth over the last two decades, both in terms of numbers of HE Institutions (HEIs), and the vast admission increase in the existing ones.

Education-to-employment is a long, complex and interrelated process that encompasses every step of the transformation of students into contributing members of the workforce. It includes many activities and decisions taken by the many stakeholders; such as, students, graduates, employers -public and private- as well as HE policymakers, among many others. Many of the decisions taken throughout the process are uninformed and are based on alternative information source due to the lack of, or inaccessibility of reliable objective decision-support information.

This remarkable expansion in HE provides a number of challenges and opportunities, including adapting HE to the labor market demands while maintaining quality by availing decision-support information and analysis capabilities to all stakeholders, and this is the focus of this research.

The objective of this thesis is to investigate the value and advantage of utilizing Business Intelligence (BI) technologies to enhance decision-making throughout the education-to-employment process. The research hypothesizes that adopting these technologies leads to reliable and knowledge-based decisions and would yield a better-quality process.

A **mixed-model research approach** was utilized to develop a BI implementation model while exploring the main factors affecting its adoption. Then an empirical investigation of stakeholders' perception and expectation was carried out. **Content analysis** methodologies and **exploratory interviews** were used in identifying the crucial factors affecting adoption and their associated variables. The survey target group includes senior students, recent graduates and employers.

This study produced a useful and usable implementation of the BI model that consolidates scattered HE data in a Data Warehouse (DW) and answers HE admission queries. Furthermore, the survey results significantly support the research hypothesis, as it has concluded that there is substantial stakeholders' support for the use of technology and the adoption of BI throughout the education-to-employment process. This support is consistent among all respondents, and yet is contrasted with their dissatisfaction with the current process in all the examined activities, ranging from HE admission and career planning to recruitment and talent retention. One of the most important findings is that major prerequisites for BI adoption in Sudan are already available and fit-for-purpose.

This thesis has laid out the foundation for improving the education-to-employment process while providing insight to HE planners, businesses and HEIs to better realize the value of BI, the possible obstacles, and the existing leverage in its adoption. It has also provided a base for further BI research and extending empirical studies to other countries with the aim of amending the statistical analysis, and refining the BI components.

ملخص البحث

إن التوسع العالمي في التعليم العالي والتغيرات السكانية والاقتصادية بالإضافة إلى التقدم التكنولوجي يضعون ضغوطًا هائلة على التعليم العالي بما في ذلك مواءمته مع سوق العمل. لقد شهد التعليم العالي في السودان نمواً غير مسبوق خلال العقدين الماضيين، سواء" من حيثُ عدد مؤسساته، أو الزيادة الكبيرة في القبول للمؤسسات القائمة.

إن **التعلم-المنتهي-بالعمل** عملية طويلة مترابطة ومعقدة تتضمن كل خطوات انتقال الطلاب من الدراسة إلى أعضاء فاعلين في القوى العاملة. وتشتمل هذه العملية على العديد من الأنشطة والقرارات التي يتخذها العديد من أصحاب المصلحة (stakeholders)؛ على سبيل المثال، الطلاب والخريجين وأصحاب العمل -القطاعين العام والخاص- وكذلك صانعي سياسات التعليم العالي بالإضافة إلى آخرين. كما أن العديد من القرارات المتخذة خلال هذه العملية غير مدعومة بالمعلومات وتستند على مصادر معلومات بديلة بسبب نقص أو عدم إمكانية الوصول إلى معلومات موضوعية وموثوقة لدعم القرار.

إن هذا التوسع الملحوظ في التعليم العالي يوفر عددًا من الفرص والتحديات، بما في ذلك تكييف التعليم العالي مع متطلبات سوق العمل مع الحفاظ على الجودة، من خلال إتاحة معلومات دعم القرار وإمكانات تحليل البيانات والاستقراء لجميع المشاركين في عملية التعلم-المنتهي-بالعمل، وهذا هو محور هذا البحث.

الهدف من هذه الأطروحة هو التحقق من قيمة وميزة استخدام تقنيات ذكاء الأعمال (Business Intelligence)، من استقصاءٍ للمعلومات وتقنياتٍ تحليلية، في تعزيز ودعم صنع القرار خلال عملية التعلم-المنتهي-بالعمل. يَفتَرِض البحث أن تطبيق تلك التقنيات يؤدي إلى قرارات موثوقة وقائمة على المعرفة مما سيسفر عن تجويد العملية.

استخدم البحث عده منهجيات لتطوير نموذج لتطبيق ذكاء الأعمال علاوة على استكشاف العوامل الرئيسية التي تؤثر على اعتماده. كما استقصى تصور أصحاب المصلحة وتوقعاتهم لفعاليته. استُعملت منهجية تحليل المحتوى والمقابلات الاستكشافية في حصر العوامل الأساسية التي تُؤثر على اعتماد تلك التقنية. شملت عينة المسح الإحصائي المستهدفة مزيجًا من الطلاب وحديثي التخرج وأرباب العمل.

من نتائج هذه الدراسة نموذج لذكاء أعمال سهل الإستخدام ومفيد يدمج البيانات المبعثرة في مستودعٍ للبيانات ويجيب على الاستفسارات حول القبول للتعليم العالي. إضافة الى أن نتائج الاستطلاع دعمت بشكل مؤثر فرضية البحث، حيث خلُصت إلى وجود مساندةٍ كبيرة من مختلف فئات الشريحة المختبرة لاستخدام التكنولوجيا واعتماد تطبيقات ذكاء الأعمال خلال عملية التعلم-المنتهي-بالعمل. بالمقارنة مع هذا، أظهرت الدراسة عن عدم رضاهم عن الوضع الحالي في جميع الأنشطة التي تم فحصها، بدءًا من القبول والتخطيط الوظيفي إلى التوظيف والاحتفاظ بالمواهب. علاوة على ذلك، من أهم النتائج أن البحث أكد على أن المتطلبات الأساسية لتبني تقنيات ذكاء الأعمال في السودان متاحة بالفعل وكافية ومناسبة للغرض.

وضعت هذه الأطروحة الأساس لتجويد عملية التعلم-المنتهي-بالعمل حيث حاولت تبصير مخططي التعليم العالي ومؤسساته والشركات بإدراك قيمة ذكاء الأعمال والعقبات المحتملة بالإضافة الى العوامل المساعدة المتاحة على اعتماده. وقد وفرت أيضًا قاعدة قوية لإجراء المزيد من الأبحاث وتوسيع نطاق الاختبارات العملية لتشمل بلدان أخري بهدف توسيع التحليل الإحصائي وصقل مكونات ذكاء الأعمال.

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Acronyms & Abbreviations

AI	Artificial Intelligence
BI	Business Intelligence
BPM	Business Performance Management
CBS	Central Bureau of Statistic
DACVA	Directorate of Admission, Certificates Verification and Accreditation
DM	Data Mining
DW	Data Warehouse
ER	Entity-Relationship
ETL	Extract, Transform and Load
FME	Federal Ministry of Education
GPA	Grade Point Average
GER	Gross Enrollment Rate
HDI	Human Development Index
HE	Higher Education
HEI	Higher Education Institution
HR	Human Resources
HS	High School
ICT	Information and Communication Technology
IEEE	Institute of Electrical and Electronic Engineers
IIEP	International Institute for Educational Planning
ILO	International Labor Organization
KDD	Knowledge Discovery from Database
KPI	Key Performance Indicators
LFS	Labor Force Survey
MHESR	Ministry of Higher Education and Scientific Research
MHRD	Ministry of Human Resources Development
MLAR	Ministry of Labor and Administrative Reform
MOOC	Massive Open Online Courses
NCHESR	National Council of Higher Education and Scientific Research
NCR	National Center for Research
NCRD	National Civil Registry Database
NCSRC	National Civil Service Recruitment Commission
NGSEF	National Graduates' Self-Employment Fund

NIC	National Information Center
NSA	National Service Administration
NTC	National Training Center
OLAP	On-Line Analytic Processing
OLTP	On-Line Transaction Processing
OSS	Open Source Software
SBEF	Sudanese Businessmen and Employers Federation
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNDP	United Nations Development Program

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Publications

Izzeldin A. Elhassan and Fanny Klett, "**Bridging Higher Education and Market Dynamics in a Business Intelligence Framework**", IEEE Xplore, IEEE Developments of E-Systems Engineering (DeSE), 2015, 198-203. Link to publication

Izzeldin A. Elhassan, "**Investigating the Success of Business Intelligence in Aligning Higher Education and Labor Market**", International Journal of Computer Trends and Technology (IJCTT), 67.12, 2019, 62-70. Link to publication

CHAPTER ONE

Introduction

1 Introduction

The research subject is introduced by presenting the following queries. What is the objective of HE? Is it to raise the intellectual level of the society? To provide human capital for the marketplace? To delay the youth from entering the job market? To produce scholarly research? Or is it just another wheel that drives the economy? Is HE in itself an end or is it a means to an end?

Numerous studies and empirical evidence have established that HE is a major enabler for economic and social prosperity. They have also shown that HE education is vital for countries' prosperity and economic development (2000; Teal 2011; Bloom, Canning, and Chan 2006; Coombs 1970; PricewaterhouseCoopers 2012). This is true on the personal level, parents sending their kids to study to get better opportunities, and on the national level, too.

Since the introduction of the "HE revolution plan" by the Ministry of HE and Scientific Research (MHESR) (MHESR 2017) in 1990, the number of public universities has grown from six in 1990 to thirty two in 2018. Furthermore, MHESR introduced in the same year legislation to establish private HEIs, and in 2018 there were 54 colleges and 16 private universities (DACVA 2017). Enrollment during the same period grew from about twenty five thousand in 1990 to over half a million today (MHESR 2017) and is still growing. Despite this huge HE expansion, there is meager research on its impact on the economy, society, and on the HE process itself including its alignment with the labor market. As research by (Gudo, Olel, and Oanda 2011; Jegede 2012) has shown, is that one of the main challenges facing HE especially in developing countries, is maintaining the much needed growth while enhancing or preserving quality.

Sudan is categorized by the World Bank as lower-middle-income economy, in 2018 it had a population of 38 million, and annual population growth that averaged around 2.6% during the past decade (AfDB 2014; World-Bank 2015). Further, the country's

population is young, with those below 15 years representing more than 45% of the populous (CBS 2015). Consequently, this growing population will continue to create huge demand for HE and exert tremendous pressure on the employment system. The unemployment rate was 15.2% in 2013 and it is even higher among youth (ILO 2014). Research by (Sanyal and Yacoub 1975) and (Nour 2011) has cited various data from Sudan's Central Bureau of Statistic (CBS 2015) and the Ministry of Labor and Administrative Reform (MLAR), showing that the public sector was and still is the main source of job creation for HE graduates in Sudan (ILO 2014).

On the positive side, Sudan has been doing well in the UNESCO's Key Indicator of HE Gross Enrolment Ratio (GER), as it has been rising steadily from 6.5% in 2000 to 16.9% in 2015 (UNESCO 2018). Another positive outcome of the HE growth, is the big increase in female participation in HE. Enrollment figures from 2010 and until 2020 show that females have been consistently more than males. Despite these huge improvement, the country is still well below the average HE GER of the lower-middle-income economies that was 24.8% in 2018. The new developments in Information and Communication Technology (ICT) and online education could provide economical solutions to the increased demand on HE. These include open or online learning (Elmubark, Cronje, and Osman 2013; Benlamri and Klett 2015) and Massive Open Online Courses (MOOC).

In regards to the issue of HE being an economic driver, research by (Sujitparapitaya, Shirani, and Roldan 2012) shows that the HE services sub-sector is a vital pillar of the US economy. Approximately 8.4% of the US population were enrolled in HEIs during the 2008-09 academic year, while in 2000-2001 over half a million foreign students studied in the USA bringing almost $11.04 billion into the U.S. economy (Salmi 2002). Sudan has great potential to be a HE destination for students from neighboring countries and the region, especially in postgraduate studies. The SUST online Computer Science PhD program is a prime example for this (Butgereit and Osman 2014).

Until the year 1990, HE in Sudan was based on an elitist labor market and almost all HE graduates were guaranteed jobs. Today, there is a big disparity between STEM (*Science, Technology, Engineering and Math*) and medical graduates, on one hand, and social studies, humanities and education graduates, on the other. During the 2011-2012 academic year 68% of the Bachelor degree graduates were of the latter group while STEM and medical graduates accounted for only 30% (MHESR 2017). Moreover, there is little cooperation between the business and academic worlds, and graduates lack of skills and knowledge required for the professional life (Nour 2013; Bloom, Canning, and Chan 2006).

Empirical research and abundant studies have shown that people and their capabilities are the ultimate criteria for assessing the development of a country, not economic growth alone. Consequently, the United Nations Development Program (UNDP) devised the Human Development Index (HDI), which is a composite statistic of life expectancy, education, and per capita income indicators that are used to rank countries into four levels. Sudan is classified among the bottom of developing countries with regards to HDI (UNDP 2014), and despite improvement in its index score, the country has been retreating in country rankings. This highlights the importance of integrating Human Resource (HR) development policies with education and performance (Klett 2010). To fulfill the objectives of the UN Sustainable Development Goals (SDG) set forth in 2015 (UN-SDG 2015), Sudan must pursue innovative measures to enhance effectiveness and efficiency of the workforce, and boost productivity. This research proposes that **BI is one of the right tools to achieve this goal** as it provides a professional discipline and prescribes organizational and technological interventions aimed at providing timely and accurate information to enable improved decision-making.

Regarding to the dilemma of preserving HE quality while maintain growth, research by (Cleary and Van Noy 2014; Gudo, Olel, and Oanda 2011; Stern and Sederburg 2014) has

shown that there are many angles to this issue. The challenges to HE planners and HEIs include maintaining up-to-date curricula that respond to the demands of the new knowledge economy, producing graduates that are well equipped for professional careers, and creating an environment that is conducive to research linked to local needs. Another important topic is building policies to bridge the gap between vocational and academic training as indicated by the joint UNESCO and Sudanese government study (UNEVOC 2011; Coombs 1970; Ibrahim et al. 2014). Research by (Nour 2011) suggested that there is a big mismatch between the educational output and labor market requirements in Sudan and that government's commitment to hire beyond the capacity of the public sector has backfired causing low productivity. Thus, HEIs and policymakers have to take advantage of innovative technological solutions to meet these challenges.

From the preceding discussion and the literature review it is well established that HE is of utmost significance to societies, economies and is a driving engine for development, hence, the answer to all the questions that were used to open the chapter is a big YES.

Sudan and all developing countries must continue to invest in HE for a variety of important reasons, among them:

- HE is a means of economic development and an avenue to eradicate poverty.
- HE could be a vital service sector and one of the economic drivers as was shown in advanced economies.
- To reduce the overall education GER gaps, since HE acts as a pull-factor for the lower education sectors.
- To equip their young and growing population with competencies required to stay connected with the global knowledge economy.

Nevertheless, developing countries should strive to maximize the benefit from their meager resources by channeling expenditure where it matters the most. This effort

could be enhanced by aligning outputs of the costly HE with the economy as research by (Stern and Sederburg 2014; Carnevale, Garcia, and Gulish 2017) (Carnevale, Garcia, and Gulish 2017) has outlined.

This research outcome provides HE policymakers, HEIs, students, employers and all stakeholders with a tool that puts decision-support and planning information at their fingertips. The aim is that with the availability of such reliable information, better knowledge-based decisions will be made that will eventually improve the overall process.

1.1 Background Information

In this section, some background and related information about HE, the labor markets and the whole education-to-employment process in Sudan is presented.

The National Council of Higher Education and Scientific Research (NCHESR 2015) is the governing body of HE in Sudan. It is charged with laying out general policies, guideline and plans including admission policy, study programs approval, performance evaluation of HEIs, etc. It also acts as a liaison between the MHESR and HEIs as all institutions are members while the council is headed by the HE minister.

Admission to all HEIs in Sudan, public, private, academic, and technical is centralized and is controlled by MHESR's Directorate of Admission and Certificates Verification and Accreditation (DACVA 2017). All interested High School (HS) graduates logon to the DACVA's website to designate their admission preferences. They make their list of choices for the HE programs they qualify for out of all HEIs throughout the country. The DACVA system then takes care of matching applicants to HEIs programs based on applicants' score, their application category, their choice and the available seats. This matching system was adopted back in the seventies for the sake of equality and

transparency when there were only very few seats available for the tens of thousands of successful HS candidates. Over the last few years, this process took advantage of ICT advances and its widespread utilization to become fully automated, yet there is very little or no use of the wealth of historical data or any intelligent technologies for analysis, planning and decision support. Obviously, the focus of this research is to utilize this available information for these exact purposes.

The same centralized method applies to all public service employment at the national and regional levels, as most of the government's entry-level and experienced positions are advertised and recruited for by the National Civil Service Recruitment Commission (NCSRC). Similar to the DACVA above, NCSRC's motivation is to provide equal opportunities to all candidates and increase transparency. In addition to NCSRC at the national level, every state has its own employment commission that hires for state level positions. All of these bodies together with NCSRC coordinate their activities technically with the Ministry of Labor and Administrative Reform (MLAR). On the other hand, the ministry also incorporates the National Training Center (NTC) that handles all civil servants needs for training and regulates the few employment agencies that hire for jobs abroad.

The Ministry of Human Resource Development (MHRD) was established in 2010 to respond to the growing concern about the national Human Resource development plans and their link with labor policies. It incorporates the National Graduates' Self-Employment Fund (NGSEF) that used to belong to the Ministry of Welfare and Social Security. The funds' main objective is to offer micro-finance for recent graduates' startup business projects as well as assist in training them in real-life and business management skills. The fund's objective is to assist and equip graduates to create their own business and become self-employed rather than seek employment. In fact, their slogan is "to be employers and not employees".

As for private sector jobs, they are recruited for directly by the hiring organization. There are no structured recruitment or job placement agencies and all is done by personal connections, advertisement in the papers and word-of-mouth.

For jobs and employment abroad, there is the Secretariat of Sudanese Working Abroad (SSWA). It is a governmental organization responsible for registering all Sudanese working abroad and validating their employment contracts. It also provides permits for leaving the country as well as collects expatriate taxes and delivers other services. While MLAR is involved in validating expatriate employment contracts for jobs that come through the official channels, SSWA deals with all expatriates including the ones that acquire their employment abroad personally or through their contacts.

Note that throughout this thesis, the term "HEIs" is used when referring to all post HS education institutions, i.e., universities and colleges. Although in the literature, this term is used interchangeably with the terms "tertiary" or "postsecondary" education institutions, as some believe the latter terms are broader (World-Bank 2019).

1.2 Research Hypothesis

As discussed in the introduction, to intelligently utilize resources and enhance HE and the employability of graduates, ICT and BI methodologies must be utilized as an enabler in the various aspects of HE planning, management and evaluation as well as in the many education-to-employment process's activities including HE admission, career planning along with recruitment planning.

Previous research by (Psacharopoulos and Sanyal 1981) in Zambia, Egypt and the Philippines, as well as a study by the State of Kansas in the United States (Com-Dept-Kansas 2013) has shown that adopting a system based on labor market statistical projections to determine the numbers of graduates needed in each HE discipline does

not provide the "perfect" answer. Inherently, there are many assumptions, limitations, and challenges that arise when using a statistical approach to examine workforce supply and demand, which in some cases could lead to potentially misleading results. As the research by (Psacharopoulos and Sanyal 1981) has identified, it is very difficult to come up with accurate projections especially with the economic uncertainties and the absence of a national work force plan and labor statistics.

On the other hand, BI incorporates much more than just statistical projections, as it provides a much broader perspective with **facts-based** knowledge as well as knowledge derived by utilizing prediction analytics such as Data Mining (DM), machine learning, and other technologies and techniques as will be discussed in detail later in chapter two "Research Scope". Besides, as discussed in the research by (Sanyal and Yacoub 1975), aligning HE with labor markets is not merely a matter of comparing **quantitative** factors such as labor statistics, and HE admission and output. But in addition, it includes an investigation of **qualitative** aspects as well. Such as, expectations and attitudes of students, graduates, employers, the society in general, about the content and structure of HE and the labor market. Correspondingly, all of these characteristics and factors will be explored by the envisioned BI framework.

Furthermore, research by (Amburgey and Yi 2011), that will be covered later in chapter two "Literature Review", has shown that the use of BI methdologies with historical data yielded better results than traditional statistical forecasting in determining the likelihood of academic success of entering students. These techniques enable finding and analyzing past and present trends resulting in **data-driven** informed decisions and interactive solutions.

Based on the above discussion, this research is founded on the **hypothesis** that adopting BI technologies in the education-to-employment process, would yield reliable

decision-support information that lead to better HE, career and recruitment planning and thus improve the process and HE alignment with labor market dynamics.

To support this hypothesis, accomplish the study and achieve its purpose, more information that explains the approach that will be adopted throughout this research is provided in chapter four “Research Strategy”.

1.3 Problem Definition

There are many global pressures on the HE system, research by (Daniel 2015) summarizes the key global trends to include national, global, economic, political, and social changes. These challenges are universal but are more critical in developing countries like Sudan because of the limited resources and growing populations. This study focuses on the education-to-employment process. It contends that there are inadequate and unreliable decision-support resources throughout the process that lead to misalignment of HE and its output with labor market demand.

An argument could be made that employing graduates merely depends on creating enough jobs, but the Sudan 2011 Labor Force Survey (LFS) (MLAR-ILO 2013) has concluded that there are many **additional** significant factors. These factors were categorized by the LFS (MLAR-ILO 2013) into **three** main classes**:**

(1) Issues related to the job market itself;
(2) The lack of a national HR plan and insufficient labor statistics,
(3) Issues with the education system and training offered, and their deficiency in responding to labor market requirement.

The deficit outlined in the third class above, contributes to the continuing mismatch between the HE production system, the actual training that HE students need to get, and jobs’ availability as well as jobs’ requirements. The focus of this research is to

thoroughly examine the existing education-to-employment process and propose a BI framework that would assist in bridging the gap between HE and the labor market.

1.4 Research Questions

In light of the scholarly research about the utilization of BI in HE including admission, student retention, policymaking, etc., this PhD thesis intends to investigate utilizing BI methodologies to exploit and enhance the HE human capital output's correlation with employment market and as such assists in supporting different levels of decision-making, improving HE strategy and economic development.

To streamline the research problem and attempt to fulfill the research objective the following **questions** will drive this research**:**

- How to effectively understand the existing education-to-employment process**?**
- How to improve the current situation**?**
- Do BI technologies offer a good fit that facilitates the research objective**?**
- How to evaluate and validate the proposed solution**?**

By seeking the answer to the above research questions, this thesis will attempt to establish the significance of utilizing BI in aligning HE outputs with the market. The next section describes the research objective.

1.5 Research Objective

Many researchers have investigated the application of BI methodologies to assist in the different aspects of HE management, admission and students' retention and

performance, etc., during the recent years (Amburgey and Yi 2011; Aziz et al. 2014; Daniel 2015; Guster and Brown 2012; Kabakchieva 2015; Luan 2002; Sujitparapitaya, Shirani, and Roldan 2012; Wixom et al. 2014; Hughes and Dobbins 2015). However, little attention —especially in developing countries— was given to **enhancing** the education-to-employment process as a whole and particularly the **alignment** of HE output with labor market demand. This study intends to **fill** this **gap**.

Furthermore, the economic and social need for improving the HE performance and its impact on the HR development and economic growth, together with advances realized in the business realm as a result of using BI techniques have highlighted the importance for such research.

This research's main **objective** is to**:**

> Lay out a Business Intelligence framework that will enhance the alignment of HE and its main output (human capital) in Sudan with labor market (economic) demand by enabling informed data-driven decisions throughout the education-to-employment process while investigating the success and effectiveness of its adoption.

The research's core **objective** is further broken down into these **three sub objectives:**

O1) Explore the current state of the education-to-employment process, its activities and procedures, especially in Sudan, to identify potential knowledge assets, data sources and data that can be utilized as input for the proposed intelligent framework, while investigating environmental factors influencing the proposed BI framework, such as key players, data owners, market potential, and uncertainty, as well as their conceivable effect on the intelligent framework role, interaction, interrelationships among them and with the environment, and possible breakdown.

O2) Develop a BI data model integrating various data from the sources identified in (O1) above while iteratively improving the model and ensuring data quality, anonymity and security.

O3) Establish and apply a qualitative framework for the evaluation of the conceived data model and intelligent framework confirming its process quality and investigating success factors for both, educational and business prospects.

As presented earlier, BI is an emerging field with various applications to be explored and investigated, and HE with its abundance of data and huge societal and economic impacts provides fertile ground for exploiting the BI concept and technologies.

1.6 Research Methodology

In order to achieve the objectives of this research, a **non-experimental** approach is adopted using a **qualitative approach**; structured **interviews** with key personnel to be used during the related literature review, while developing the survey, and after conducting the survey. The objective is to elaborate some of the essential points and to identify main characteristic factors affecting the BI model's adoption and their associated variables. A **mixed model research** approach was used in developing a basic BI implementation model while exploring the main factors affecting its adoption. This was followed by a quantitative approach with the use of questionnaires to further validate the proposed BI framework. In constructing the framework, a thorough review of previous related literature from different disciplines was conducted. This included BI and its adoption in HE, and various issue related to BI, such as approaches, perspectives, frameworks, and methodologies. The review also included HE planning, human resource management, labor market studies, information technology adoption and other related issues. The stakeholders' investigation is based on a **survey**

instrument administered to key stakeholder groups, namely, students, graduate and employers. The survey involved 242 students, 264 recent graduates and 51 employers scattered throughout the country and representing private and public institutions and employers.

Later in chapter four "Research Strategy", a detailed discussion of the methodology adopted to provide answers to each of the research questions outlined in the previous section will be presented, and consequently achieving the research objective.

1.7 Research Significance

This research is significant as it highlights the overwhelming complexity of HE policymaking in general and as it relates to employment in particular. It also provides a "pathway" by which the HE and training systems can be modified to help achieve the goals of a sustainable economic development while maintaining quality. According to the Sudan 2011 LFS (MLAR-ILO 2013), tremendous pressure is being levied on the Sudanese labor market as the number of new entrants continues to rise due to demographic changes.

It is anticipated that the envisioned BI framework will serve the **convergence** of all the data from various systems and formats and the establishment of a central DW. This will facilitate the exploration of trends; provide information for enrolment planning and policy formulation as well as comparing the quality of the different HEIs.

The proposed solution will give HE policymakers, employers as well as students the opportunity to make decisions based on real fact-based knowledge since it provides an easy presentation of all data. For example, it would assist HS students choosing the major, and HE applicants with information about HE programs based on the most employed/unemployed graduates. Also, it would assist HE policymakers with

information on programs that are most/least desirable by students, etc., as well queries about trends over time could be answered.

Furthermore, the conceived framework will allow for discovering non-intuitive relationships, provide rapid feedback regarding actions, and validate or discredit assumptions. It will also support academic quality reviews based on HEIs programs' academic performance data.

The Sudan 2008 Census data (CBS 2015), shows that HE graduates only accounted for 5.3% of the population older than six years of age which is below the lower-middle-income countries average. This fact, alongside with the role of HE as a pull-factor for lower levels of education adds to the significance of the proposed thesis. As discussed earlier Human Development Index (HDI) –not economic growth alone– is a key factor in determining a country's prosperity and this research will eventually assist in improving Sudan's HDI status.

Moreover, this research contributes to the conceptual and theoretical understanding of BI and analytics as well as its utilization and benefits within HE. It also describes the opportunities this growing research area brings to HE alongside with major challenges associated with its exploration and implementation. Also, related concepts are easily transferrable to businesses and environments other than HEI and at the same time, they can be extended to include further aspects of HE, too. In addition, the significance of this research is postulated in the opportunity to advance the research area by publishing in reputable academic journals to make the approaches and results available for the global research and development audience.

1.8 Thesis Structure

In this chapter, an introduction to the research topic was given with background information about HE planning and labor markets globally and in Sudan. An explanation of the main research problem is provided. Then the research hypothesis is presented, followed by the its objective, how it intends to achieve it, and an outline of the expected outcome and significance.

Chapter {2} covers the literature review, and is organized into two main parts, the first focuses on research about HE planning with an investigation of the education-to-employment process internationally and particularly in Sudan. The second includes and labor markets studies, reports and statistics in Sudan. The focus is on the many global attempts at aligning HE with labor demand and their results.

Chapter {3} provides background information about BI and its components, evolution and architecture. This is followed by a thorough review of the research on the many current utilizations of BI in the area of HE. The approach is to provide a better understanding of the research problem and at the same time collect quantitative and qualitative data. The information acquired from the BI literature is summarized at the end of the chapter in the form of a table listing inputs, outputs and BI methodologies utilized.

Chapter {4} starts by highlighting the motivation behind the proposal of BI as the most appropriate methodology to tackle the research problem. Then it discusses the embedded mixed model research approach used towards achieving and evaluating the research goal. Every step of the research tasks is explained in detail with its expected output, including the identification of data sources, stakeholders, and environmental factors classification. Additionally, the framework design and validation are discussed including the two-track approach utilized. Finally, the chapter concludes with a matrix that maps the research tasks to be carried out against their expected output.

Chapter {5} details an in-depth investigation of the education-to-employment process in Sudan. This includes the identification of all activities, procedures, stakeholders, and the analysis of data, its sources, and all environmental factors. Exploratory interviews with key stakeholders are utilized to improve understanding and corroborate findings. The chapter then lays out the proposed solution framework architecture with an exhaustive explanation of the data model and its validation. At the end of the chapter, the design of the survey processes, its target group and intended goals are explained.

Chapter {6} describes the two-pronged approach to validate the BI framework, including the steps taken for model validation, verification and a discussion of outcomes and consequence. It also covers the proof-of-concept implementation of the Admission data mart as well as, the evaluation of open-source BI technologies. The initial validation utilizes analysis of simple reports generated from the sample data loaded into the model. The chapter then ends with providing details about the survey instrument and its processes and lays out a plan for data analysis.

Chapter {7} starts with listing preliminary findings about the survey data. Then it presents a discussion of a selected group of significant results of the statistical analysis of the survey outcomes. SPSS is the statistical tool utilized for the data analysis, and the full analysis of all the three surveys' results is listed in the appendices. The chapter concludes with a summary of the survey analysis findings.

Chapter {8} initially provides a recap of the research objectives, findings and then lists its contribution. The thesis then concludes with a description of the proposed future work and a chapter listing all research References.

The appendices at the end are organized as follows: appendix A lists the three survey questionnaires, that is students, graduates, and employers. This is followed by

appendices B, C, and D that include the complete analysis of the three survey results, in the same order as in the questionnaires. Then appendix E that displays a sample of the SUST student application form, and appendix F that list the three questionnaires in Arabic. Finally, appendix G consists of the research academic publication transcripts.

CHAPTER TWO

Literature Review

2 Literature Review

This research problem is multidisciplinary involving HE planning, Economics, HR policies, labor markets, and BI. Therefore, we have tried to select the most relevant literature in each discipline that would add value to our research objective. In addition, literature on best practices and guidelines used in the BI projects is reviewed.

In this chapter, we examine the theoretical and practical aspects of intelligent technologies, BI and analytics with emphasis on their applications in HE. A thorough review of the literature, especially studies of similar developing countries experiences and lessons learned as well as recommendations for KPIs from international bodies and practices of leading countries.

The following are the **three** main **research areas:**

(1) Research on HE planning, the entire education-to-employment process and the alignment of HE output with economy.

(2) Research, reports and statistics about labor markets and work relations with special focus on Sudan.

(3) Gaps and possible contribution.

2.1 Higher Education Planning

Here we focus on one of the cornerstones of education-to-employment planning, that is, exploring the alignment of HE output with employment and market demands. Does the market drive HE policies? or do HE outputs dictate market demand? Moreover, what is the correlation between HE and economic development? How do we manage

the balance to achieve sustainable development? We study various literature that examine these issues in detail.

Research by (Daniel 2015) presented the key global trends affecting HEIs (Figure 2-1), as it outlines the multitude of pressures that HEIs have to respond to, including national, global, economic, political, and social changes. It also discusses the role that data and information could play in decision-making and responding to these challenges.

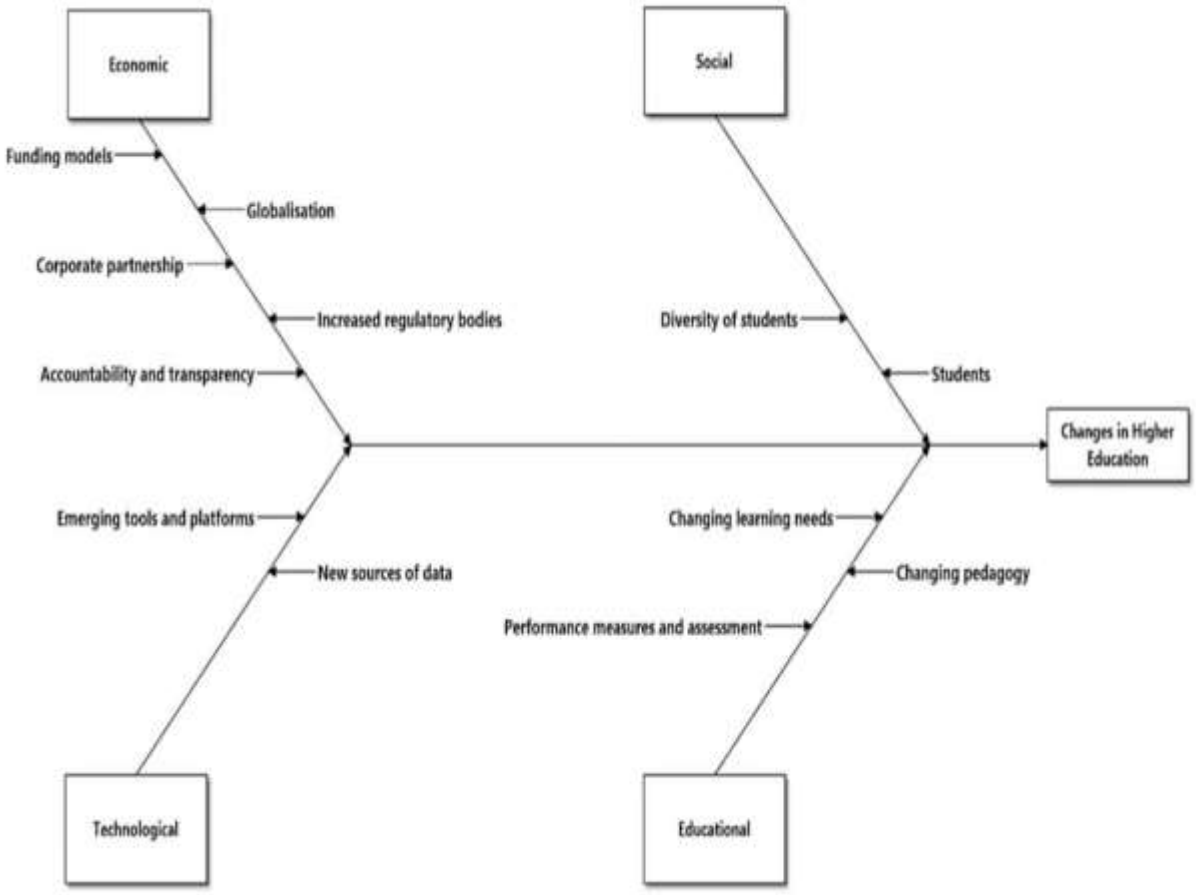

Figure: 2-1 Current Trends Affecting HEIs (Daniel 2015)

Sudan has made significant gains in the HE GER as formerly explained, however the ability to match HE programs of study with job opportunities remains.

Various studies have shown that there is strong linkage between HE and economic prosperity. However, in the current knowledge-economy, graduates are competing globally and brain-drain is a common practice in developing countries including Sudan. Regarding this issue, (Salmi 2002) reported in the World Bank report that the Sub-Saharan Africa countries have an average HE enrollment rate of only 4% –compared with 81% in the USA, yet it is estimated that about 30,000 Africans holding PhDs live outside Africa. In addition, Bulgaria estimates that 65% of all university graduates (almost 300,000) left the country during the nineties (1990 to 2000), while at least 40% of the graduates of the highly regarded Indian Institutes of Technology seek employment abroad. (Salmi 2002) also pointed out that the main reason why tertiary enrollment levels are still relatively low in many parts of the developing world is the lack of institutional differentiation to accommodate the diverse and growing demands.

(Bloom, Canning, and Chan 2006) is one of the many papers that dealt with the issue of HE and economic development. The World Bank supported this study to challenge the long-held belief in the international development community that HE has little role in promoting economic growth. The authors reviewed evidence about the impact that HE can have on economic growth and poverty reduction in Sub-Saharan Africa where enrolment rates for HE, are by far, the lowest in the world. Bloom et al. and other researcher, (Task-Force-HE 2000), (Teal 2011), and (Hanushek and Woessmann 2011) confirmed the finding that one possible channel through which HE can enhance economic development in poor developing countries is through technological catch-up. In a knowledge economy, HE can help economies gain ground on more technologically advanced societies as graduates are likely to be more aware of and better able to use new technologies.

Aligning ICT education with employment, (Abu-Samaha 2007), research presented an industry lead initiative sponsored by the government to align computing programs offered at HEIs in Jordan with local market demands. The researchers studied the ICT

curricula, comparing it with ACM's (Association of Computing Machinery) (Golfarelli, Rizzi, and Cella 2004) and IEEE's (Institute of Electrical and Electronic Engineers) recommendations, and the local IT business needs. They identified the following factors as obstacles to progress; (i) limited interaction between IT industries and HEIs, (ii) limits on the commercialization of research; (iii) absence of specialized institutes in the IT area; and (iv) limited computer resources and awareness in all aspects of the educational system. The survey also pointed to a number of knowledge areas that the current ICT courses lack, including ERP, Online DB, research and critical thinking. This finding is consistent with similar research carried out in the United States (Carnevale and Smith 2011; Choy and Bradburn 2008; Duderstadt 2009) where employers cite critical thinking and problem solving skills as lacking by graduates. Based on their findings, the authors recommended making improvements to ICT curricula, offering incentives to business and college to engage, and forming a body to oversee quality assurance. Further to this study, continuous evaluations and adjustments are needed since ICT education and business are dynamic and fast evolving.

(Shirani and Roldan 2014), proposed utilizing an information technology education *maturity model* to objectively assess the adequacy of ICT education in Pakistan with a view to prepare graduates for jobs within the country and worldwide. Their research is consistent with our intent in this study in the sense that they are investigating the status of HE graduates in the global market place. The authors' study is part of a project to enhance distance learning and ICT education cooperation between the USA and Pakistan. They employed an ICT education maturity model for examining the current state of ICT education in Pakistan in terms of its preparedness to respond to the ICT workforce demand. Maturity models assess a technology or a business process for its "maturity" or level with respect to some benchmark.

The researchers (Shirani and Roldan 2014), utilized an online survey instrument to collect data from ICT graduates in Pakistan, as well as publicly accessible data from

employment websites and international organizations. They cited the ACM categorization of computing education and thus focused on these four disciplines computer science, software engineering, information technology, and information systems. The survey results, viewed in terms of the maturity model framework indicate great potential for expanding ICT education in more specialized and advanced areas of information technology. The researchers compared demand for ICT jobs in Pakistan versus USA, this was done by investigating data from two prominent job sites one per country. As expected, they discovered a staggering difference in demand and claimed this is a good indicator of relative mismatch in the magnitude of the demand between the two economies. The researchers suggested that for ICT graduates to compete globally their academic programs must be accredited by globally trusted accrediting organizations. Moreover, their academic qualification must be complemented with certifications by international leading ICT companies, for example, Cisco, Microsoft, VMware, etc. The researchers proposed that Pakistan and other developing countries could potentially benefit from the new academic business model of open or online learning and MOOCs.

Similar to the (Shirani and Roldan 2014) study, research by (Turner and Lowry 1999) aimed at achieving a better-fit between HE studies and the professional practice of ICT in Australia. They utilized two surveys; one aimed at ITC students and the second at employers of ITC graduates. The two target groups were asked similar questions about what they perceived as important technical knowledge, academic knowledge, and personal attributes sought by employers of entry-level ITC graduates. On comparing results from the two groups, some contrast was found in the views of the two groups on some attributes. Employers place high value on four qualities such as "Accept direction", "Programming language knowledge", "Acquire new skills", and "Work in a team". These are the very qualities that are less valued by the ICT students. In conclusion, the researcher found out that employers want graduates who can accept direction, good team workers, and have the ability to learn new skills on their own.

Other personal attributes, other than knowledge of programming languages, appear to be more important to employers than specific academic skills. On the other hand, students rank management, leadership potential and other business-related subjects as being more important to employers. This disparity in expectations suggests that students need to become more aware of what is realistic for them early in their careers. Employers could assist by providing more part-time and summer opportunities to students. And enabling ITC professionals paid work at HEIs and more cooperation with them.

In a study about the economic impact of HE expansion in Kenya, (Nyangau 2014) studied the correlation with quality. Kenya went through a huge HE expansion by continuously doubling the intake similar to the *HE Revolution* in Sudan that started at the beginning of the nineties. While in another study (Morley 2010) deliberated on the concept of quality in HE in the UK. Both authors argued that quality means different things to different stakeholders; they wondered if it is value for money or is it a measure of perfection. While both agree that HE quality is *fitness for purpose*, each has their definition of HE purpose. (Nyangau 2014) concluded that for a developing country, economic growth and development should be high priority, and thus HE must prepare a well-educated, highly trained workforce to achieve industrialization, modernization and to compete in the global knowledge economy. The author also examined HE status in Kenyan and compared it to the success stories of the emerging economies Brazil, China, Taiwan for lessons learned. A similar comparison is found in the Economist Intelligence Unit's report on HE in Africa (Guerrero 2014) as they presented the status of HE in Ghana in comparison to Korea. Additional success story about Brazil is presented in the plant pathology study given in (Salmi 2002).

(Nour 2013) in her study about education and talent development hypothesize that Sudan needs to upgrade its skills base through policies for enhancing education system, provision of training and knowledge transfer. She argued that this would lead to

enhanced training provision and matching educational output with the needs in the labor market. To substantiate her hypothesis, she utilized the 2010 Census data and a survey of medium and large size industries in the Sudan. The author cited other research studies and showed that educational policies in Sudan suffer from a multitude of factors including insufficient duration of compulsory education, the imbalanced distribution of facilities and the inadequate public expenditures on education as compared to the lower-middle-income economies as recognized by the World Bank. She compared training plans and budgets in the public and private industries surveyed and found some success stories in the private side. The researcher indicated that based on the CBS census and International Labor Organization's (ILO) definition, the majority of economically active Sudanese workers for 2008 and 2010 respectively were *medium* and *low skilled* (86%; 83%) and minority (14%; 12%) were *highly skilled*. The author's findings are substantiated by the 2011 LFS (MLAR-ILO 2013) that reveals one third of the people of working age (15 years old and above) are illiterate, while 37.4% have attained only primary/basic education. This implies that the share of those considered highly-skilled (having attained secondary and tertiary education qualifications) among the working age population is still limited (at less than 30%).

(Nour 2013) concluded that improving the educational systems in Sudan is essential and requires improvement of adequacy, equity and efficiency and particularly HE and technical education. This recommendation is strongly related to the objective of this research as we envisage BI to offer a broad and solid base to achieve the goals outlined of improving quality and efficiency of the workforce.

In the topic of HE expansion and quality, (Gudo, Olel, and Oanda 2011) research the impact of Kenyan public universities doubling of the intake and how to restore quality. The researchers studied and surveyed 502 students and 127 faculties and collected data from prominent public and private universities. They cited that teaching and learning is hampered by lack of lecture rooms, labs, lab equipment, libraries, and above

all qualified staff. The ratio of lecturer to students is well below the international and local acceptable levels. The authors observed that the increased demand led to shift to quantity over quality.

This is ironic, as almost identical circumstances to the ones cited by (Gudo, Olel, and Oanda 2011) in Kenya exist in Sudanese HEIs, as pointed out by (Elmubark, Cronje, and Osman 2013) research on readiness of HE for online study. Recommendation by both researchers included more collaboration between public and private HEIs, enhance staff training, improve physical facilities, increase access to journals, and the rethinking of the students' financial model.

(Carnevale and Smith 2011) analyzed the HE outputs of the Midwestern states of the USA, utilizing census data between 2008-11, data from the US Bureau of Labor Statistics, and regional labor departments and chambers of commerce. Their objective was to forecast educational distributions within occupations by the year 2018. The authors realized that the rapid decline in the demand for less-skilled occupations in agriculture and manufacturing was coupled with a significant rise in fastest-growing occupations in the service industry. The Midwest states' economy was slowly shifting into services economy including healthcare, insurance, high technology and HE service. They noted that between 1973 and 2008, the share of jobs requiring HE degree increased from 28% to 59% and is projected to grow to 63%. They elaborated, not all HE training, however, will result in good jobs that pay living wages. Simultaneously, not all occupations, industries, and degree types are the same. Employment mismatch between available jobs and graduates' skills highlights the fact that colleges need to streamline their programs to emphasize employability. Similar findings were observed in (Nour 2013), (Abu-Samaha 2007), (Wixom et al. 2014), (Psacharopoulos and Sanyal 1981) and (Sanyal and Yacoub 1975). The researchers used a four-step forecasting approach to predict educational distributions within occupations, estimate long-term

employment projections¸ estimate change in the occupational structure, and finally project educational demand until 2018.

The most inspiring outcome of the previously reviewed research by (Carnevale and Smith 2011), that was at the **top of the list of recommendations** is the **need** for **creating an analytical data system** that would assist in decision-making. As they put it "we should not settle for just projecting —we need to build analytical capacity to effectively answer the questions". They proposed a mechanism that connects the college supply engine (transcript data), workforce development (unemployment wage records), and opportunities in real time (current job openings). This is the topic of this thesis.

Youth and specially HE graduates starting their careers continue to face relevant structural employment problems. The long practice of offering unpaid internships as well as the inconsistency between the job market and the skills cultivated during the learning process, still continue to exist. There is consensus among researchers that more cooperation and integration between industry and HEIs is needed, as businesses are not satisfied with the graduates' levels of "real-world" experience, and HEIs are struggling to keep pace with the ever-changing market demands. This was evident in both, top world economies as well as developing countries.

2.2 Labor Market Studies

The structure of the labor force means the professional composition and sectoral distribution of the labor force in addition to educational levels. MLAR and CBS categorize employers as public sector when the public corporation was established in accordance with Corporate Law. On the other hand, private sector corporations are owned solely by individuals or groups, and cooperative and mixed sector are jointly owned by the state and the private sector. The public sector in Sudan is the largest

employer with more 700 thousand employed in the Federal government and around half a million in states' governments (MLAR 2014).

Normally higher levels of education are inversely correlated with unemployment however; in Sudan unemployment is comparatively higher for the highly skilled individuals. The Sudan 2011 LFS (MLAR-ILO 2013) revealed that 44% of the unemployed have HE degree. At the same time, the survey showed that the educational level of the labor force has improved as the percentage of university degree holders increased from 5% in 1990 to 10.8% in 2011. While in the population as a whole, (CBS 2015) shows the number of HEIs graduates increased from 2% in 1992 to 6.6% of the population today.

The Central Bureau of Statistics (CBS 2015) and the 2011 LFS (MLAR-ILO 2013) estimate the labor force in Sudan at around 9.3 million with an annual growth rate of 2.1%. That is, 7.5 million employed and 1.8 million unemployed, out of that 61% never held a job. According to the 2011 LFS (MLAR-ILO 2013), agriculture is the main employment sector with almost 45% of total employment, the service sector including civil service accounts for about 40%, and industry for around 15%. The unemployment rate is 19.3% which makes HE graduates' unemployment twice the general rate. Despite the improvement in enrollment rates over the past years, educational attainment levels at tertiary levels remain low and the country is well below average of the lower-middle-income economies (World-Bank 2015). Nevertheless, the country still needs more HE graduates to participate in its development, but what kind of graduates, and where and how to employ these graduates. These are the kinds of questions that this research aims to help in providing answers for by availing the platform to acquire information.

Three very interesting studies out of the UNESCO's International Institute for Educational Planning (IIEP) (Psacharopoulos and Sanyal 1981) about HE and employment in Sudan, (Sanyal and Yacoub 1975) and (Psacharopoulos and Sanyal

1981). The study by (Sanyal and Yacoub 1975) examined the relationship between HE graduates and employment in the Sudan. While (Psacharopoulos and Sanyal 1981) compared the finding of the first study and against other developing countries; namely, Egypt, Philippines, Tanzania and Zambia. The researchers cited the qualitative and quantitative discrepancy between the output of graduates and the absorptive capacity of the labor market. This was more prevalent in arts related fields of study. The researchers pondered whether HE content and performance would be able to meet changing needs of society. They surveyed 500 students, 376 employed graduates and 51 employers. This was a huge effort sponsored by UNESCO and the Sudan National Center for Research (NCR). The produced research by (Sanyal and Yacoub 1975) established that in addition to the disproportion in ratio between arts-based and science-based students, there is also a disparity between science-based bachelor and sub-professional, technical or vocational degrees, especially in the fields of health and agriculture. Table 2-1 below shows the current MHESR categorization of study programs; Social, Human and Education studies are all considered arts-based while the rest are science-based programs.

Table 2-1 MHESR Study Programs Categorization

Category		Colleges
1	Social Studies	Economics, Business, Law, Commerce, Community Development, etc.
2	Humanities Studies	Arts, Languages, Fine Arts, Music, etc.
3	Education Studies	Education, Sports Education, Teachers' Education, etc.
4	Agriculture Studies	Agriculture, Forestry, Veterinary Medicine, Environmental Studies, Animal Production, etc.
5	Health Studies	Medicine, Dentistry, Pharmacology, Nursing, Medical Labs, X-ray Imaging, Ophthalmic Optics, etc.
6	Science	Science, Earth Science, Mathematical Science, Marine Science, etc.
7	Computer Science & IT	Computer, Info Science, Information Systems, IT, etc.
8	Engineering	Engineering, Engineering Technology, etc.
9	Other	Distance Learning, Tourism, Services, etc.

(Psacharopoulos and Sanyal 1981) argued that one of the reasons of the imbalance between arts and science studies is the **cost**, since HE technical/vocational costs more than that of arts-based studies. Their study revealed that the proportion of arts versus science enrollment in HE in Sudan has dropped from 66% in 1969 down to 53% in 1973. It is remarkable to point out, that in spite of this drop during the seventies, this trend is reversed, and in fact in the year 2010 we noticed it has been steadily rising. It is also worth mentioning that the research by (Psacharopoulos and Sanyal 1981) study did not take into account the thousands of HE students who study abroad, especially in Egypt and eastern Europe. At the time of their study, almost half of the admitted HS graduates used to study abroad due to the limited HE capacity in the country. Today, in the year 2020, the HE environment has changed from the time of the (Psacharopoulos and Sanyal 1981) study, but the need for deep analysis and strategic planning remains the same. This highlights the need and significance of this study as it proposes developing a HE education-to-employment DW that assembles all relevant data in one place for supporting decision-making and planning.

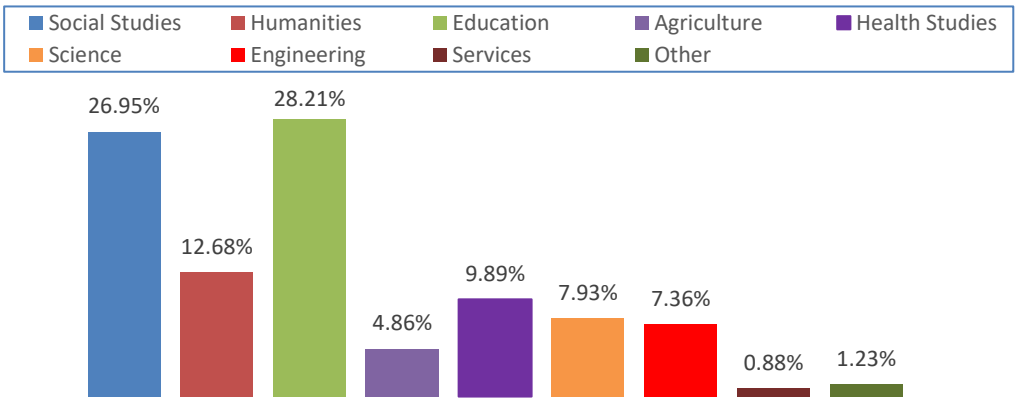

Figure 2-2 2011-2012 Graduates by Discipline (MHESR 2017)

Figure 2-2 above was compiled from MHESR data and it illustrates this fact during the 2011-2012 academic year. It shows that 68% of Bachelor degree graduates were arts-based (MHESR 2017). Therefore, the question is what went wrong! This is what this research aims to provide, that is, a means by which HE planners and policymakers could investigate this and other similar issues.

The (Psacharopoulos and Sanyal 1981) study also showed that most of the HE graduates, 84% in Sudan, worked in public sector in 1974. The researchers reported that the percentage of population with secondary plus educational qualifications in the Philippines was about 14.2% while it was only 0.8% in Sudan. It is logical to assume that this advantage was due to a longstanding government policy. On the contrary, the Philippines government only spent 8% of its national expenditure on education (1.4% of GDP) as a whole while in Sudan it was 14.8% (5.5% of GDP). An even more interesting fact is that the breakdown of this spending was as follows; in the Philippines 2.6% was spent on HE, 8.4% on secondary education and 82.4% on primary education, while in Sudan 17.8% on HE, 22.4% on secondary and 40.1% on primary education.

The study by (Psacharopoulos and Sanyal 1981) has concluded that the main reasons for graduates' unemployment are**;** the slow economic growth rate, the decreasing gross domestic fixed capital, the low level of saving, and the fast rate of graduates' growth –especially in the arts-based fields. They made a list of recommendations **ironically** including **creating an information system** that would **assist** national policymakers, HE administrator, potential employers and students in their **decision-making**. This recommendation in part is what this research intends to achieve, that is, provide a tool that utilizing BI technologies to assist HE policymakers, students, employers, etc., by availing decision-support, planning information and the analysis capabilities.

The earlier research finding by (Wixom et al. 2014) that employers complain about graduates' quality confers with (Fitzgerald 2012) as his paper laments the impact of the Business and HE Forum (BHEF) on aligning HE outputs with industry. BHEF is a collaborative initiative between HEIs and the industry in the USA, and it focuses on finding ways to increase graduates in the STEM fields. The author presented improvements resulting from the introduction of a modelling tool developed by

Raytheon company to assist in decision-making. Although his study focused only on STEM enrollment but similarities to our study could be drawn as the overarching objective is aligning graduates with industry demands.

Nour, S.S.O.M. in her research (Nour 2013) has indicated that Sudan remains a labor exporting country, especially to the Arab oil rich Gulf countries. Notably, the migration of highly skilled labor. This fact might be a positive indicator for HE and the economy as a whole since in a stagnant limited economy like Sudan where more than 50% of labor force work in agriculture, the Gulf States offer graduates and Sudan economy, a huge demanding market. Nevertheless, it is always developing economies that stand to lose from this brain-drain phenomenon.

Continuing with the issue of talent acquisition and retention, (Klett and Wang 2013) in their research argued that governments and business have realized that the "War for Talent" will persist for many decades due to the fact that its roots are deeply anchored in society, including demographic change and policies. The authors claim that governments and business have started realizing that competency and skills development are the most critical issues for the workforce, and the workplaces.

In a related subject, and as discussed earlier UNDP's Human Development Index (HDI) and not economic growth alone, is a key factor in determining a country's prosperity. As illustrated in Figure 2-3 below, human capital formation in Sudan is generally low by regional and international standards. Since the early 1980s, the country has been faring not only below the regional average for other neighboring Arab states, but also below the level categorized as "low human development". This research intends to assist in improving Sudan's HDI status.

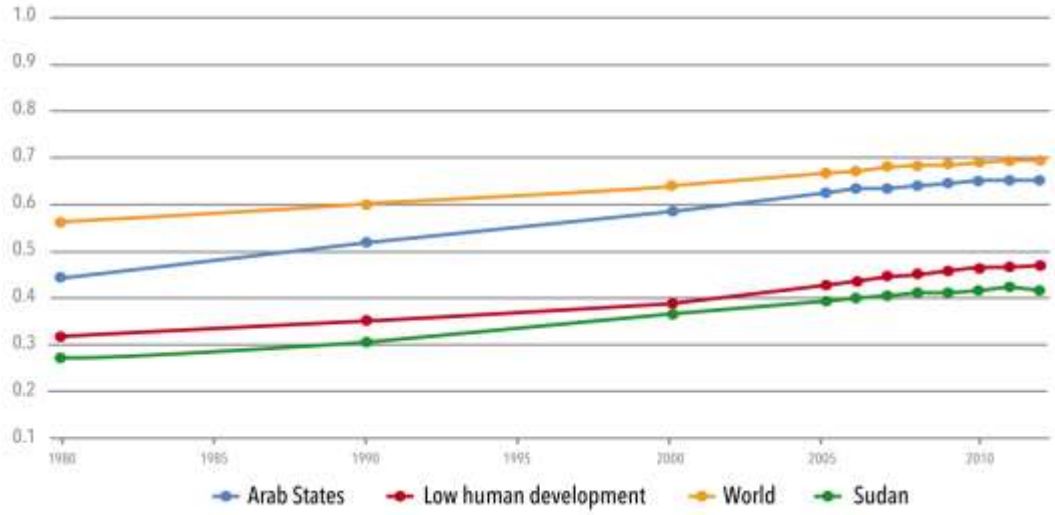

Figure 2-3 Sudan Human Development Report (ILO-UNDP 2014)

An interesting research paper by (Morley 2010) argues that industries and the corporate interests are already playing a more powerful role in determining HE objectives and policies than they should. She claims that with the knowledge economy the emphasis now is more on knowledge management rather than on knowledge acquisition. Furthermore, the author argues against utilization of the concept of "employability" and core-skills of graduates, as they are hollow and misleading. She proposed the concept of "employer-ability" to counter-act the power relation embedded in "employability". Suggesting that employer must learn about social and economic difference of their prospective employees.

2.3 Summary

This chapter covered the review of literature focusing on HE planning and labor markets studies globally and in Sudan. The next chapter explains BI and its components with a description of its evolution and architecture. It also includes a review of relevant BI literature in the area of HE and a summary of the lessons learned.

CHAPTER THREE

Business Intelligence Overview

3 Business Intelligence Overview

In light of the earlier discussion in the introduction, this research argues that ICT and BI are drivers to facilitate the handling of data and to enhance decision-making. But then again, what is BI? and what does it involve? Why should the education-to-employment process adopt it?

BI means different things to different people but generally, it is an umbrella term that combines architectures, tools, databases**,** analytical tools, applications, and methodologies. It represents the ability of an organization to manipulate its own data, and sometimes external data, to produce knowledge and forecasts.

In this chapter an overview of the evolution of BI and its core components and architecture is presented. Additionally, the chapter also covers a review of scholarly research about the adoption of intelligent technologies, especially the use of BI and its different components in the field of HE.

3.1 BI Components

Before a formal definition of BI is introduced, the following **three** related concepts will be described as a starting point, namely, Data Warehouse, On-Line Analytic Processing, and Data Mining. OLAP and DW are technologies or concepts that were introduced and widely used prior to the advent of BI, as will be explained in the following sections. Further, BI Systems are built around the concept of a DW with OLAP and DM, along with other technologies, used to exploit information in order to support making better decisions. (Olszak and Ziemba 2007) expressed that each BI systems component represent tasks used to exploit information in order to perform five actions in decision-

making that include acquiring, searching, gathering, analyzing and delivery of information.

3.1.1 Data Warehouse

A Data Warehouse (DW) is a collection of data from multiple sources, internal to the organization and external, cleansed, transformed, and integrated into a common repository and extended by summarized information for the purpose of analysis. This repository allows enterprises to collect, organize, interpret and leverage the information for decision support (Watson and Wixom 2007).

Furthermore, the DW represents a model of enterprise data, especially structured for facilitating querying and analysis processes on integrated and consolidated data. The main goal of a DW is to enable business users to make effective tactical and strategic decisions based on factual data, by answering business questions timely and accurately.

The following definition is attributed to the father of the term "Data Warehouse" William. H. Inmon (Inmon 2005):

- A DW is a *subject-oriented*, *integrated*, *time-variant*, and *nonvolatile* collection of data in support of management's decision-making process."
  - subject-oriented: organized around major subjects, such as customer, supplier, product, sales, etc.
  - integrated: constructed by integrating multiple heterogeneous sources, such as relational databases. Data cleansing and data integration techniques are applied to ensure consistency in naming conventions, encoding, etc.
  - time-variant: changes to the data in the DW are tracked and recorded so that reports can be produced showing changes over time.

- nonvolatile: data is never overwritten or deleted - once committed, the data is static, read-only, but retained for future reporting.

Having mentioned Inmon's definition of a DW, Ralph Kimball's (Kimball and Ross 2013) definition should be added, as he is credited with creating the concept of "data marts". A data mart is a subset of the DW that is usually focused on a department or a specific subject.

Kimball defined the DW as:

- A copy of transaction data specifically structured for query and analysis.

Obviously, Kimball's is a functional view of a DW as he did not address how the DW is built like Inmon, but instead he concentrated on the functionality (Figure 3-1).

Two integral components or processes of the DW are *metadata repository* and *data preparation*. Metadata is defined as the data dictionary of the DW, describing data content, manner of its use and creating the semantic layer of the organization's informational system. It plays a key role because of the complexity of managing the data throughout its lifecycle. This semantic layer ensures a proper and shared interpretation of the organization's data by all the actors involved. The enterprise's information systems contain various types of metadata, including business, technical, static, dynamic, descriptive, structural and administrative metadata.

Alternatively, data preparation is also called Extraction Transformation and Loading (ETL), and it involves the integration of data from multiple source systems and performing data cleansing where variations in data schemas and data values from disparate transactional systems are resolved, in preparation for their Loading into the DW as a data consistent database. According to (Aziz et al. 2012), data conversion consumes about 70-80% of the time used to build a DW.

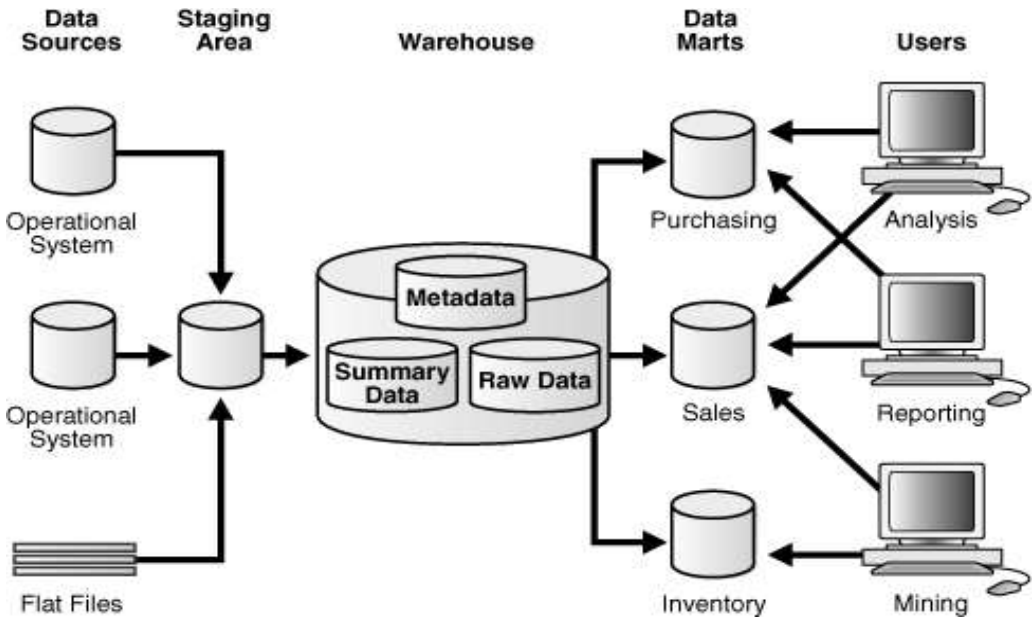

Figure: 3-1 DW Components with Data Marts (Oracle-BI 2003)

To conclude this section, we define a DW as an integral part of BI systems, it is better explained by (March and Hevner 2007) "A DW is a repository of *intelligence* from which Business Intelligence can be derived".

3.1.2 OLAP

OLAP tools enable users to interactively analyze multidimensional data stored in the DW from multiple perspectives. The core of the OLAP technology is the "data cube", which is a multidimensional database model. This model consists of *Dimensions* and *Measures* or *Facts*; Measures are numerical data such as revenue, cost, sales and budget. Those are categorized by Dimensions, which are used to group the data similar to the "group by" operator in relational databases. Typical Dimensions are time, location and product, and they are often organized in hierarchies. A hierarchy is a structure that defines levels of granularity of a dimension and the relationship between those levels. A time dimension can for example have hours as the finest granularity and higher up the hierarchy can contain days, months, quarters and years.

OLAP tools enable users to slice and dice, pivot, sort, filter data to see patterns that help in making better decisions. They process huge amounts of historical data as opposed to the On-Line Transaction Processing (OLTP) systems and tools that focus on operational data. OLAP queries involve aggregation of the data in the fact table.

3.1.3 Data Mining

The term Data Mining was first proposed in the early 1990s, it is the science of applying data analysis and discovery algorithms to automatically and intelligently produce new patterns and relationship from large amounts of data. It utilizes Artificial Intelligence (AI), statistical analysis, and other techniques (Figure 3-2) to discover (mine) new patterns and relationship from data stored in the DW. According to (Romero and Ventura 2007) DM is a step in the overall process of Knowledge Discovery from Database (KDD) that consists of pre-processing, DM and post-processing.

Another definition given by (Luan 2002), is that "DM departs from the well-established, traditional, hypothesis-based statistical techniques. It offers a new type of exploratory and predictive data analysis whose purpose is to delineate systematic relations between variables when there are no a priori expectations".

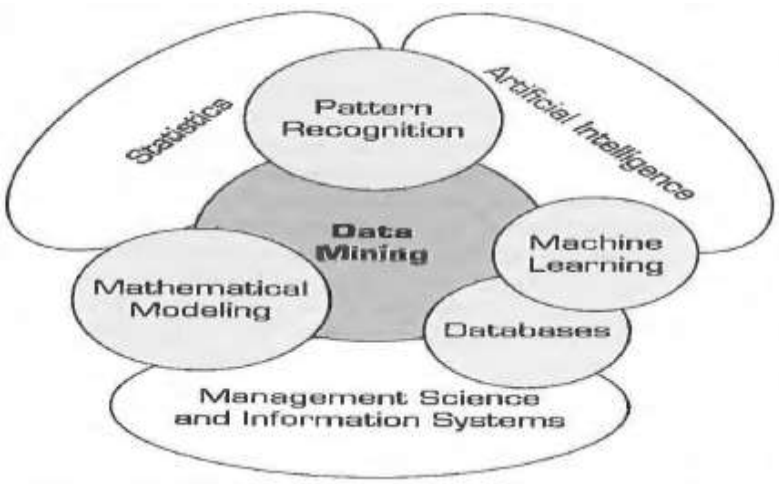

Figure: 3-2 Data Mining as a Blend of Multiple Disciplines (Turban et al. 2010)

Many DM techniques are practiced by various businesses, the most dominant include prediction, classification, association and clustering. DM along with OLAP are essential components of the business analytics phase of the BI system.

3.2 Evolution of BI

BI is a more inclusive concept than DW; the classic definition of BI is that, it is the ability of an organization to take advantage of its processes, systems, data and capabilities to gain competitive advantage. BI systems utilize technologies and processes to collect data, analyze it, and present it to facilitate decision-making (Golfarelli, Rizzi, and Cella 2004). They cover the entire DW environment from data storage to analysis, and include charting tools, DM algorithms, and alerting mechanisms.

The IBM researcher Hans Peter Luhn was the first to use the term "Business Intelligence" (Luhn 1958). He defined intelligence as:

> *"The ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal".*

Another definition used by Wixom et al. (Wixom and Watson 2010) is:

> *"BI is a broad category of technologies, applications, and processes for gathering, storing, accessing, and analyzing data to help its users make better decisions."*

Decision Support Systems (DSS) are defined by (Power, Burstein, and Sharda) as interactive systems intended to help decision makers use communication technologies, data, documents, knowledge, and analytical models to identify and solve problems. They are categorized into:

(1) communications-driven (2) data-driven (3) document-driven

(4) knowledge-driven (5) model-driven

BI systems belong in the data-driven DSS category.

The term BI was popularized by Howard Dresner of the Gartner Group in 1989 (Power 2018) as an umbrella term to describe a set of concepts and methods to improve business decision-making by using fact based computerized systems.

Benefits of BI include creating forecasts based on historical data, past and current performance, running impact analysis, performing ad-hoc data access and "What if" scenarios, and gaining strategic insight. (Golfarelli, Rizzi, and Cella 2004) describe BI as the process that turns data into information and then into knowledge.

Figure 3-3 below shows the various concepts, techniques, tools and processes that contributed to the evolution of the current BI system as described by (Turban et al. 2010).

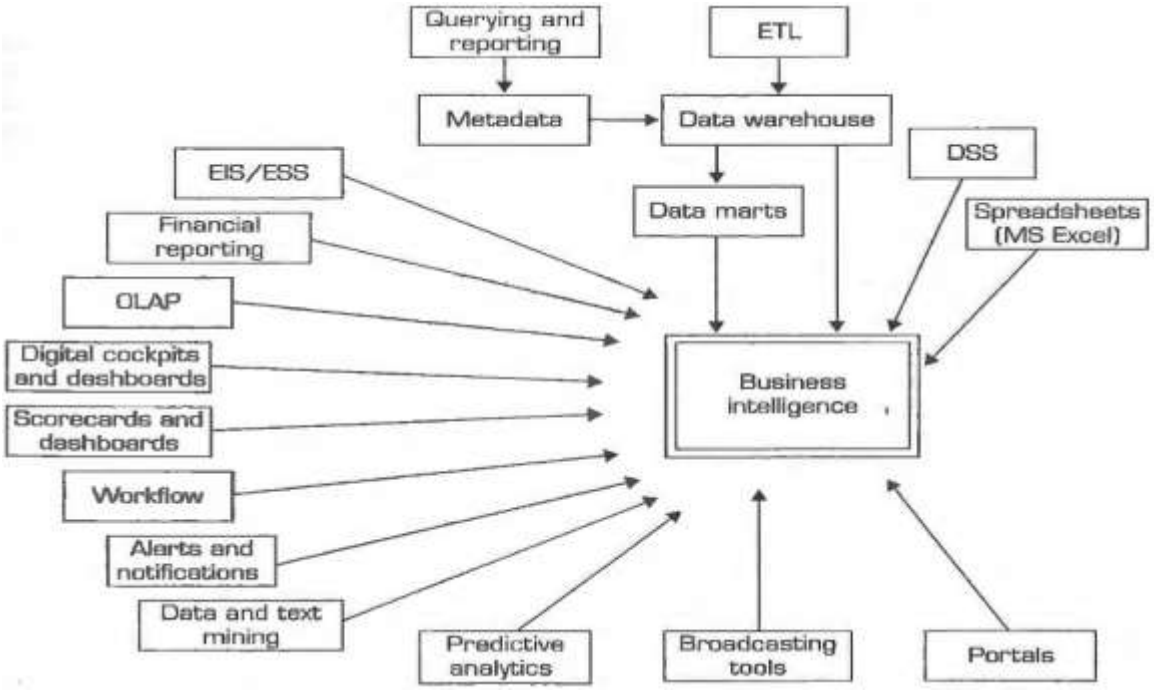

Figure: 3-3 BI Evolution (Turban et al. 2010)

3.3 BI Architecture

From what we have learned so far, we realize that BI systems incorporate and utilize many techniques and concepts to achieve their objective of creating knowledge by

collecting, storing, analyzing and presenting information to enhance decision-making. BI systems deal with both structured and unstructured data simultaneously, and thus its data architecture is business oriented rather than technically oriented (Negash 2004).

(Turban et al. 2010) have identified the following four major components of BI systems:

(1) A D*ata Warehouse,* with its source data.

(2) Business Analytics, a collection of tools and techniques for manipulating, mining, and analyzing the data in the data warehouse. This is categorized into two groups:
    a) Queries including ad-hoc, standard and strategic reporting, OLAP.
    b) Data mining.

(3) Business Performance Management (BPM) for monitoring and analyzing performance. BPM extends the monitoring, measuring, and comparing of Key Performance Indicators (KPIs) by introducing the concept of management and feedback. It includes a set of management and analytic processes to link organizations' performance with goals.

(4) A user interface, e.g., management cockpit, dashboard, balanced scorecard applications, and data visualization.

As illustrated in (Figure 3-4) below, (Rouhani, Asgari, and Mirhosseini 2012) recognized that a good BI system must provide the following capabilities; production reporting, end-user query and reporting, OLAP, dashboard/screen tools, DM tools, and planning and modelling tools.

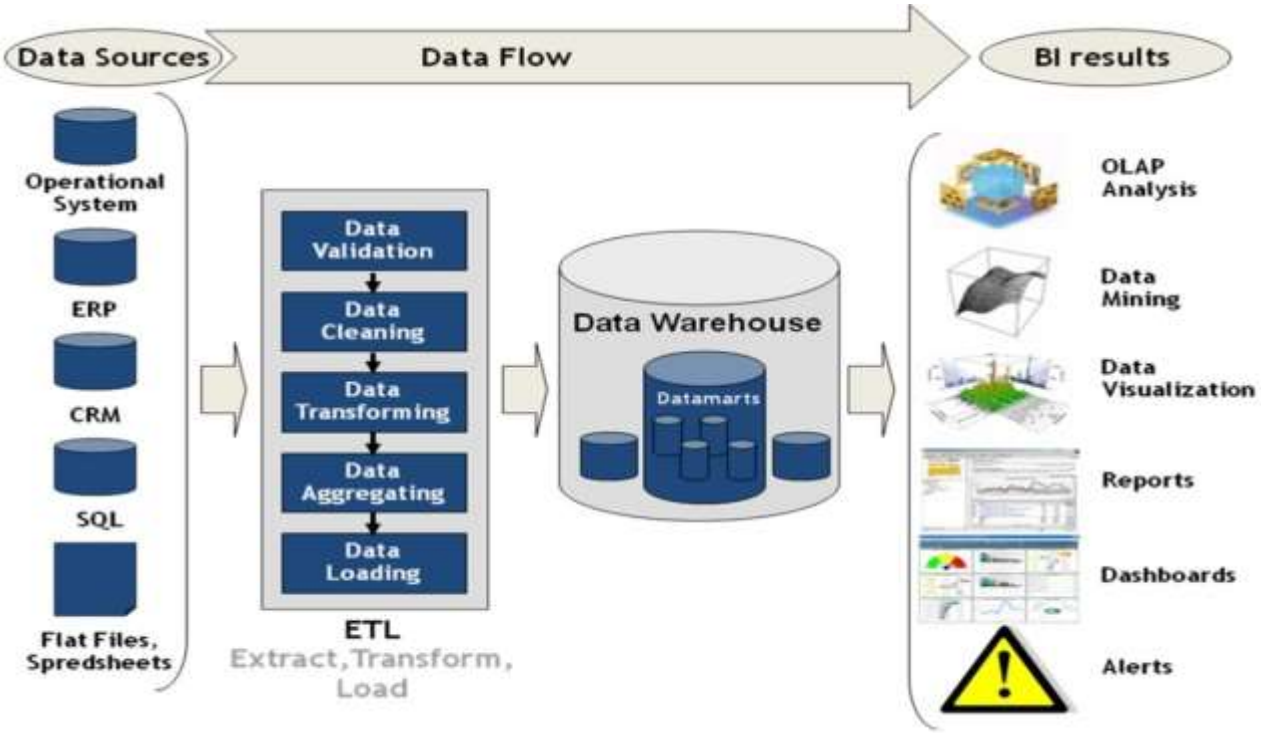

Figure: 3-4 BI Components Architecture (Krmac 2011)

Finally, the Gartner Group forecasts that BI and business analytics will continue to expand in the foreseeable future more rapidly than the overall market. The emerging BI trends include mobile analytics, in-memory analytics, BI embedded in collaboration and social software and cloud-based BI.

From the preceding review of BI, its components, evolution and benefits, it was shown that advanced analytical technologies, including BI systems and DM tools and techniques, provide an outstanding opportunity to make better and informed decisions by utilizing existing reliable data.

Data quality plays a critical role in BI success since poor quality data can hinder business decisions at all levels of the organization. Another challenge for BI systems is the engagement of the human element, as shown by (Guster and Brown 2012).

3.4 BI Research in HE

Many research articles were published in recent years about the various Business Intelligence (BI) utilizations in academia, ranging from predicting students' performance in the UK (Hughes and Dobbins 2015), to admission (Amburgey and Yi 2011) and administration (Sujitparapitaya, Shirani, and Roldan 2012) in the USA, to HE management in South Africa (Mutanga 2015), and student retention in Bulgaria (Kabakchieva 2015). Similarly, several studies exist on BI applications and utilization in business and industry (Chee et al.), and yet there is scanty research on its adoption and application in enhancing the education-to-employment process.

HE is continuously adjusting to the growing demands of operational efficiency while still remaining competitive and relevant for students and researchers alike (Barrett 2010). HE today is a dynamic and complex environment with an increasing competitiveness between HEIs due to globalization and the rapid development of ICT (Kabakchieva 2015). The research article by (Wixom et al. 2014) presented results of a survey on the status of BI in HE and how HEIs responded to the rising market demand for students with BI and analytics skills. Their study encompassed all angels from employers, professors, and students' perspectives. It had a base of 319 professors from 257 universities in 43 countries around the world. At first, the authors noticed a big increase in BI study programs offered by HEIs, both in their depth and number. In spite of this rise, their survey showed that businesses are still not satisfied with graduates' level of practical real-world knowledge. Challenges mentioned included: access to data sets, finding a suitable textbook, finding appropriate cases and providing realistic experiences. The authors concluded with a list of recommendations highlighting the importance of the close cooperation between academia and the industry. They listed objectives for the two sides, ranging from curricula development, enhancing business cases' studies, and developing work internships. Their findings highlight the significance of this research in bridging the gap between HEIs output and the labor market.

Reseach by (Amburgey and Yi 2011) focused on the use of BI in HE admission. The authors noted that in the past decade there has been an effort by HEIs to utilize historical enrollment data to develop predictive analytics. The driver behind this was the fact that HEIs now have to compete to attract students and retain the ones they have. The authors proposed a predictive model to assist undergraduate admissions officers in determining the likelihood of academic success for entering first-year students. They analyzed data from first-year enrolling students at a private, master's-level institution in the USA. The motivation was that admissions offices were noticing an increase in the percentage of applicants falling into the *marginal* category –those who are not definite "admits" or definite "denials". The authors conducted three types of analysis; decision tree, neural network, and multiple regression, and compared their results in predicting each student's Grade Point Average (GPA). The basis for measuring the overall performance for the model was the Average Square Error (ASE) of the validation population. In addition, numerous geodemographic variables were analyzed to develop the models to predict the target variable. They collected data for 3,000 admitted students from various sources including, the common application, the university application, the college board, and the Free Application for Federal Student Aid (FAFSA). Comparing results of the three models showed that the neural network model yielded the lowest ASE value, followed by the decision tree model, and lastly the multiple regression model.

The study by (Amburgey and Yi 2011) cofirmed the researchers' hypothesis that use of a DM approach to predictive modeling yielded better results than use of traditional statistical forecasting tools. Thier conclusion is in complete agreement with this reseach's hypothsis that BI utilization would imrove aligning HE and its output with labor market demand by yielding better results that would guide HE policices. The Amburgey et al study's methodology only focused on enrolling first-year students over a three-year period. However, the authors recommended extending the model to

include students' data for more than three years and to predict expected GPA beyond the first year.

(Hughes and Dobbins 2015) realized that only 7.5% of Massive Open Online Courses (MOOC) enrolled students end up completing their study programs. This combined with the enormity of data generated online by students and their physical locations provided motivation for the authors to utilize data analysis to predict student perfromance. They hypothesized that data analytic techniques can be used to study student engagement with their course in order to identify and predict trends about a student's performance. Their work has attempted to illustrate how an ETL approach is able to "fill in the blanks" that often occur within big datasets by normalizing the data into a consistent series so that the end result can be transformed into a dashboard of statistics shown to students as a motivation tool. They modified their university's eRegister attendance management system for the purposes of the study.

The results of Hughes et al indicate that high/active engagement, interaction and attendance is reflective of higher marks. Additonally, their approach to normalize the data into a consistent series so that the end result can be transformed into a dashboard of statistics that can be used by organizers of the MOOC.

The research's case study findings and the related concepts are easily transferrable to a MOOC environment, where attendance can relate to engagement with lecture videos and assignments, as opposed to physically attending a lecture. They concluded that data analytics are of utmost importance to e-learning in general and MOOC in particular. Future work would consider implementing a version of the eRegister system within a MOOC environment in order to monitor its effect on retention.

One of the obstacles that face the implemention of BI systems in HEIs is cost. (Aziz et al. 2012) presented the concept of Educational BI (EduBI) and examined the design and

implementation of Open Source Software (OSS) ETL tools in heterogeneous databases integration. OSS tools are usually free of charge, and their creators allow access, modification, and redistribution the software and its code. The researchers proposed fitting OSS technologies into DW architecture to bring the cost barrier down. Based on prior research recommendation about OSS tools for BI, the authors chose Talend Open Studio (TOS). Their research application was on the data preparation stage in the building of the DW. They integrated student data from an Oracle and MySQL databases with data from a Microsoft Excel spreadsheet using TOS. In their simulation, all data from these heterogeneous sources was extracted to a respective DW tables in the target database.

The lesson from this research is that OSS tools in general are as good as commercial ones and they provide a good alternative to bring down the cost of DW implementations. Nevertheless, it would be more comprehensive if their study were extended to include business analytics, visualization and other parts of the BI framework and with real life cases.

Bulgaria, unlike the *massification* of HE in Sudan, is facing quite the opposite, the problem of not finding enough students for available seats. Furthermore, specifically regarding competitiveness and BI, (Kabakchieva 2015) argues for HEIs to stay competitive they must analyze the available data to thoroughly understand their organization's students, administrative staff, and class, etc. (Kabakchieva 2015) had two parts to her study, first, she investigated BI utilization at many HEIs in the USA, UK, Sweden, and Australia. She discovered that most of the BI initiatives focused in three main areas; (1) supporting administrative and management activities, (2) academic issues and (3) university relations. Her most important finding –which all the investigated HEIs unanimously agreed upon, is that integration of data from the various sources when building the DW achieved the so called "*single source of truth*" that resulted in improved, prompt and proactive decision-making. In the second part of the

research, the author demonstrated how BI could be utilized to predict students' academic performance by using the *QlikView* BI software suite. She loaded students' performance and characteristic data for a period of two academic years and created KPIs for her analysis. Despite having a limited sample, her research showed that BI highlights hidden patterns of students learning characteristics and specific educational needs leading to better-informed interventions and decisions. She discerned that adopting advanced analytical technologies, e.g., BI and data mining technologies provides various possibilities for extracting useful information to enhance decision-making and improve organizational efficiency.

A similar BI application in HE like (Kabakchieva 2015) above, for creating a comprehensive analysis of student characteristics was carried out by (Luan 2002) as he examined the likelihood of students in community college in the USA transferring to university. The author listed and categorized tools based on the DM task they perform; namely; *classification*, *estimation*, *segmentation*, and *description*. He claimed that most of the processes involved in DM are explainable by mathematics and statistics, and then he laid out an interesting correlation between DM models and algorithms, statistics, and DW based on OLAP. His study called for creating a data exchange consortium between the college in question and its surrounding universities. The purpose was to build a longitudinal DW of the transferred students' relevant data. The author followed the guidelines of the Cross Industry Standard Process for DM (CRISP-DM) and he recognized that the investigator must have adequate skills in feature extraction, where more than 65 percent of the time can be spent on getting the features and attributes correctly presented and primed for mining purposes. The author chose *Clementine*, a software by IBM's SPSS, as the DM software tool while using Neural Networks' (NN) unsupervised (Kohonen nets); and two supervised C5.0 and C&RT rule induction algorithms to compare models and to complement the scoring. NN model produced decent and balanced accuracy but not as good when compared to the C&RT model. C5.0 provided the highest accuracy for predicting

students who had transferred, but it was far less accurate in predicting non-transferred. Overall, C&RT appeared to be the best model to use. The author recommended three strategies for DM; first, verifying results by classical statistics such as linear regression and logistic regression, second is to use factor analysis and principle component analysis to weed out nonsignificant variables or variables that are highly correlated with each other, and third, is to consider clustering and segmentation analysis using Two-step, K-means, or Kohonen even though the target fields are known. The research outcomes would enable HEIs better allocate resources and staff, proactively manage student outcomes, provide targeted marketing materials to prospective students, and improve the effectiveness of alumni development.

Research findings from the above two studies demonstrate that BI systems provide limitless possibilities for use thorough analysis of available HEIs data, ensuring more effective and efficient performance, better management and informed decisions.

The use of DM in education was surveyed from 1995 to 2005 by (Romero and Ventura 2007). The authors reviewed the application of DM to traditional educational systems, and web-based education, which they categorized in three groups; particular web-based courses, the well-known Learning Content Management Systems (LCMS), and Adaptive and Intelligent Web-Based Educational Systems (AIWBES). They underlined the differences and similarities between DM in conventional classrooms, e-commerce and e-learning. The researchers claimed that commercial DM tools are not suitable for pedagogical purposes; they are cumbersome and require extensive knowledge. As a result, they claim that a number of educational DM, statistical and visualization tools that are specific to education were developed. The authors listed and classified the research completed during their study period based on the particular DM task applied to the previously listed educational system groups. They concluded that DM in education is different from commerce, essentially in the need to take into account pedagogical aspects of the learner and the system. The authors recommended that

educational DM methods must be standardized, tools be integrated into the e-learning environment as another author tool, and specific mining techniques be developed. Education specific mining techniques can help improve the instructional design and pedagogical decisions.

(Zilli 2014) presented the concept of a self-service BI system for HE management. Self-service BI, as the name implies, is defined as end users designing and deploying their own reports with little or no IT or BI team support. The author argued that efficiency of the study or learning process could be measured by the student graduation rate, which is an important KPI for all HEIs as employable graduates are their most important goal. Another important KPI is undergraduate retention rate as it affects the graduation rate. The author's research presented the results of a case study of implementing a BI solution at a HEI. Several KPI's and measurements were employed to track intermediate results of study process, and Microsoft's "Power BI for Office 365" BI environment was used to share, collaborate, and access data and reports from anywhere. The created multidimensional model was organized into perspectives that correspond approximately with KPI's. The authors claim that their research is not extendable to other HEIs as there are other factors like funding, regulations, etc., that influence the management of HEIs. While the concept of self-service BI is appealing, the study did not strongly elaborate on its findings and left most of the work for future research.

In the issue of BI adoption by HEIs, research by (Sujitparapitaya, Shirani, and Roldan 2012) collected and analyzed data from 243 institutions. Their goal was to examine technology, organizational, and environmental factors that influence adoption of BI in private and public HEIs. The researchers drew from earlier study on organizational adoption of IT in general. They cited the main reasons why organizations adopt innovative technologies is that they provide support in accomplishing organizational objectives. They developed a survey instrument adapted from published literature on

organizational innovation adoption. Ten study-variable were used to solicit feedback, namely, organization structure, institution size, absorptive capacity, organizational legitimacy, stakeholder support, perceived costs, perceived complexity, executive support, competitive advantage, and perceived benefits. Respondents were asked to indicate their level of agreement with statements on some of the independent variables on a Likert scale; other variables were measured using multiple choice and open-ended question. The majority of responses (75%) came from 4-year institutions, and 25% came from 2-year institutions while 56% of the respondents were BI adopters. The most surprising finding contradicted authors' assumption that private institutions are leaders in adopting new technologies, since the survey found out that public HEIs are more likely to adopt BI than private. Furthermore, the research showed that the perceived complexity of BI applications was not a deterrent to its implementation in HEIs.

Research article by (Guster and Brown 2012), presented a case study of implementing a BI system to a public university to improve its decision-making process. The authors pointed out that, due to the lack of data integration at HEIs and the sparse sources of raw data that it is useless for decision-making. They also claim that cost is a great entry barrier for HEIs implementation of BI. The researchers proposed utilizing common IT planning concepts such as: top down design, definition of data governance, Service Level Agreement (SLA), data dictionary requirements, DW, etc., to reach a BI solution. They adopted the agile approach –rather than waterfall, in building the DW as they claim it provides improved quality, reduced risk, and responsive changes. The authors outlined the many challenges facing BI implementations at HEIs including the misunderstanding of the concept of BI and what they are intended to serve, data governance and security issues, gathering sparse data and selecting the right BI tools. While initially committed to the Inmon approach, they later changed to the Kimball mini-mart approach due to the many interrelationships within the data and organizational politics. They cited many political and control issues, including lack of

control in data extraction, business definitions, operational source data errors, disparate data source integration and politics that prevent data related decisions from being made. Nevertheless, the authors claim that they were able to create a successful BI system structure but the limitations prevented it from reaching its full potential. The outcome of their study supports the hypothesis that BI systems can support the better management of HEIs. However, (Green, Rutherford, and Turner 2009) argue that while it is true that BI may be adopted in HEIs, similarly to business environments, there is no unified approach on how to do it. Considering it takes a lot of planning to implement BI in small and medium sized businesses, they claim that it is fair to argue that it is also difficult applying BI to public HEIs. Successfully implementing BI in HEIs can also be problematic considering political factors such as the matter of who the owner of the data is and how the data should be protected (Guster and Brown 2012).

(Dell'Aquila et al. 2008) investigated developing a BI systems to support decision-making and analytical activities at an Italian university. They summarized the most important aspects of university management as:

(1) offering a better quality of education;

(2) managing employees and human resources;

(3) managing finances;

(4) avoiding wastes.

To build the DW the authors chose to adopt the Kimball approach of building data marts and have developed four; namely, Didactics, Finance, Research, and HR. They utilized OLAP and DM methods and techniques in students' enrollment data. Their system generated many reports as for example the name of the faculty whose students pass the examinations with highest score, the number of graduate students in each college in a specific period of time. The author's objective was to present indicators about the quality level of the teaching process at the university. However, they didn't elaborate on the specific DM techniques and OLAP tools utilized. Their system was

designed for their university but keeping in mind that it might be extended to the national level.

The scholarly articles reviewed indicate that BI, and data analytics is a new field that is rapidly gaining a foothold in businesses as well as academia and HE in particular. They have an important role to play in various aspects of the HE processes, including administration, enrollment, student behavior, strategic and short-term planning, etc.

3.5 BI Technologies Summary

In the preceding sections, we have seen that BI technologies and methods have been successfully used within HE in many facets. For example, DM and analytics have been used to analyze student data, guide course redesign and for admission assessment as well as to encourage new communication models between instructors and student learning. Researchers have investigated how analytics and DM can shape the effectiveness of teaching and learning.

The following table provides a summary of data inputs and output of BI methods in HE literature reviewed.

Table 3-1 Summary of Input Data, BI Technology and Output in the Literature

Paper	Purpose	Input Data	BI Method and Output
(Amburgey and Yi 2011)	Admission: Determine the likelihood of academic success for entering students.	Admitted students' data from various sources including: The common application, the university application, the college board, and the Free Application for Federal Student Aid (FAFSA).	• Predicted potential applicants' GPA. • Compared DM techniques decision tree and neural networks against multiple regression analysis. • DM approach yielded better results than traditional statistical forecasting. Targeted marketing.
(Aziz et al. 2012)	Integrate heterogeneous DBs using OSS ETL tool to build Edu DW.	Dummy data for simulation from two DBMS; Oracle and MYSQL, integrated with a Microsoft Excel spreadsheet. In MYSQL, a table r2is, stores records of students' results with info like student names & gender. In Oracle, a table stuinfo, stores students' personal info, e.g., address, state and parent incomes. Excel file contains student assessment marks for the semester.	○ Oracle DB & Talend Open Studio (TOS) ○ Designed a multidimensional table that consists of fact and dimension tables. Aim is to perform analysis on student result based on ongoing assessments and demographic analysis using BI tools. ○ Fact table in target DB fctStu contains students' results, specifically programming subjects. Two-dimension tables are connected to fctStu; dimPro with student personal info, e.g. name, gender & geographic info. While dimAsses contains detailed assessment results of particulars subject.
(Hughes and Dobbins 2015)	Predict student performance in MOOCs	7 years' worth of data from the eRegister attendance monitoring system direct entry, RFID scan, post Windows login, etc., through DB, XML and text. As well as personal details, e.g., name, age, gender, and past qualifications.	• Built eRegister DW. • MS SQL server, ETL, OLTP and OLAP. • DM including machine learning and social media analytics.

			• Data Visualization reports that describe course, module, or student attendance.
(Kabakchieva 2015)	Predict students' academic performance.	Student details, including gender, age, etc., and results in the course exercises combined with attendance data for three academic years.	○ QlikView BI software suite. ○ Graphical KPI display. Trend discovery. OLAP. Monitor & control to tackle issues early. ○ 2/3 of students achieve high results & only 5% fail ➔ Delivered material is well accepted by students and the provided support is efficient. ○ Class participation enhances students' chances of passing. Average student absence is acceptable. Females score better than males.
(Luan 2002)	Predict community college students' probability of transfer to four-year institutions by creating a comprehensive analysis of student characteristics.	An existing DW formed by a number of institutions for historical data; includes transferred students and all their course information. Combined with current planning DW including HS GPA, SAT, Fin Aid, Major selected. 32 thousand records in total. This is a list of the data fields selected: • Demographics: age, gender, ethnicity, HS, zip codes, planned employment hours, education status at initial enrollment. • Financial aid. • Transfer status. • Total transfer, vocational, basic skills, science, and liberal arts courses taken. • Total units earned & GPA by course type.	• Built a DW of the transferred students' relevant data. • Clementine DM tool by SPSS. • Compared output of DM with Neural Networks (NN) and two rule induction algorithms, C5.0 and C&RT. • The NN model resulted in an accuracy of 76.5% • C5.0 rule induction model was used to list the rules uncovered. • C&RT node was used to generate a decision tree. Result showed that DM with C&RT appeared to be the best model. C5.0 provided the highest accuracy for predicting students who had transferred, but it was far less accurate in predicting non-transferred students.
(Romero and Ventura 2007)	Survey of DM in HE between 1995 to 2005	Review of DM use in traditional and web-based educational systems. Possible data sources: Student attendance, course information, curriculum goals, and individualized plan data. Traditional databases with students', educators', class and schedule info, etc., Online info, e.g., online web pages and course content pages, multimedia databases, etc.	○ A number of educational DM techniques, including statistics and visualization; clustering, classification and outlier detection; association rule mining and pattern mining; and text mining. ○ Possible target group: ▪ Educators and academics in charge of designing, planning, building maintaining the educational systems. ▪ Students. ○ Objectives include student retention, monitoring, recruitment, HEI and research management.
(Zilli 2014)	Self-service BI system to manage HEIs and enhance the efficiency of the study process.	Unspecified academic information systems. Students and faculty info. Focus on these KPIs: Enrollment, Exam Performance Rate, Retention Rate, and Faculty's Academic Workload.	• Power BI for MS Office 365. • MS Excel with DM Add-in. • Several KPI's and measurements were employed. • Data analysis & visualization. • Dimensional modelling was done within Excel PowerPivot modelling tool.

(Sujitparapitaya, Shirani, and Roldan 2012)	BI Adoption in HE Administration	Data from 243 institutions, ten variables in technology, organizational, and environmental dimensions were examined	○ BI technologies enable: ▪ Data integration from internal and external sources. ▪ Comply with regulatory reporting requirements. ▪ Help standardize attributes and terminology. ▪ Provide end user analysis and reporting tools. ○ Findings: ▪ Public HEIs are less likely to adopt BI than private one. ▪ Perceived BI complexity encourages its adoption rather than deter it.
(Guster and Brown 2012)	BI Application to a Public University: Technical and Managerial Perspectives	95% of data is coming from the centralized ODS and the remaining 5% from local department sources, e.g., spreadsheets and online data entry forms, etc. This includes student, faculty and financial data.	• Microsoft Performance Point Server BI tools including: ▪ MS SQL server cluster. ▪ Microsoft Report Builder to generate reports. • Strategy map Dashboard. • Drilldown and export reports.
(Dell'Aquila et al. 2008)		Six transactional DBs, namely: 1) Secretary Services for Students (ESSE3) DB that supports didactic curricula, admin processes & services to students. 2) NOGE a legacy DB that contains residual historical data about students enrolled before introducing ESSE3. 3) Athenaeum Integrated Accounting (CIA) financial mgmt system that views the university as a business. 4) Careers & Wages of Athenaeum (CSA) takes care of the legal and economic management of the university personnel. 5) SAPERI is the DB of the scientific research competence of the University. It includes publications & patents of researchers. 6) SINBAD for the management of the athenaeum research projects.	○ Data marts that represent the departmental databases: ▪ Didactics, Finance, Research & HR ○ Stakeholders: ▪ Academic Supervisory Staff, Organizational Structures, Admin Structures, MIUR, & CRUI ○ OLAP and DM methods and techniques in students' enrollment data. ○ Their objective was to present indicators about the quality level of the teaching process at the university.

Source: Own research

In the next chapter, a discussion of the research strategy and methodology used to achieve the stated goal is given. The aim is to identify the information needed to build this model, gather it, verify it, design, and then evaluate the model.

CHAPTER FOUR

Research Strategy

4 Research Strategy

The previous chapter, defined BI and its key components and outlined the scope of this research. Here, we detail the approach and steps taken towards realizing and evaluating the research objective outlined earlier.

Before delving into the research methodology, the next section provides an explanation for the reasons behind adopting BI for enhancing the education-to-employment process, and why it provides a best-fit.

4.1 Why BI?

It is evident that all stakeholders of the education-to-employment process realize the importance of ICT and the vital role it plays in streamlining operations, retrieving information and achieving organizational goals. They extensively utilize computer systems, applications and networks to collect their own data. Thus, the common challenge is consolidating this separately accumulated huge amounts of data in such a way that enables extracting objective, reliable and actionable information in support of the overall education-to-employment process and for their mutual benefit.

BI integrates this dispersed data into a central DW enabling interactive and easy access, and thus facilitating data manipulation, analysis, visualization, and taking action. Research by (Rouhani, Asgari, and Mirhosseini 2012), indicated that data can be a valuable resource for extracting knowledge and making important managerial decisions in different business scopes.

The concept of BI focuses on creating knowledge by collecting, storing and analyzing information to enhance decision-making (Golfarelli, Rizzi, and Cella 2004), and as such seems as a **viable approach** for this **research objective**. Additionally, motivation to adopt ICT in general and BI in particular, as shown by (Sujitparapitaya, Shirani, and Roldan 2012; Wieder and Ossimitz 2015), stems from that fact that they facilitate achieving organizational objectives and improve the quality of the decision making process.

In Sudan, it seems that there is no correlation between the data about students and graduates at the MHESR and the employment and labor data at the MLAR and other involved organizations. By integrating this data, BI offers the opportunity to enable intelligent analysis, reports and investigation of trends and patterns to make better forecasts, decisions and performance evaluation, not only for the research objective but also for many other aspects in HE planning and HEIs as a whole.

4.2 Methodology

To achieve the goal, this study utilizes an **embedded mixed model research approach** to simultaneously provide a better understanding of the research problem and at the same time collect quantitative and qualitative data. In embedded design, a secondary form of data is used to augment or provide additional sources of information that has not been provided by the primary source (Creswell 2012). Content analysis is the process of identifying, coding, and categorizing the primary patterns in the data. As seen in Figure 4-1 below, feedback collected through **exploratory interviews** with key stakeholders and **content analysis** output from later processes is reused as input for earlier ones. This iterative process of validation and enhancement improves the overall solution.

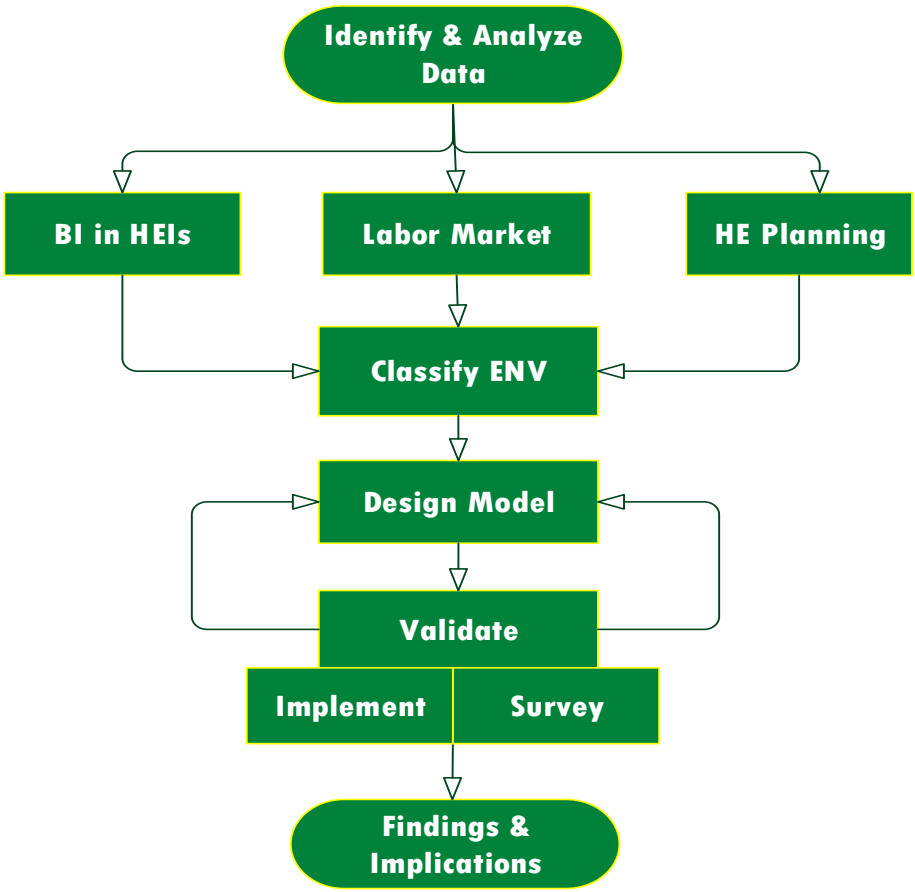

Figure: 4-1 Research Process Outline

A qualitative survey instrument will be utilized to collect primary data for validation as will be explained in detail later. Secondary data will be collected through the study of BI use during the literature review and the data analysis toward refining the research objective and developing a preliminary version of the proposed model. Subsequently, the path will be laid out to validate the proposed model.

Figure 4-1 shows an outline of the research process. It initiates an extensive exploration of literature pertaining to BI in general, HE planning and labor markets for the purpose of collecting data to sharpen and refine the objectives. This includes, exploring the existing processes, data, and data sources in Sudan, while recognizing key players and factors that are involved in the whole education-to-employment human capital

management lifecycle. As well, collecting feedback and initial evaluation of stakeholders and their interaction and expectations will be conducted.
Based on the identified information from the different sources, and the preliminary feedback, a BI data model will be proposed with a strategy to combine data for building a DW along with formative assessment at each development stage. Iterative validation and enhancements of the model will be carried out combined with a proof-of-concept implementation that will be loaded with collected assessment data.

To gain a greater understanding of the dynamics of the envisioned framework, we gauge the attitude and expectations of three crucial groups of participants in this process; namely, students, graduates and employers. Investigating these qualitative aspects substantiates the research objective as these three groups are essential stakeholders and play a pivotal role in the success or failure of the proposed framework. Moreover, as explained in the "Research Hypothesis" section of chapter one, aligning HE with labor markets involves qualitative as well quantitative aspects.

The process to realize the research objectives is categorized into the following FIVE main tasks. These tasks are not presented in a chronological order and are not meant to be performed sequentially; rather, they are grouped based on their relevance and method.

4.2.1 Identify and Analyze Data

The analytical research methodology as described by (Neville 2014), serves to identify factors that play a role in HE and employment practices in Sudan. The specific objective in this task is to locate data sources and as much quantitative historical and up-to-date data as possible, such as statistical sources, annual reports, etc. To address the research questions, primary and secondary data are collected, carefully studied,

examined, analyzed, synthesized, and interpreted toward finding patterns, and generalizing results, to discover main variables and factors involved and detect inconsistencies. This meticulous study is carried out to substantiate and refine the research hypothesis, extract knowledge, and prior research recommendations to utilize in later steps.

This effort is carried out **simultaneously** while reviewing scholarly works in the following three main areas:

1. The use of intelligent technologies in HE in general and data-driven analytics in general to aid all facets of HE education administration including its assistance in decision-making and planning.
2. HE planning, education-to-employment process, and the alignment of HE and its output with economy.
3. Reports and statistics about labor and work relations with specific focus on Sudan (see Figure 4-1 above "Research Process Outline").

Then, all data sources, attributes, data types, and other characteristics are documented in Table 4-1 below shows an extract from the preliminary data dictionary.

Table 4-1 Extract from Data Dictionary

Source	Sub Organization	Data
HEIs		Confirmed Enrollment #
		Courses Studied
		Graduate # (Dropouts)
		Job Seeking Skills ?
CBS		Economic Indicators
		Census Data
		Population Growth
		Per Location
MHRD	States	National Registery
	Training Body	Blanket Projects
	Self-Employment Fund	Specific Guided Projects
MLAR	States	National Employment Policy
	Expat	Labor Market Stats
		Foreign Labor Exchange
Private Sector		Job Descriptions
		Occupation Titles #
		Employer Prespective
		Skills Required

During this process, conceived missing data are identified based on the research objective and possible sources are highlighted. Subsequently, data cleansing and integration strategy can be set to enhance data quality, security, completeness, anonymity, and accuracy at the source, before, and during the ETL process. For instance, consistent naming convention and encoding to resolve any schema conflict that may arise can be utilized.

The objective is to categorize entities and attributes of the source data identified previously and start the process of creating the metadata repository to build a DW model. To take advantage of BI analytic tools, all the data from all these sources must be integrated into a single repository to make it accessible for querying and analysis. As stated by (March and Hevner 2007), the DW should be able to derive BI knowledge.

In this task, the first research subobjective {O1} "Explore the current state of the education-to-employment process" is addressed by implementing an inductive approach. As defined by (Greener 2008) "an inductive approach starts by looking at the focus of research and through investigation by various research methods, aims to generate theory from the research". In particular, this approach covers the analysis of the knowledge arrived at during literature and education-to-employment process review including listing factors that are anticipated to influence the process (secondary data).

This iterative process will be repeated until a satisfactory, relevant, and meaningful data for the research is achieved.

The preliminary list of data sources consists of:

- Annual admission and graduation statistics published by MHESR.
- Reports and surveys conducted by the National Center for Research (NCR).

- Labor statistics and public sector jobs, published by MLAR's and NCSRC reports on civil service employment.
- For private sector jobs, the Sudanese Businessmen and Employers Federation (SBEF) annual reports.
- CBS for reports on, education, employment and economic indicators.
- HEIs for detailed characteristic information about their students.

4.2.2 Classify Environmental Factors

In this task, the focus is on the exploration as well as identification of stakeholders that currently have influence on the whole education-to-employment process in Sudan. The target group for the proposed BI framework involves the projected users of the conceived model, this includes HEIs, employers in both, the public and private domains as well as students and graduates. As outlined earlier, this target group will be surveyed to collect primary data that can also be used to evaluate the conceived BI framework in a later stage. Interviews and follow-ups for key personnel at all identified data source entities will be conducted.

According to the employed mixed model research approach, the qualitative imbalance between HE output and employment can be investigated by measuring the influence of various factors on the BI model, while iteratively getting insights to improve the model. Simultaneously we will explore the stakeholders' attitude towards the conceived model and gather more socioeconomic and characteristic information from the potential target groups.

The preliminary list of stakeholders includes:

- MHESR, its NCHESR and DACVA.
- MLAR and NCSRC.

- Private businesses and industries through their Chambers.
- HEIs, graduates, and students.

The above list is not static and it will evolve as the exploration and identification work is carried out throughout the research.

Now that the data and its sources have been identified a brief review of suitable data modelling technologies is conducted to satisfy the research objective. We explored a number of tools including SQL Power Architect (BestOfBI 2017), erwin Data Modeler (erwin 2017), and Oracle Data Modeler (Oracle-Modeler 2015). The later was chosen to implement the planned BI data model.

Concluding, this task deals with the first subobjective {O1} "Explore the current state of the education-to-employment processes", as well it deals briefly and at high level with subobjective {O3). Table 4-2 "Tasks and Output" at the end of the chapter has a summary as its name indicates.

4.2.3 Design BI Model

Data models describe, from both logical and physical perspectives, the layout and properties of the data structures designed to store data in the operational and analytical environments. The goal of the model is to facilitate the conclusion of qualitative results deriving from the quantitative data collected in the previous tasks. Consequently, revealing characteristic information that leads to affirm the research objectives by assisting in decision-making at the various stages of the education-to-employment process. For example, assist HE applicants with information about HEIs based on the most employed/unemployed graduate's percentage, support MHESR

personnel with information on programs that are most/least desirable by students, etc., as well as provide answers to queries about trends over time.

Since all input data will be coming from existing operational systems and/or statistical sources supported by relational databases as well as hardcopies, spreadsheets, etc., we initiate an Entity-Relationship (ER) model of the proposed solution. Then, a transformation of this ER model following the required steps (Oracle-MDM 2003; Inmon 2005; Kimball and Ross 2013; Chuck Ballard and Eunsaeng Kim 1998) into a multidimensional model that is suitable for the DW is essential. The main subjects of the data store must be identified and then based on how far back in history the data is retrieved from sources, the following characteristics will be set:

1) Historical boundary,
2) Main Facts' grain,
3) Candidate Dimensions, and
4) Aggregation rules for consolidation.

Subsequently and iteratively, industry standards and best practices (Oracle-Modeler 2015; Verbitskiy and Yeoh 2012; Lawyer and Chowdhury 2004) of model validation and data verification will be carried out to ensure data quality and model's coherence and correctness.

The well-defined top-down approach proposed by (Inmon 2005) will be followed in order to achieve the goal of building a comprehensive DW solution.

As well documented in the literature, many ETL issues may arise, but the key to overcoming these challenges is taking sufficient care in maintaining the metadata repository and setting up proper data quality rules. Once the DW repository has been modelled, depending on data quality and completeness as well as prior research

findings, an investigation of suitable BI technologies will be conducted in accordance with the research objectives.

In addition to the design of BI model, a preliminary outline for the validation of the proposed framework will be setup on the basis of stakeholder surveys (Suvedi, Heinze, and Ruonavaara 1999) to test the effect of a comprehensive set of variables. Data collected from the survey will be analyzed.

In this task, the second research subobjective {O2} "Develop a BI data model" and the third and last subobjective {O3} "Establish and apply a qualitative framework for the evaluation" were addressed toward the delivery of an effective BI model and serve as preliminary basis for its evaluation.

4.2.4 Validate Framework

To support the research objective and to verify the hypothesis, a **two-pronged** framework validation approach will be carried out as will be explained later in detail. On the **first track**, data modelling validation techniques will be applied on both the developed ER and multidimensional models to ensure data quality, completeness and fit for purpose. This process is performed iteratively and at every design stage, to:

a) Ensure that the models adhere to modeling rules and conventions (Oracle-MDM 2003; Chuck Ballard and Eunsaeng Kim 1998), and

b) Verify that the education-to-employment process business assertions made in the model affirm the research objectives.

Additionally, and depending on data availability, a proof-of-concept **multidimensional model** will be developed, implemented, tested and validated using the carefully chosen

BI technology tool. The rudimentary data collected will be populated and queried to further authenticate the model.

The **second track**, solicits qualitative feedback via a survey instrument from three key stakeholder groups that are deeply involved in the education-to-employment process. Main **factors** affecting the **alignment** of HE with labor markets and the **success** of BI **implementation** in general were already identified during literature review and data analysis, including (Dacre Pool and Sewell 2007; Yeoh and Koronios 2010; Gaardboe and Svarre 2018; Stern and Sederburg 2014; Cleary and Van Noy 2014).

These characteristic factors are the basis of the survey questionnaires and the survey aims at:

(1) Determining their perception about the status of the current HE to employment processes and the various information sources, stakeholders and their interaction by highlighting the proposed BI systems enhancements, including, data availability, integrity, presentation and visualization, also

(2) Gauging environmental readiness and discovering their reception and expectations from the use of intelligent technologies and the improvement to be introduced to estimate their support for wide application of the BI framework.

A cross-sectional representative sample of HE students, a pool of recent graduates (less than five years since graduation) and employers, both private and public, will be selected. Conclusions will be drawn/deduced by comparing the existing situation against the framework and thus validating the research objective.

Primarily, an online survey instrument will be employed to collect data, and it will be complemented with a hardcopy version to cater for respondents who might not be

able to use the online version. Special consideration will be given to the formulation of the survey questions and the sampling of the survey target group as this plays a pivotal role in the reliability of the results.

This task serves the treatment of the second {O2} and third {O3} research subobjectives providing a sound foundation for discussing and analyzing the results obtained from all tasks explained earlier.

4.2.5 Analyze Findings

This research hypothesizes that utilizing the envisioned BI framework will increase the quality of HE decision-support information and thus leads to improved alignment of HE output with labor market. As discussed in the previous section, the second framework evaluation track utilizes primary data resulting from the survey to validate the model. For this purpose, multiple statistical analysis techniques will be applied to analyze the data including simple descriptive analysis to identify and investigate the relationship between different variables. An appropriate statistical analysis tool will be selected and utilized.

With regards to the first framework evaluation track, results obtained by applying modeling rules and conventions on the conceived model at every stage of development will be evaluated against the research objectives. Simple reports will be generated from the sample data loaded into the model and knowledge gained from this preliminary analysis and throughout the process (Stern and Sederburg 2014; Sparks and Waits 2011) will be utilized to draw deductions as well as implications on the BI framework.

This task covered the third and final objective {O3} “Establish and apply a qualitative framework for the evaluation”, and sufficiently contributes, by implementing the

double validation approach explained, to the reliability of the research methodology as well as the stability of the envisaged solution.

4.3 Tasks and Outputs Summary

Table 4-2 shown below illustrates the mapping of the research tasks onto their expected output to effectively visualize their interrelationship.

Table 4-2 Research Tasks and Outputs Mapping

Task		Output
3.1	Identify and analyze data	○ Secondary data (qualitative and quantitative) ○ Key BI components. ○ High-level BI framework abstraction. ○ Data sources, data gaps and ETL strategy. ○ Preliminary Metadata repository.
3.2	Classify environmental factors	○ Qualitative and quantitative data refinement. ○ Key players and influencing factors. ○ Identify BI adoption characteristic factors. ○ Data owners and stakeholders' feedback. ○ Modelling technologies identified.
3.3	Design model	○ Validated logical and ER models. ○ Multidimensional DW model. ○ Refine characteristic factors ○ Preliminary survey instruments. ○ Initial BI technologies investigation.
3.4	Validate framework	○ Validated DW Model. ○ ETL sample data. ○ BI tools selected and Data Mart implemented. ○ Final survey instrument.
3.5	Analyze findings	○ Quality assurance and BI framework verification. ○ Survey analysis and results. ○ Draw conclusions.

This chapter provided a discussion about the approach and steps taken towards achieving and evaluating the research goal. Every step of the research tasks was explained in detail with its expected output. The next chapter lays out the proposed solution framework architecture with an in-depth explanation of the data model and

its validation including the identification of BI characteristic factors, the design of the survey, its goals and an outline of the results analysis.

CHAPTER FIVE

Proposed Solution Framework

5 Proposed Solution Framework

We dedicate this chapter of the thesis to explaining our **contribution**, namely the **model** and **framework** proposal for the **implementation** of the **analytical environment**. The chapter is structured in **four** main **sections**:

1: The first presents the data, its sources and key stakeholders contributing to the framework.
2: The second analyzes the environment and the gathered data with emphasis on gap analysis, data quality and security.
3: The third section describes the architecture of the proposed framework, along with its components, their detailed explanation, and the interaction between them.
4: The fourth section covers the identification of key factors affecting the adoption of the proposed framework, the design of the survey instrument and its intended goals.

5.1 Data Sources and Stakeholders

In this section, we expand on the preliminary list of data sources that was compiled during our initial investigation discussed earlier in the Methodology section of the previous chapter.

During the literature review phase, a comprehensive study of all the relevant activities and procedures involved in the education-to-employment process internationally and specifically in Sudan was carried out. Additionally, and to cover all angles of the process in Sudan, an in-depth study of the many educational routes available to HS graduates

to pursue HE studies is conducted; going through HE admission procedures, graduation and then employment. To fully understand and document the current HE admission process, and both the public and private employment practices, structured and unstructured interviews were conducted with key personnel in all the previously identified stakeholders, including MHESR, MLAR, recent graduates, students, employers, etc.

As more data sources were discovered during detailed analysis, Figure 5-1 below shows all sources identified for our proposed framework. They are categorized into **primary** and **secondary** sources. Multiple rounds of collecting feedback as deemed necessary were carried out for clarification and follow up.

By explaining the various objects in Figure 5-1 below, we will have covered all stakeholders and sources of data for the envisioned DW. The DW is central to the figure since all data is fed into it. The objects background color is used to distinguish **primary** and **secondary** data sources with **primary** sources having the **green** background.

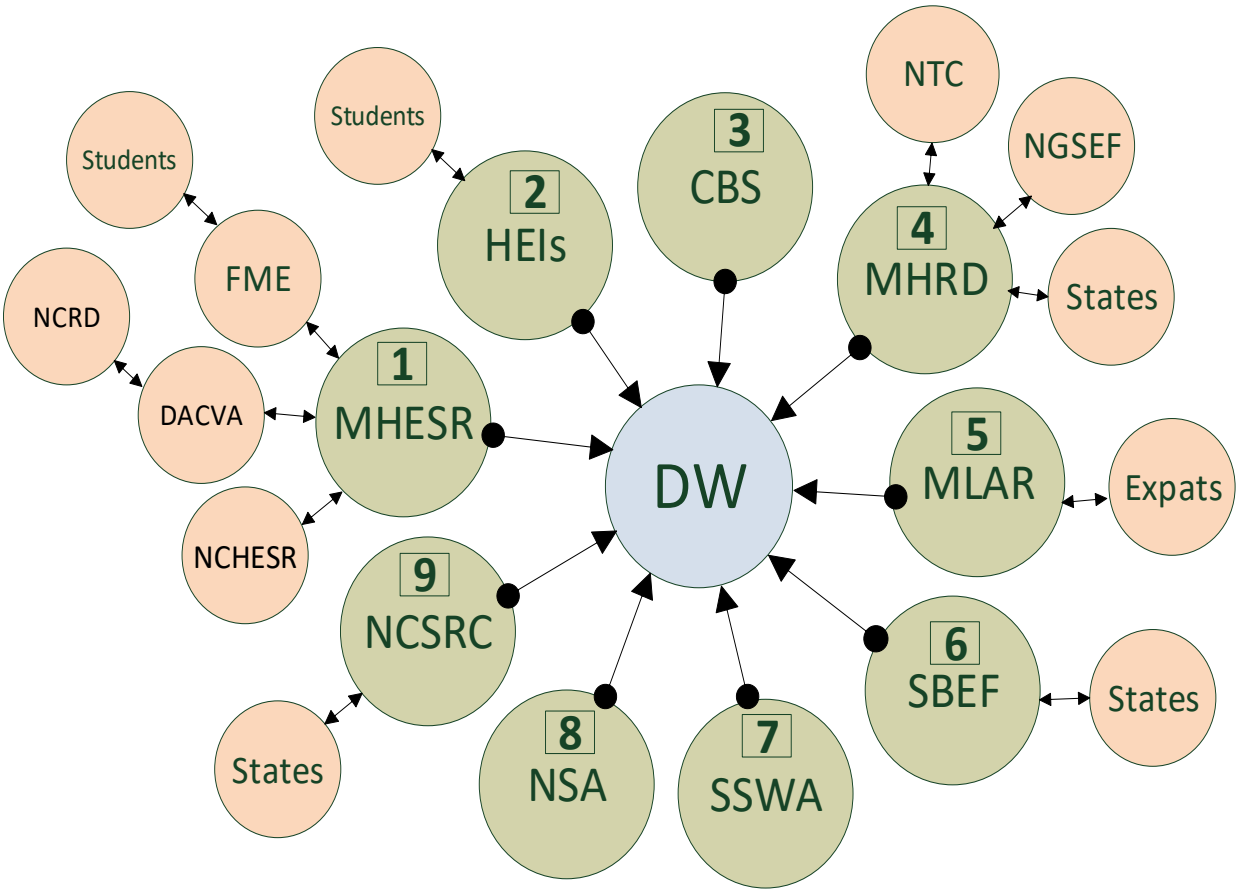

Figure 5-1 Data Sources and Stakeholders

The explanation of the figure above, starts with number one {1}, namely MHESR and its secondary sources, and then moves in an ascending order in a clockwise fashion.

1) MHESR provides data about HEIs, programs of study, degrees, enrollments, graduates and their distribution, etc. It has three secondary data sources, namely, FME, DACVA, and NCHESR. As stated earlier in the introduction chapter, the National Council of Higher Education and Scientific Research (NCHESR 2015) creates the national HE policy and approves all programs offered in public and private HEIs. MHESR's Directorate of Admission and Certificates Verification and Accreditation (DACVA 2017) governs the admission process at the national level, as well as validates transcripts and certificates upon graduation. Although it is a department within the MHESR, we have decided to put it as an

independent entity to highlight its importance as it is the main gateway/entry-point of data into the whole process.

The first source of electronic data into MHESR systems is the application filled out by students sitting for the National HS exam. The Federal Ministry of Education (FME) captures this data and shares it electronically with MHESR during the application for admission process. Table 5-1 below lists the data attributes captured. As the table shows there is a wealth of biographic information about applicants and their socioeconomic background.

Table 5-1 Data Attributes from the National HS Exam Applicant

Name Arabic	Name English	Gender	Exam Seat#
H. School Name	H. School Type	Certificate Track	Certificate Date
#Time Sat 4 Exam	Accepted 4 HE Before	Where Accepted	Reason Resigned
DOB	POB	Age	Religion
Nationality	Nationality Type	National ID	National ID DOI
National ID POI	Residence State	City/Village	Marital Status
Employed? Y/N	Where Employed	What Employed	Perm Address
Health Cond	Disabled? Y/N	Disability Type?	Phone Number
Mother Alive? Y/N	Father Alive? Y/N	Guardian Name	Guardian Edu
Guardian Occupation	Guardian Relation	Guardian Income	Mother Name
Mother Edu	Mother Occupation	Mother Income	Brothers?
Sisters?	Siblings in HE	Siblings in School	Siblings in Preschool

Table 5-2 below shows the data attributes captured online by DACVA from the HE admission applicants. DACVA then **synchronizes** its applicants' data with the information received from the **FME**, and **verifies** the National ID information with National Civil Registry Database (NCRD) at the Ministry of Interior. The next step is to integrates all this information with applicants' HE programs choices data, and run the electronic admission process. Finally, once applicants are

accepted then assign a "National University Student-ID" to all candidates enrolled and forwards their relevant information to the admitting HEIs.

Table 5-2 Data Attributes from the Electronic HE Admission Applicant

Exam Seat#	App Form Num	Certificate Track
App Type (Pub/Private)	Nationality	Exam State
Phone Num	HEI & Prog Choices (Total 10)	
www.admission.gov.sd		

Additional important data that DACVA should make available is a historical ranking of all HE programs in each discipline (as per the MHESR categorization Table 2-1), based on various well-established criteria. For example, a ranking of all ICT programs in all HEIs based on admission grades per year, i.e., what programs admitted the highest scorers and in which HEIs. Currently, MHESR partially publishes programs ranking information in its yearly admission guide. The ranking published is based on the lowest admitted grade (no other criteria) and is limited to the previous academic year only and to public HEIs only.

In spite of the limitation, this is still a vital piece of information, as it provides applicants an insight into choices made by previous year's HE applicants' preferences and if they are somehow related to the applicants' perception of landing a job once they graduate.

2) HEIs provide MHESR with students' updated information, as during the admission process DACVA sends lists of accepted candidates' information to the nominated HEI. The candidate student then fills out another application at the HEI (see SUST sample application form in Appendix E), and once he/she meets all the HEI's requirements then the registration is completed and the candidate becomes a student pending finalization with MHESR. To formally complete the acceptance process, the accepting HEI shares the names of its final lists of

accepted students with MHESR. Furthermore, upon students' graduation HEIs transmit lists of their graduating students to MHESR for the required verification of their certificates. Currently, HEIs do not offer their students or graduates any form of job-placement assistance or job-hunting skills to prepare them in any way for securing their first entry-level position.

3) The Central Bureau of Statistics (CBS) compiles data about employment in all sectors of the economy, unemployment rate distribution per education level, and geographic location. It also publishes Economic Indicators for all sectors, including job growth, population growth, industrial census, etc. This information is an integral part of the proposed framework. CBS census when read with the MHRD plan provides the "national" projection of employment demand based on national development projects.

4) MHRD is in charge of training and upgrading all civil servants' skill as well as overseeing graduates' transformational training programs. This is achieved through its national and regional training arms. It strives to achieve the federal government's national comprehensive development goals aimed at reducing unemployment.

- One of the most influential arms of MHRD is the National Graduates Self-Employment Fund (NGSEF). This fund attempts to tackle graduates' unemployment in two tracks. First, by dealing with a number of Banks nationwide to provide micro-finance guarantees to HE graduates' projects as a mechanism to encourage entrepreneurship and self-employment. On the other track NGSEF teams up with a number of institutes to provide practical hands-on training to graduates in a variety of disciplines, e.g., starting a business or managing a workshop or small industry. The objective of the training is to raise the spirit of entrepreneurship and private work in graduates. Additionally,

MHRD coordinates all its activities with MLAR similar bodies in all "States". Between 2005 and 2012, the Fund has provided training to over 28 thousand graduates and financed about four thousand small enterprises. Despite the unique structure of the Fund and its achievements, there are gaps in the its services provision, such as the lack of career counselling services prior to the training stage and the lack of business support services at the end of the training and prior to the start of the businesses.

- Another vital arm of MHRD, is the National Training Center (NTC) that handles all civil servants needs for training and regulates the few employment agencies that hire for jobs abroad.

5) Over the past few years, MLAR and MHRD were joined in one ministry, and now they are separate entities. MLAR creates the National Employment policies in coordination with its stateside offices, similar states' organizations, and the ILO. They also oversee the alignment of employment opportunities for Sudanese overseas with the national interest. MLAR also creates the national lists of jobs and qualification structures, e.g., job titles and qualifications required for them. MLAR also provides data about Sudanese working abroad including their distribution, categorization, etc. In addition, MLAR stateside offices handle all states' civil service jobs as well as private sector jobs advertised and recruited for through them.

6) Sudanese Businessmen and Employers Federation, SBEF, supplies data of the private sector employment. For this sector jobs, MLAR relies on its stateside offices, bearing in mind that not all private sector jobs are advertised through these offices. The majority of private sector jobs are filled straight by the hiring organization and there is no consolidated data or entity that collects such data.

7) The Secretariat of Sudanese Working Abroad (SSWA) provides data about Sudanese expats including their distribution abroad and categorization based on education and skill levels, etc. It also provides the voice of expats and their families to the government and promotes their ties to their mother country. The International Organization for Migration 2011 report on Sudan (IOM 2011) estimates that there are between 880 thousand and 1.3 million economic migrants, over half of them concentrate in Saudi Arabia and only a smaller proportion in Western countries.

8) The National Service Administration (NSA) is affiliated to the Ministry of Defense and it coordinates the compulsory national service for all youth including HE graduates. All Sudanese graduates are obliged to register with NSA upon graduation, where they are assigned to acquire basic military training and then to a civil-service post nationally. Once graduates have completed their one-year national service, they can authenticate their graduation certificates and then look for a permanent position in the country or abroad.

9) The National Civil Service Recruitment Commission, NCSRC, manages the hiring process for all civil service jobs including entry-level and positions requiring experience. Applicants' information for advertised positions is captured online; Table 5-3 below shows a sample of the data collected in the NCSRC application. Candidates are contacted for written test via text messages or email in addition to posting their names on the NCSRC main boards. Based on test results, candidates are selected for interviews, and once completed, accepted candidates are notified. NCSRC is expected to provide data about type of positions by education category, pay level, location, etc. to the proposed DW.

Table 5-3 Data Attributes from the Electronic NCSRC Applicant

Job-ID	National ID	Name Arabic	Name English
DOB	Gender	HEI Program	HEI Name
Grad Degree	Grad Grade	Grad Date	City
State	Disabled?	Applied Before?	Phone Num
http://www.sudarecboard.gov.sd/			

NCSRC statistics show that there is a huge gap between the numbers of applicants for available civil service jobs and hired candidates with an even bigger disparity in Arts-related fields. Figure 5-2 below shows that in spite of the overall civil service intake increasing during the reported period, in fact the ratio of employed-to-registered has decreased, not to mention the ratio to the full number of graduates.

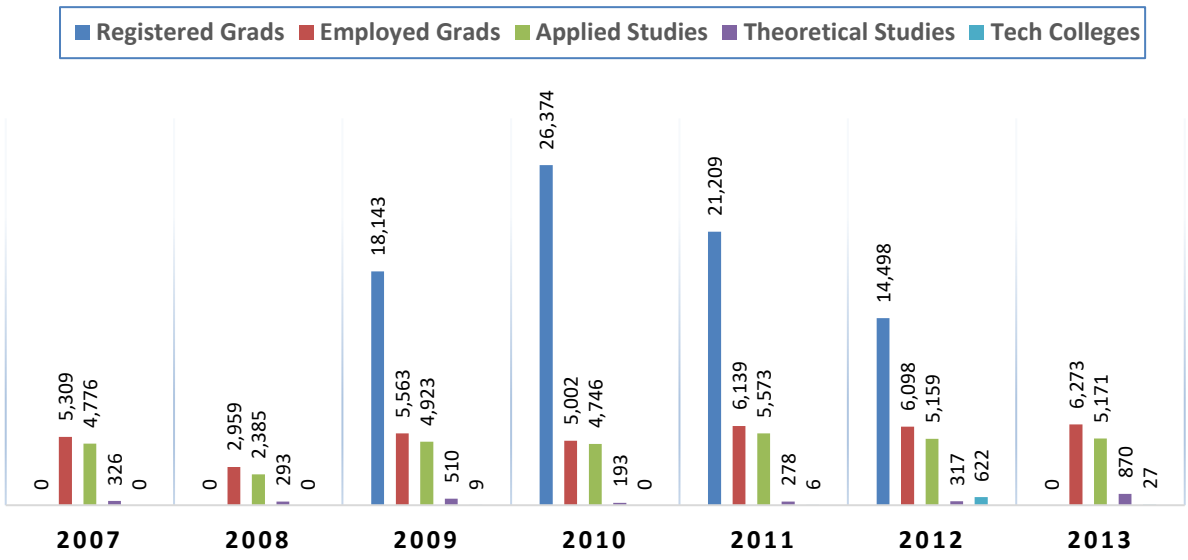

Figure: 5-2 Civil Service Entry-Level Employment 2007-2013 (Nour 2013)

Moreover, NCSRC has corresponding entities in each state that handle the recruitment for the states' local government jobs. They sometimes handle private sector jobs too if requested. Also, MLAR and MHRD have statewide counterpart ministries and/or offices that coordinate the states' policies and activities with the national effort.

From the above discussion we conclude that the list of stakeholders includes:

- HEIs, graduates, and students.
- MHESR, its NCHESR and DACVA.
- MLAR and its NCSRC.
- MHRD and its NGSEF.
- Private businesses and industries through their Chambers.

5.2 Data Analysis, Security and Environment

A metadata repository or data dictionary is created for all the data collected during the previous stage describing the meaning, source, and naming convention. This information will be very useful during design and when creating our data abstraction layer.

Data security and privacy issues are important in any system that collects and utilizes personal data. For this framework and to protect anonymity and security of data, a striping or masking of all identifying information is conducted at the data source before sharing its information. This approach assures data owners of the absolute security, integrity and privacy of the data and guarantees their strong support for the whole process. For example, MHESR provides its data without any personal information such as the "National ID" or student's "National University ID". The framework applies a trusted and agreed upon data masking algorithm to replace students' "National University ID" with new identification number or code, "**dummy ID**", and thus preventing personally identifying information from being included in the data set.

Subsequently, the collected data needed for the DW is extracted into the **staging area** for further manipulation including cleansing of the data, dealing with missing elements

or data gaps, combining data from multiple sources, reduplicating data, and assigning warehouse keys.

As indicated in the previous section, MLAR creates the national lists of jobs and qualification structures, but this information is not done in consultation with MHESR and not linked to HE programs. As this information is the cornerstone for the envisioned framework, a comprehensive list that correlates all HE programs in the country and actual job-titles or occupations they qualify their graduates for will be created. Table 5-4 below shows categorization of the employment qualifications in Sudan as identified by the published National Employment Policy Report (ILO-UNDP 2014).

Table 5-4 Qualifications System in Sudan (ILO-UNDP 2014)

Qualification	Educational Attainment
Engineers	University Graduates with Bachelor degree
Technicians	Graduates from technical colleges with Diploma degree
Skilled workers	Vocational Training Certificate (Apprenticeship Diploma)
	Technical school (Certificate)

MEHSR statistics for 2015 show the majority, or about 80%, of HE students are enrolled in programs leading to a Bachelor degree while only 20% study for Higher Diplomas and Technical degrees. About 6% of HE graduates go on to pursue graduate studies.

Both (MLAR-ILO 2013) and (Psacharopoulos and Sanyal 1981) show that most of HE graduates in Sudan work in the public sector. Expanding employment in the civil service was the government's response to unemployment and (Nour 2011) showed that civil servants productivity has gone down because of this increase. Moreover, many civil service organizations have an exemption from recruiting through the NCSRC. This adds to the fact that labor statistics in Sudan are scant and disjoined.

In developed economies, the organized private sector is the biggest source of jobs, while in Sudan, according to (ILO-UNDP 2014), large-scale organizations, that employ one hundred workers or more, do not exceed more than 2% of the private sector. Whereas micro, small and medium-sized enterprises represent up to 98% of the sector. Sudanese Businessmen and Employers Federation, SBEF, does not maintain data about entry-level jobs creation in their sector and there is No specific body or entity dedicated to collect such data. MLAR regional or statewide offices maintain some of this information for the private sector jobs they recruit for. The above results and discussion highlight the importance of **a centralized repository** that consolidates and tracks labor statistics for all **civil service** and **private sector** jobs for improved visibility and ease of access.

5.3 Framework Architecture

The framework defines the layers and components that are to be integrated and aligned to deliver a strategic vision and plan for implementing the BI system. This is achieved by understanding the education-to-employment process and identifying all the business objects, activities and procedures involved in the process. Many interviews were held during the previous phase with stakeholders and data owners exactly for this purpose.

It is clear that students in their education-to-employment lifecycle undergo many state (status) changes. For example, as seen in Figure 5-3 below, a HS student changes state to HE applicant and then to HE student, etc.

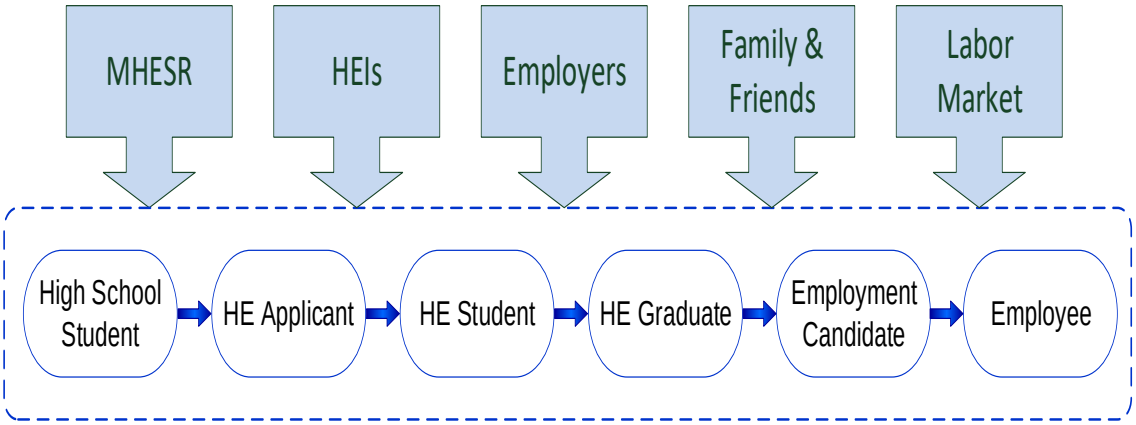

Fig: 5-3 Education-to-Employment Decision Chain

Every state change involves many decisions connecting the many stakeholder shown on the figure, and there are many decisions throughout the process. The conceived framework provides assistance to all stakeholders that is tailored to their scope of interest.

The data collected from the various sources identified in the previous section was categorized into the following main groups:

I. Students' demographics information.
II. Academic information relating to both students and HEIs.
III. Jobs, qualifications and market information.

5.3.1 Logical and ER Models

Building on the initial business metadata created earlier in the previous phase, here a technical metadata is created into the data dictionary. Here we describe entities, their attributes, their source, data type, naming and versioning convention, description and possible target database. This process is carried in parallel with the design of the logical model as this information will be very useful when we come to populate our DW.

As a result of the data modelling tools review carried out during the previous stage, Oracle SQL Developer Data Modeler was selected (Oracle-Modeler). The logical model shown in Figure 5-4 below was developed using this tool and it reveals many interesting relationships recognized between the many identified entities. For example, the mapping between HE studies programs and occupations, and the relationship between HS applicants and HE study programs, etc.

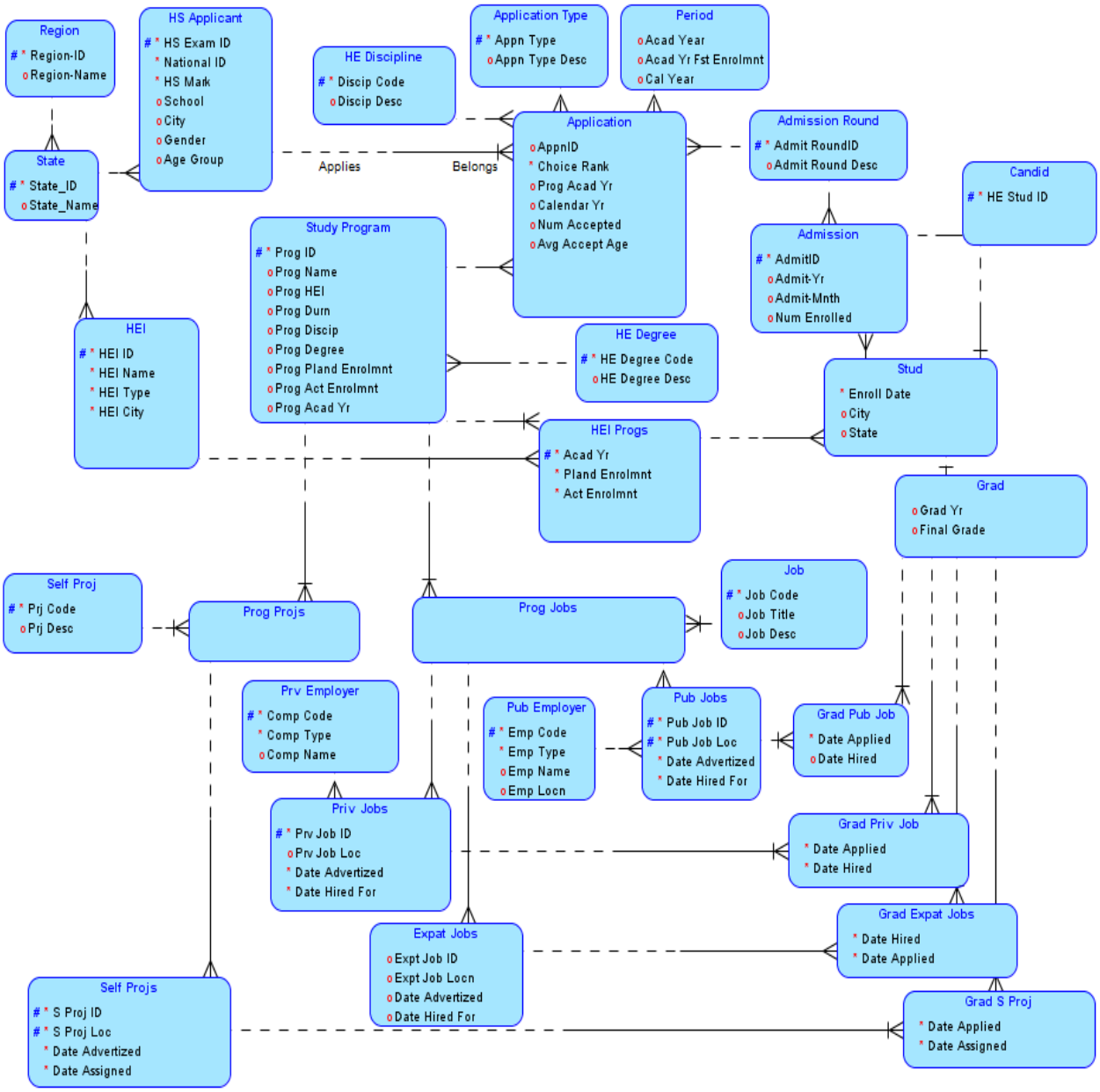

Fig: 5-4 Logical Data Model

Many gaps in the data were discovered once entities were listed and relationships among them identified. Additional data attributes were created when needed and feedback was solicited from the key stakeholders.

We continue developing the data model iteratively while adhering to modeling rules and conventions (Oracle-MDM 2003), as well as verifying at every stage that the business assertions made in the model affirm the research objectives of improving the quality, effectiveness, and efficiency of information.

Once the logical data model was completed, again Oracle SQL Developer Data Modeler (Oracle-Modeler) was utilized to create the ER diagram or physical model as shown in Figure 5-5 below.

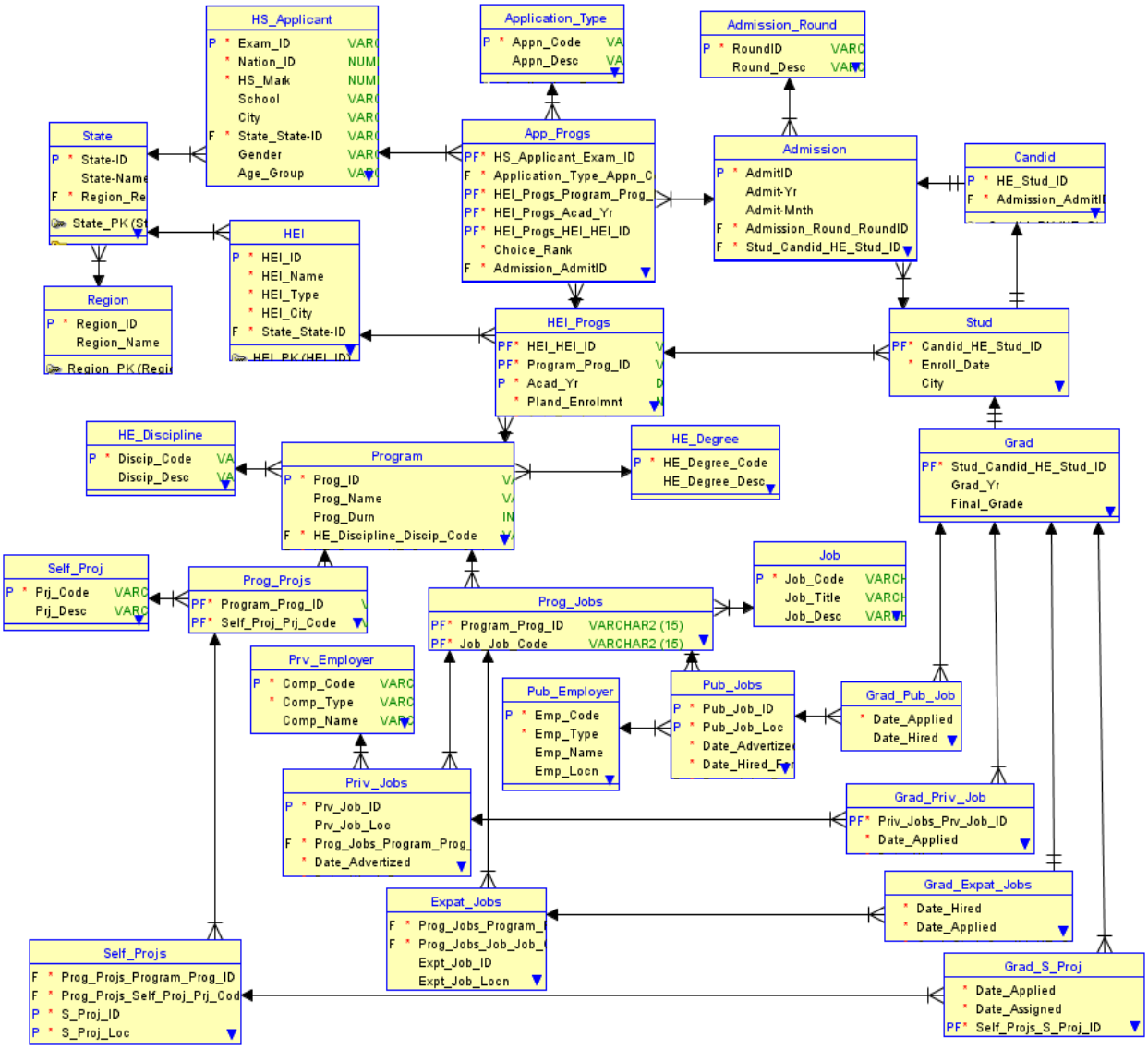

Figure 5-5 Relational Data Model

The ER diagram shows all primary and foreign key constraints as well as the physical layout of the tables in the database. A full-scale thirty-five tables DW model was created and is expected to grow as the framework's scope is expanded and more relationships and data become available.

5.3.2 Multidimension Model

Earlier in chapter three "Research Strategy", during the design stage, adopting Inmon's top-down approach was proposed to achieve the goal of building a comprehensive DW

solution. Nevertheless, the researcher has come to realize that Kimball's data marts are more suited to our situation and will be implemented instead. This staggered approach is more appropriate to resolve the many interrelationships between data control and organizational politics. It also satisfies the business requirements of the framework and is flexible and scalable, i.e., it grows with the availability of additional data and thus compensates for the initial lack of data. Figure 5-6 below shows a breakdown of the DW architecture

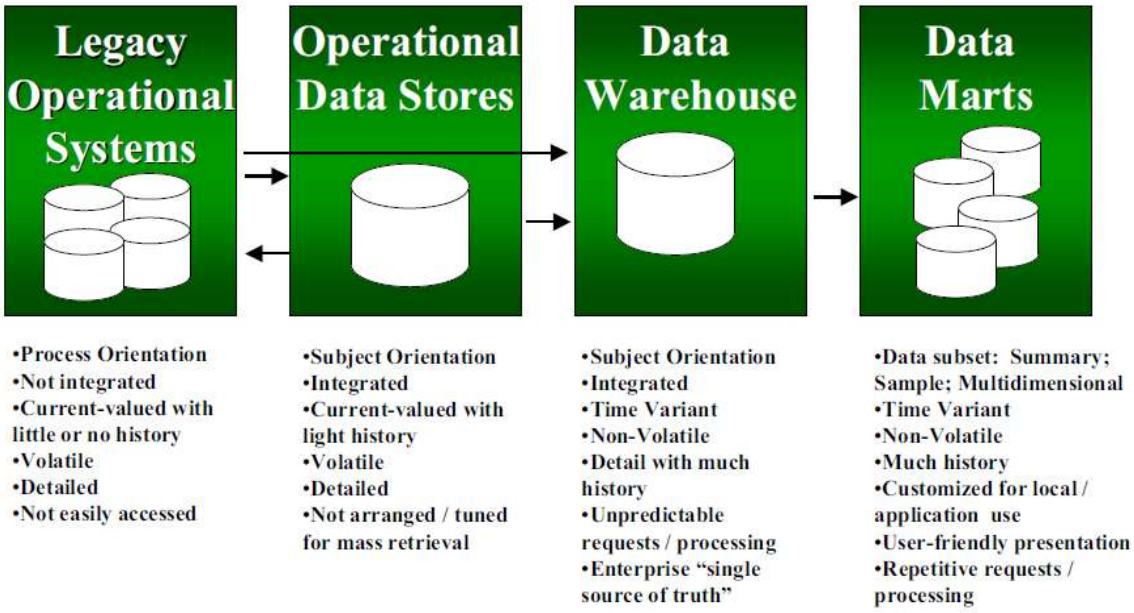

Fig:5-6 Data Warehouses Architecture (Lawyer and Chowdhury 2004)

The proposed DW main subject areas are recognized based on a thorough study of the developed physical (Figure 5-5) and logical (Figure 5-4) models and by employing techniques recommended by (Chuck Ballard and Eunsaeng Kim 1998; Lawyer and Chowdhury 2004) and (Oracle-DW 2014). The plan is to develop a data mart for each subject area in a Star Schema design while all these models could be interconnected to form a Galaxy Schema. The advantage of building data marts gradually is to facilitate acquiring stakeholders' acceptance once useful and meaningful results are shown and it is also better suited in our case of insufficient data.

From the previous discussion, the main subject areas of the proposed education-to-employment DW are**:**

I. Admission (Enrolment)
II. Graduation
III. Employment (Job Seeking)

Each subject area represents a main **Fact table** in our Dimensional model and for each of the three subject areas there are**:**

a) Candidate Dimensions. Dimensions are mapped to nonnumeric, informative entities such as, students, study programs, Location/region, period, HEIs, public jobs, self-employment projects, private jobs, graduates, etc.
b) Aggregate attributes or Measures. A measure is numeric attribute of a Fact, it is determined by combinations of the members of the dimensions, for examples, “Number Accepted” and “Average Accept Age” are measures.
c) Attribute (Dimension) hierarchies. They add more characteristics or properties to the Dimension. This is done by examining the business process.

All the one-to-many relationships defined in the normalized logical design were de-normalized to reduce the number of joins for better query performance. By breaking these relationships in the Dimensions, we achieve a star instead of a snowflake schema. The researcher elected to concentrate on the Admission subject area of the DW since it is the one with the most available electronic data. The Admission data mart (shown in Figure 5-7 below) was designed in preparation for its planned implementation that will be discussed in the next chapter.

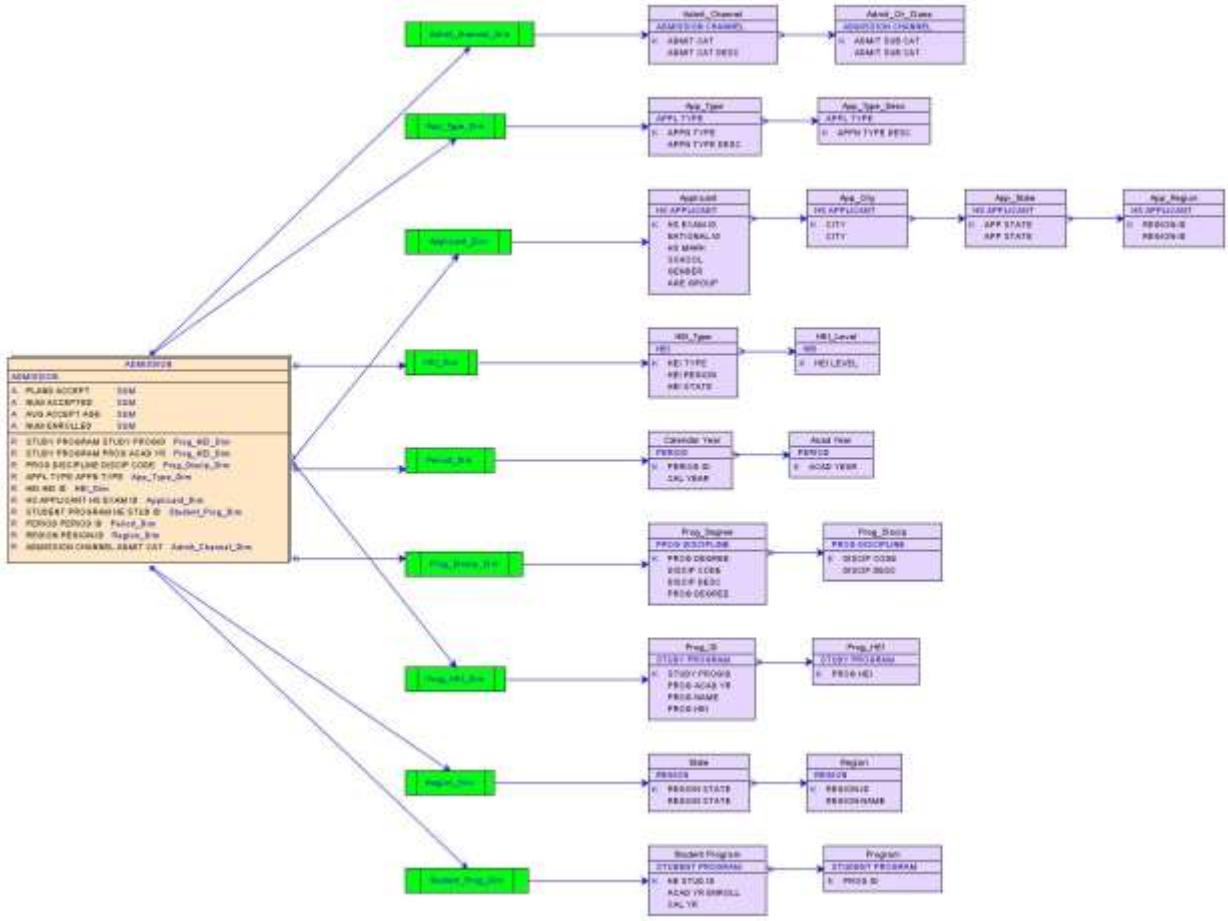

Figure 5-7 Admission Data Mart

Clearly testing is extremely critical to the success of the DW as it ensures the quality of the information and enhances our trust in its outcome. Specific data mart testing procedures outlined by (Golfarelli and Rizzi 2009), were adhered to when validating the designed Admissions data mart. In addition, and at every step, exploratory interviews with key stakeholders throughout the process were carried out to confirm findings.

It is apparent that we only concentrated on the subject areas that are of interest to this thesis and did not elaborate on other areas of the education-to-employment process, such as financial information relating to the cost of HE programs, HE faculty, HE administration or employment compensation, etc. Additional data marts could be incorporated in the future to cover the many aspects discussed above and this illustrates the power of the Kimball approach.

5.4 Survey Design

Switching to the second track of framework validation, namely the qualitative analysis. A survey instrument is developed to gauge stakeholders' perception and expectations towards both the existing and proposed processes. How stakeholder perceive the process and framework affects their attitude towards them and this has a big impact on the success or failure of the solution.

5.4.1 Characteristic Factors

In light of the previous discussion, various characteristic factors affecting **both**, the alignment of HE with the labor market as well as the overall acceptance of intelligent technologies, and particularly BI, were identified and documented to build the basis for further analysis. These characteristic factors came as a result of the content analysis and interviews with key-personnel carried out during the analysis stage (Yeoh and Koronios 2010; Gaardboe and Svarre 2018; Dacre Pool and Sewell 2007; Stern and Sederburg 2014). They include **non-technical** factors: such as organizational and process-related issues, social factors: such as cultural and perception-related issues, as well as **technical** factors addressing infrastructure, technology readiness, data quality, and presentation of information.

The following is an uncategorized list of these characteristic factors:

> Technology utilization prevalence; students', graduates', and employers' sources of news; the current situation and expectations of respondents' with regards to; motivation and support for HE, awareness about employment and job-listing agencies; availability, integrity and accessibility of decision-support information for HE programs of study and career choices, entry-level recruitment; satisfaction with the job market processes; awareness and

acceptance of intelligent technologies and the growing importance of ICT in supporting decision-making.

This formative assessment of these factors by stakeholders will serve as a vehicle to validate the proposed framework.

A detailed discussion and categorization of these factors will follow later during the survey data analysis planning in the next chapter.

5.4.2 Target Group

We measure the influence of the abovementioned factors on the BI model by investigating the imbalance between HE output and employment as indicated by three crucial groups of stakeholders, namely, students, graduates and employers.

These three are core groups that affect and are affected by the education-to-employment process and thus are selected as survey target group. They play a pivotal role in the process itself and in the success or failure of the BI solution. More specifically, the three groups are:

(i) Students: These are HE students in their final year or the one before.

(ii) Graduates: These are limited to recent graduates who have graduated in the last five years.

(iii) Employers: These are organizations both public and private that employ HE graduates.

5.4.3 Survey Goals Breakdown

In line with the research methodology, the goals of the survey are twofold:

(1) To examine the effect of the characteristic factors on the BI adoption in the education-to-employment process, while providing an opportunity to iteratively improve the underlining model.

(2) To deduce conclusions on a successful BI adoption practice by comparing the existing process against expectations of the target group.

Validating the proposed framework is achieved through the surveys by confirming several sub-survey goals. The following is a breakdown and explanation of these sub-goals:

- First, and with regards to the basic information the surveys aim at**:**

  I. Assessing samples' reliability and validity by comparing survey results for questions like gender, HEI type, organization type, etc., with "reference values" or facts from other sources. If survey results corroborate these numbers and information then we establish that the survey is reliable.

  II. Establishing that the environment and participants are "technically" ready for BI.

- Second, the surveys intend to show that:

  I. The existing education-to-employment process's activities, data and procedures provide inadequate decision supporting information or no-information (e.g., HE admission, entry-level recruitment planning, etc.); and when information is available it is not accessible and is not well-presented.

II. Satisfaction with current processes and situation is low and thus justify the need for improvement.

- Third, the surveys aim at gauging the knowledge about intelligent technologies among respondents and evaluating their reception and attitude towards their use in enhancing the current process.

- Last, the surveys assess respondents' opinions about the importance of seven preselected essential features for the success of adopting BI to align HE output with markets.

Answers to each of the survey questions contributes directly or indirectly to one or more the survey goals, and conclusions are deduced while evaluating the framework against the current situation bearing in mind the BI nature of the framework.

5.5 Summary

This chapter described the proposed solution framework architecture with its data model and validation including the survey instrument, its goals and an outline of the analysis plan. The next chapter describes the steps taken to validate the framework, the data mart implementation, and presents the details of the survey processes including the survey sample selection and results analysis plan.

CHAPTER SIX

Framework Validation

6 Framework Validation

In the previous chapter, a layout of the solution framework and its architecture were presented together with a preliminary outline for its validation. In this chapter, an expansion of those initial outlines is discussed including an in-depth description of the means to verify, evaluate and validate the proposed BI framework. The section also details the survey instrument, its processes, including sample selection and data collection while providing an outline of the data analysis plan.

6.1 Model Validation

As explained previously in chapter three "Research Strategy", a **two-track** validation approach is carried out to support the research objective. Figure 6-1 below illustrates this approach, the first track applies state-of-the-art model validation techniques, and additionally depending on data availability, implements a proof-of-concept multidimensional model, which is the Admission data mart. Whereas the second track solicits stakeholders' feedback via questionnaires.

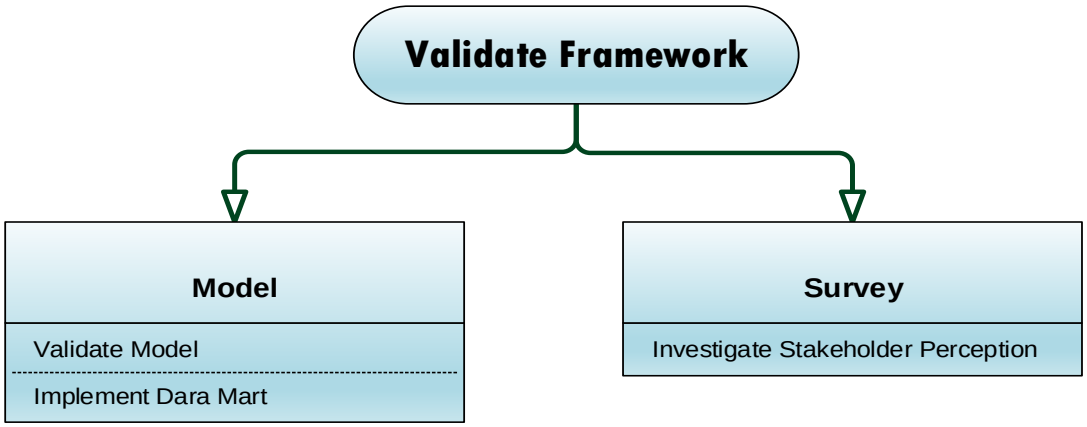

Figure 6-1 Framework Validation Approach

A detailed discussion of the implemented **model validation** techniques, including referential integrity, normalization, and denormalization, etc., was presented in the "Framework Architecture" section of the previous chapter. In addition, queries related to the education-to-employment process covered during analysis were directed to the multidimensional model to verify fit for purpose and completeness. This effort was performed iteratively and at every stage to ensure adherence to modeling rules and conventions (Oracle-MDM 2003), as well as to verify that the business assertions made in the model affirm the research objectives of improving the quality, effectiveness, and efficiency of information.

As multidimensional modeling principles indicate (Oracle-MDM 2003; Oracle-DW 2014), using BI enables answering aggregation and "predefined" questions of the following nature:

1) How many
2) What average
3) Total
4) Top HE programs, top jobs, HEIs, etc.
5) Correlation and qualification of these queries.

It is evident that our developed Admission data model does provide answers to such questions, as this is simply demonstrated by running simple SQL queries against the model to produce the desired results.

For example, to find the total employed (accepted) graduates (students) –over time– of each HEI in public positions we:

> "select stud_id, HEI-id, pub_job-id SUM /COUNT stud_id from fact table GROUP BY joining HEI and Pub-Jobs tables".

Providing answers to questions like the aforementioned, using actual and reliable data, offers students, graduates, MHESR planners, employers and the public in general, with the opportunity to improve their decision-making. This enhancement, at all levels in the education-to-employment, eventually leads directly and indirectly to better and improved alignment between HE outputs and the labor market.

Furthermore, and in addition to the **knowledge** based on **facts** discussed above, this framework lays the groundwork for a presentation layer that utilizes **prediction analytics** and **data discovery**, that enable answering "unknown" questions. Once data is stored in the DW, data analysis techniques, such as data mining, machine learning, social analytics, etc., can be applied to acquire knowledge from this information.

6.2 BI Technologies Evaluation

As preparation for the planned Admission data mart implementation, an extensive assessment of Open Source Software (OSS) and Free license BI technologies was carried out, including BI suites and metadata tools. The objective of this assessment is to identify the best suitable tool for the upcoming implementation of the Admission data mart. As explained in this paper (Drake 2017), both OSS and Free license software are free of charge, they only differ in how their licensing is built. Research by (Aziz et al. 2012) was discussed during the literature review, and it concurs with the survey by (Thomsen and Pedersen 2009). They both confer that OSS BI platforms have sufficient level of reliability and performance and are a perfect match for the proposed data mart requirements especially, with the existing licensing restrictions on the country.

A list of factors such as accessibility locally in Sudan, ease-of-use, integrability and compatibility with popular databases, documentation and support availably, and

inclusion of robust and visual tools in all layers were prioritized to assist in choosing the most suitable technology for the research objective. An investigation of a number of platforms as shown in Table 6-1 below was conducted by the researcher.

Table 6-1 Evaluated BI Technologies

BI Platform	OSS / Free
Microsoft Power BI	Free
Pentaho Business Analytics	OSS
Jaspersoft Community	OSS
Tableau Public	Free
SpagoBI	OSS

Each of the listed BI tools was downloaded, installed and tested. The review also included published reviews (BITOOLs.net 2017; Muilwijk 2016) and rankings carried out by reliable authentic sources. The conclusion was that Pentaho Community Edition (CE) BI suite, is the most suitable and was thus selected to implement the Admission data mart for the following reasons:

- It integrates natively with far more Database engines, JDBC, and ODBC as well as a variety of flat files.
- It has a large user community, the "Pentaho's community forum" that provides a place for collaborative technical assistance, addon tools, discussion and support.
- Pentaho Business Analytics (BA) Platform consists of the well-known Apache Tomcat web and Java Servlet application server and runs.
- It employs visual design tools such as Aggregate Designer, Metadata Editor, Schema Workbench that enable creating OLAP queries using the Mondrian OS OLAP engine.
- It utilizes a GUI application to create ETL jobs. Pentaho Data Integrator (PDI), also known as Kettle.

Overall, the selected tool is supported with comprehensive documentation and contains all the necessary features and options for the proposed data mart implementation.

6.3 Data Mart Implementation

Continuing with the second part of the first validation track (Figure 6-1 above), and to further substantiate the framework, the Admission data mart (Figure 5-7) as explained in the "Multidimension Model" section of the previous chapter, is implemented and validated using the selected Pentaho CE suite.

At this point, the data that was already available in the staging area is easily uploaded into the Admission data mart. Then all the identified **data gap** issues are resolved. Many OLAP queries involving aggregation of the data in the Fact table were run as part of the data load to fully populate the DW. Once this was complete, simple queries were run and reports generated to validate the data mart.

For example, to find the total accepted students –over time– of each HEIs by study program we:

> "select stud_id, HEI_id, stud_prog_id SUM /COUNT stud_id from fact table GROUP BY joining HEI and Study Prog tables"

Figure 6-2 below shows a sample of the types of general queries that we are able to answer using the data mart.

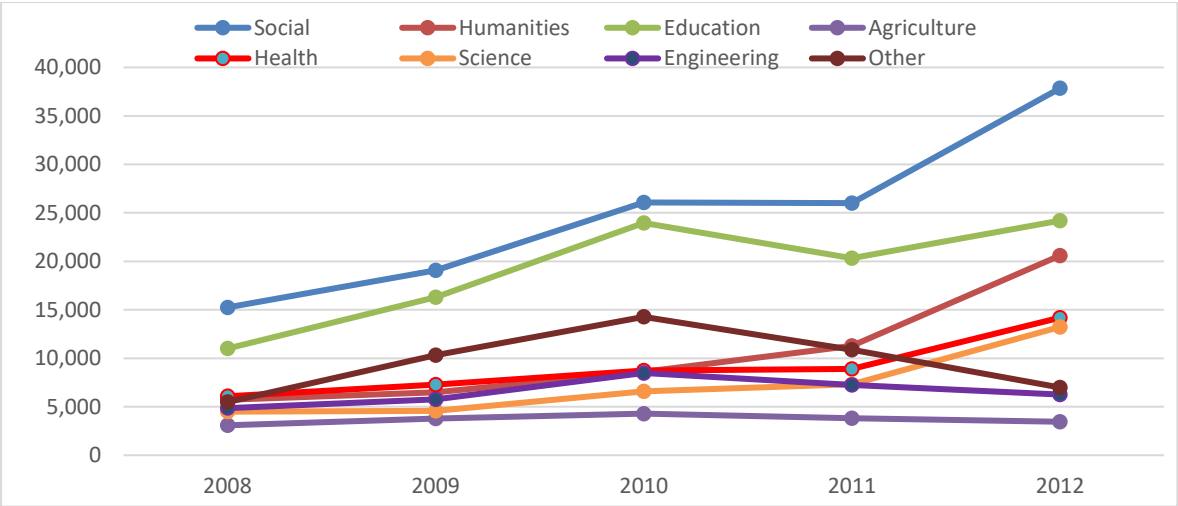

Figure 6-2 HE Distribution by Field of Study 2008-2012

Reports generated from the sample data loaded into the DW, together with the knowledge gained from the analysis throughout the process, confirm the research objectives of improved quality, effectiveness, and efficiency of information.

6.4 Survey Instrument

Continuing with the two-track validation approach outlined earlier in the chapter, here we turn our attention to the second track, that is, the qualitative stakeholders' study. An efficient survey instrument as recommended by (Suvedi, Heinze, and Ruonavaara 1999) is applied to test the effect of the comprehensive set of variables on the adoption of BI in the education-to-employment process. Toward this aim, a set of three questionnaires was developed using an innovative approach, which accounts for the alignment of HE with labor markets needs not merely as a matter of analyzing **quantitative** factors, such as labor statistics, trends of HE output, and admission rates. Besides, it embeds an investigation of **qualitative** aspects as well, such as attitudes and expectations of the target group on the content and structure of HE.

The questionnaires included many types of questions to better solicit information from respondents, the following is a sample of all question types with an explanation:

a) Questionnaires include **singular-answers** questions that the respondent chooses only one of multiple choices, for example, question 2 of Section-I of the Students' Questionnaire:

   How many years left for your graduation?
   ①<1 ②2 ③3 ④4 ⑤5

b) They also include **multiple-answer** questions that the respondent chooses one or more of multiple choices, for example, question 4 of Section-I in the Graduates' Questionnaire:

   *Do you own or use a? {Put a ☑ by the correct answer**(s)**}*
   ①PC ②Laptop ③Tab ④Smartphone ⑤Non-Smartphone ⑥TV ⑦Radio

c) Another type of questions is **rank-answers** questions that the respondent ranks one or more from a list of multiple choices, for example, question 7 of Section-I of the Employers' Questionnaire:

   Rank your organization's most hires in the last 5 years out of these MHESR categories?
   ①Economics & Social Studies ②Humanities ③Education ④Agriculture
   ⑤Health ⑥Science ⑦CS & IT ⑧Engineering ⑨Other

d) One more type of questions is **ordinal-scale** (**Likert** scale) questions that measure levels of agreement/disagreement. For example, question 4 in Section-II of the Students' Questionnaire:

   Are you satisfied with the HE programs and possible career path info you found?
   ①Extremely ②Satisfied ③Somewhat ④Dissatisfied ⑤Strongly Dissatisfied

e) They also have **Yes-No-Unsure** type questions, e.g., question 3 in Section-III of the Employers' Questionnaire:

   Does your organization utilize any "Intelligent Solutions"?
   ①Yes ②No ③Unsure

f) The last type of questions in the questionnaires is the **Matrix question** with several questions listed in a matrix with each row having the same response options (**Likert** scale).

The three questionnaires were developed by taking into consideration specifics of the target group members. The initial questionnaires were test, retested, and refined

based on an initial feedback to ensure ease of reading, understandability of questions, and to avoid any ambiguity. Modifications included reformatting, or consolidating questions, translating the surveys to the Arabic language and revalidating the translation in terms of meaningfulness. The survey was then piloted in four states including the capital Khartoum, both in private and public HEIs, and businesses.

6.4.1 Sample Selection

Participation in the survey target group was solicited according to the **stratified random** sampling method. The studied population was divided into subpopulations (strata) based on geographic location, in the capital state and other states, and also by private and public HEIs and employers. The objective is to enhance the representativeness of the sample population by ensuring that each stratum is adequately represented within the whole sample. Furthermore, to verify the reliability of the sample and credibility of the sampling methodology, during data analysis, variables were mapped against well-established facts and or reference information. For instance, comparisons between the results of gender breakdown, graduates' employment rate, HEIs' type and location were carried out against published HE data and national labor statistics.

6.4.2 Data Collection

Despite having planned to utilize an online survey for all its well-known advantages, during the preliminary survey design, the mock questionnaires phase, and the pilot survey, it became evident that a hardcopy version would be better-suited the target group and would achieve better feedback.

Appendix-A lists all three questionnaires; i.e., Students, Graduate, and Employers respectively, while Appendix-F lists the Arabic language questionnaires that were actually used to collect data.

6.4.3 Analysis Plan

The identification of the characteristic factors conducted during the previous phase of the research, resulted in more than a hundred survey variables being created. To facilitate and improve understanding of the impending analysis, these factors are categorized into the following **four** interrelated groups of factors as shown in Figure 6-3 below.

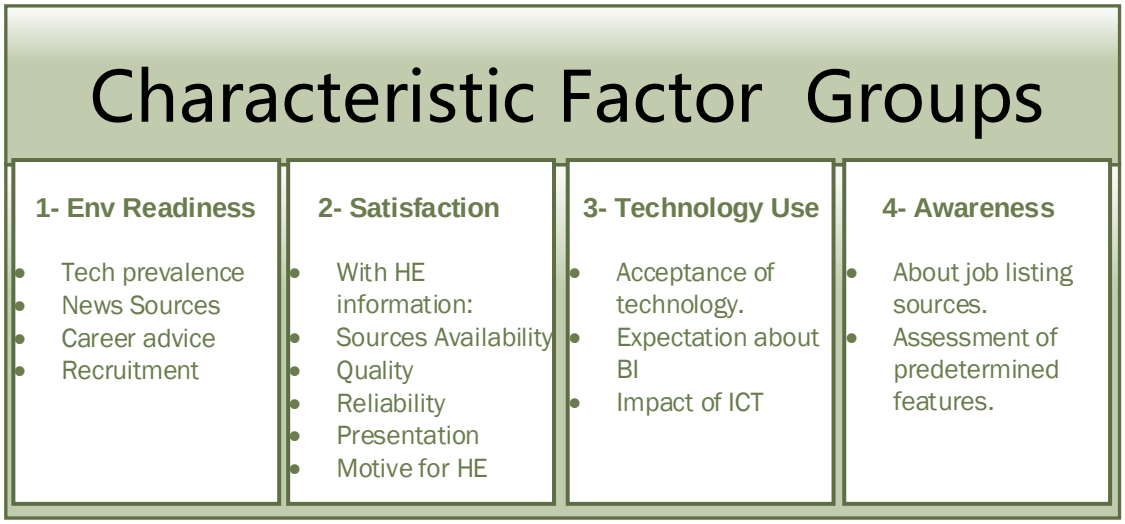

Figure 6-3 Survey Analysis Plan

The following is a detailed description of the four groups:

(1) **Environmental Readiness**:

This group of factors deals with the identification and assessment of the various information sources and stakeholders of the education-to-employment process. Data is collected about the target groups' biographic information, their decision-support and

general informative sources, their use of technology both, individually and institutionally.

The objective of this environment readiness inquiry is threefold, that is to**:**

(a) Examine if stakeholders, data, and infrastructure are prepared for the BI implementation or not.

(b) Establish that the survey sample is reliable and representative of the overall population.

(c) Explore important interdependences to identify potential statistically significant relationships by mapping variables in this group against other variables. Examples are, the correlation between respondents' age and their use of technology, or the institutions' geographic location and their utilization of intelligent solutions, etc.

(2) Satisfaction:

This groups refers to the target group's satisfaction with the existing process, the information it produces, and their evaluation of data-relevant characteristics. Data is collected from the target groups'**:**

(a) Perception of the various education-to-employment activities and features, for instance, career advice, job listing sources, employment agencies, etc.

(b) Level of satisfaction with the information received reflected by its characteristics, such as, availability, quality, reliability, integrity, accessibility, presentation and visualization.

The objective of this group is to discover if respondents' assessment indicates a need for improvement in the current process, in which activities? in what direction? and to what extent?

(3) Technology Use:

This group of factors addresses both the perception and expectation of the target group toward utilizing technology, specifically in the education-to-employment process. It expands on the first group's assessment of the general technology use by focusing on intelligent technologies and BI in particular. Data is collected about the target groups':

(a) Readiness and inclination towards the use of technology and massive data in HE decision-making.

(b) Level of willingness to embrace intelligent technologies for the purpose of aligning HE with labor market demand, and ultimately improving the education-to-employment process.

The objective of this group is to explore if and how the target groups' assessment renders the growing importance of information and communication technologies in supporting the decision-making process. In particular, BI technologies with their well-documented benefits of data consolidation, analytical tools, and decision-making support.

(4) Awareness:

This group concerns the evaluation of major characteristic features that have the potential to seriously affect the adoption of BI technology. Data is collected about the target groups' knowledge and ranking of seven essential preselected influencing features. These features represent technological risks and social barriers to the impact of BI application and adoption. The BI implementation model and the in-depth education-to-employment process review have necessitated the presence of these indispensable features. This inquiry's objective is to examine respondents' insight into how they prioritize these distinctive features and its reflection on a successful BI adoption.

Overall, and in agreement with the employed **mixed research approach,** the survey tests the effect of variables belonging to these four groups on the adoption of the conceived BI framework, and **iteratively** provides insights to **improve** the model. Thus, conclusions will be deduced by comparing the existing situation against the framework.

6.5 Summary

In this chapter, a layout of the methodological steps of the research approach was presented. Vital BI adoption characteristic factors were identified and categorized to enable an easy to understand analysis. Data collection and the approach to validate the framework was outlined in the analysis plan. The next chapter covers in details the analysis of survey outcomes and consequence.

CHAPTER SEVEN

Results and Discussion

7 Results and Discussion

In this chapter, we present and discuss in detail a selection of significant survey results from each of the four groups of factors outlined in the previous chapter. The purpose is to effectively expose the interrelationship between seminal factors and the underlining variables in improving the current education-to-employment process and thus in support of the framework validation. The full analysis of all the three surveys' questions is listed in Appendices B, C, and D.

7.1 Statistical Methods

To achieve the objectives of the second validation track, we proceed with the analysis of the survey results. To perform the analysis, data from the questionnaires was decoded and captured into IBM's SPSS for Windows (IBM-SPSS 2018). In fact, all data was first keyed into Microsoft Excel and then imported into SPSS. All the multiple answer questions were decoded into **dichotomous** value cells and the ranking questions into multi-cell replies.

Results were cross-tabulated to examine the interdependence between variables. The following statistical methods (Johnson and Wichern 2002) were applied to analyze the collected survey results:

(1) Tests for **statistical significance** were used to confirm that the observed effect reflects the characteristics of the whole population and to validate the hypotheses.

(2) Statistical analysis was performed using **Chi-square** for test of association. A **p-value** of less than 0.05 was considered significant in all statistical analysis.

(3) Frequency distribution, Mean (μ), and Standard Deviation (STD).

(4) Frequency tables' bar, line graphs, and pie-charts were performed as **descriptive statistics**.

7.2 Initial Findings

Before delving into the detailed analysis of the selected survey questions, the following points outline a summary of preliminary observations about the collected survey results:

- When it comes to access to technology and its utilization, most respondents, i.e., students, graduates, and employers are skilled and savvy users.
- Electronic media is the most consumed information, i.e., "Social Media" and "Internet"; are the most utilized general news source for the three groups of respondents, with the first being top. Also, there is no a correlation with age, gender, organization size, HEI location or any other factor. Table 7-1 below shows a rankings' comparison of news sources between the three groups.

Table 7-1 Respondents' News Sources Comparison

Rank	Graduates	Students	Employers
1	Social Media (51.3%)	Social Media (49.8%)	Social Media (51.3%)
2	Internet (24%)	Family & Friends (26.6%)	Internet (24%)
3	TV (16%)	Internet (9.5%)	TV (16%)
4	Family & Friends (3.8%)	Newspapers (7.9%)	Family & Friends (3%)
5	Newspapers (3%)	Radio (2.9%)	Newspapers (3.8%)
6	Radio (1.1%)	TV (1.7%)	Radio (1.1%)

- Almost all students and graduates did not receive any formal career advice in their HS or HEI.

- The majority of career planning information is disseminated and received by word-of-mouth or “orally” and from alternative sources.
- Very few respondents are “Extremely Satisfied” with the career planning information they received while roughly more than 50% are “Somewhat Satisfied”.!
- An overwhelming majority of student and graduate indicated they do not know about the public employment agencies and their mission.
- Regarding intelligent systems and BI knowledge and use; intelligent solutions are ranked pretty high as a factor that helps in aligning HE output with labor market.

These aforementioned initial results are consistent with the research premise that planning and decision-support information is not readily visible and reliable; and when it is available, it is not presented in a useful manner.

These preliminary survey outcomes validate many aspects of the research objectives and this is further substantiated and solidified by the detailed analysis. As indicated earlier, a thorough analysis of a select group of questions is discussed next.

7.3 Survey Results Analysis

As outlined earlier in the chapter, here we present in detail a selection of significant survey results from each of the four main groups of validation factors. These results include correlation between different variables, statistical significance testing, and visual presentation. The four groups were explained in detail in the previous chapter, we start with results pertaining to the first group, environmental readiness.

7.3.1 Environment Readiness

This group of factors focuses on identifying information sources and stakeholders of the education-to-employment process to assess the readiness of the environment for the BI framework. And at the same time, to corroborate the data collected by cross-referencing results against reference values or preestablished information.

For this purpose, the surveys enquire about technology prevalence among students and graduates, and results in Figure 7-1 below show that the majority of the two groups are technology savvy, with most owning or using more than one communication device. Smartphones (79.1% graduates: 80.5% students) and laptops (65% graduates: 73.8% students) top the list.

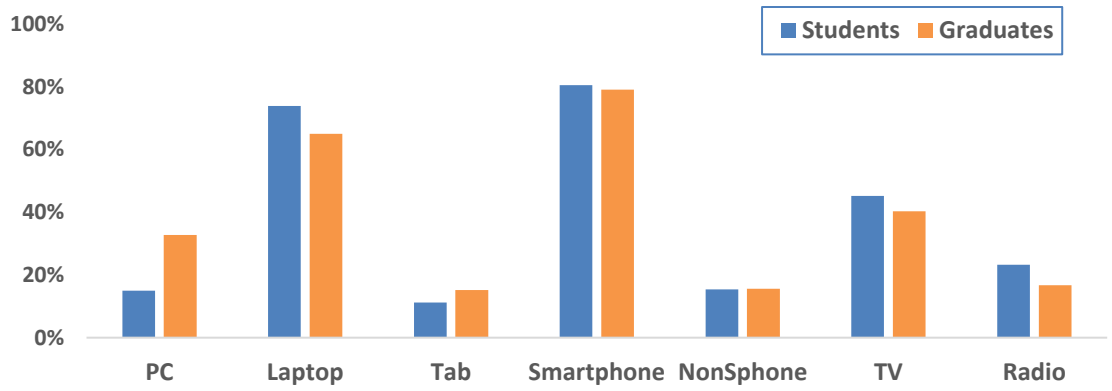

Figure 7-1 Technology Prevalence

The use of technology is quite widespread among institutions as well, since almost all the surveyed organizations own or use PCs, LANs/WLANs, Emails, Laptops and websites. As outlined in the previous chapter, infrastructure and technology readiness is a crucial factor in the successful adoption of the framework and the aforementioned results clearly confirm that the environment is ready.

Moreover, the survey found that 58% of surveyed employers are private, consistent with the Sudanese labor force survey (ILO-UNDP 2014) that found 53% of the

workforce are employed by private or family owned businesses. Also, the survey samples' gender distribution shown in Figure 7-2 below, for both students and graduates, indicates that females are slightly more than males consistent with the overall HE enrollment and output (MHESR 2017).

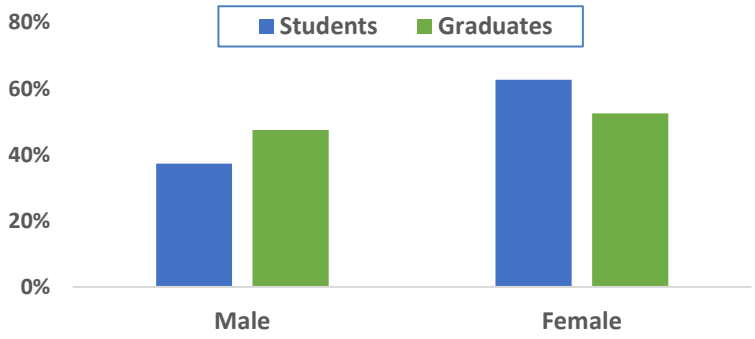

Figure 7-2 Sample's Gender Distribution

Likewise, the respondents' breakdown by public or private HE institution is reflective of the population HEI as shown in Figure 7-3 below, with 59.7% of responding graduates and 64.3% of students coming from public institutions. These results clearly demonstrate the relevance and accuracy of surveys' data and thus establish the overall quality and reliability of survey outcome.

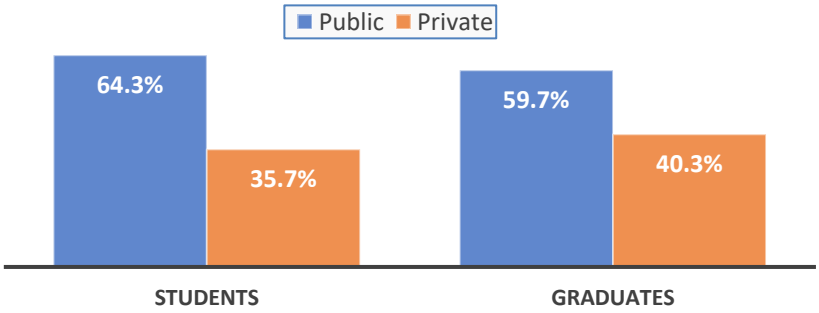

Figure 7-3 Respondents' HEI Public/Private Breakdown

In addition, the survey found the percentage of unemployed graduate respondents at (25.9%) and this is consistent with the records released by the latest released LFS (MLAR-ILO 2013) for HE graduates.

All of the findings discussed above clearly demonstrate the relevance, consistency, and accuracy of the surveys, and that the samples provide a true representation of the population, thus establishing information quality as a step in validating the framework.

7.3.2 Satisfaction

Regarding the second group of validation factors, quality of decision-support information, its sources, their reliability and satisfaction levels, the following two questions were directed to graduates and students. In the first question, the two groups were asked to *indicate the format in which they received information that helped shape their opinion about HE programs of study and possible career paths when applying for admission*. Both groups unanimously selected "verbal" while all other formats were insignificant. While in the second question, they were asked to *rank the sources of information that helped shape their opinion about programs of study and possible career paths when they were applying for HE admission*.

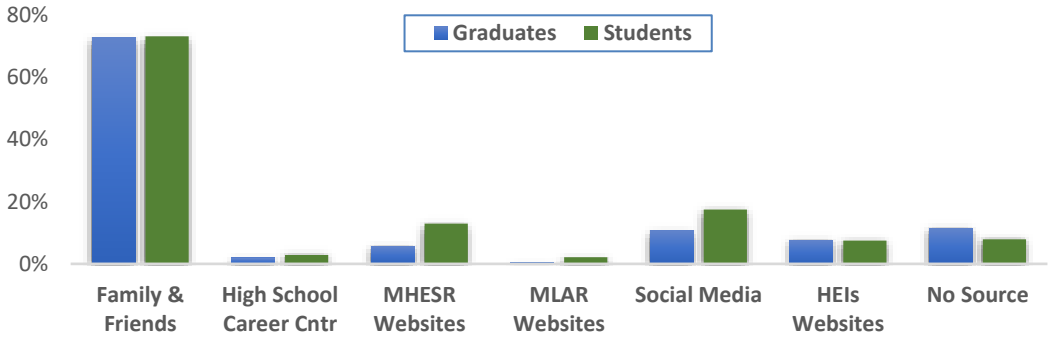

Figure 7-4 Respondents' Career Planning Information Sources

Figure 7-4 above clearly demonstrates that both respondent groups unanimously selected "Family & Friends" as top career planning information source while all other sources seem to have little or no significance as (91.6%) of graduates and (85.1%) of students opted to rank only **four** responses out of the available **seven**. Thus, it is not surprising when they were asked about their satisfaction with career planning information availability and quality, both were consistently dissatisfied. Additionally, MHESR, MLAR and HEIs websites were ranked pretty low as sources of career planning information by most respondents. These results highlight the need for a system that presents precise and accurate information at one place in an easy to use and understandable format and thus support the survey goals.

The following is a follow-up enquiry to the above-mentioned question about information sources. Respondents were asked if the decision-support data they received included any of the six attributes named in Table 7-2 below. A three-point Likert scale with ("1-Yes", "2-No", "3-U{Unsure}") was used to capture feedback. Figure 7-5 below shows the frequency distribution for the graduates' survey results.

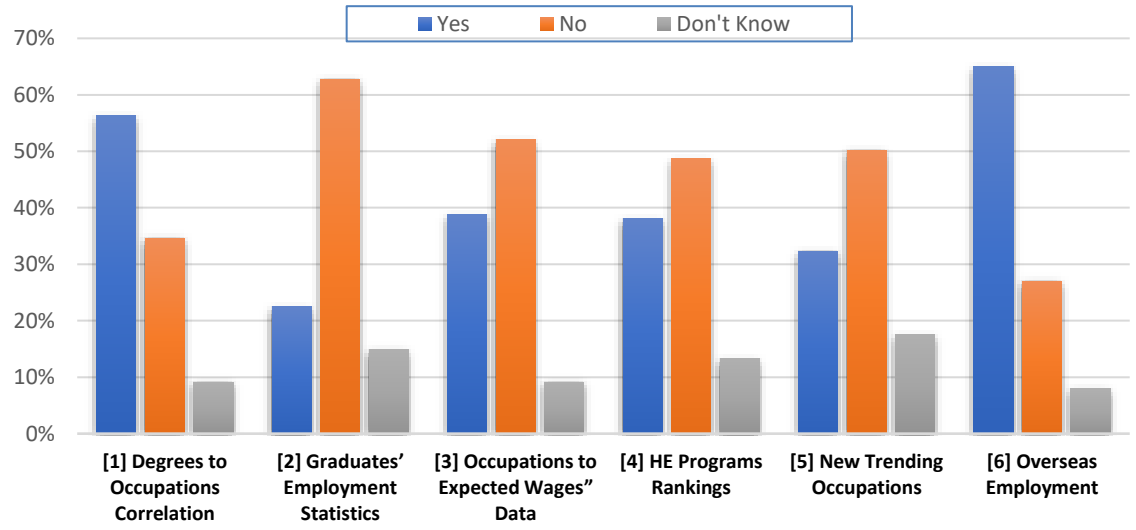

Figure 7-5 Graduates' Information Sources Integrity

From the chart (Figure 7-5) above we notice that:

- Most replies are focused between "Y" and "N" with "D" receiving the lesser share of responses.
- Respondents are certain about statements (1) and (6) as the "Y" is more than the total of replies "N" and "D" unlike all other statements.
- Statement (6) received the highest "Y" frequencies while statement (2) received the highest of "N".

Table 7-2 Graduates' Information Integrity Descriptive Statistics

Statement	Mean μ	STD	Chi-square	P-value
(1) Degrees to Occupation Correlation	**1.53**	0.658	87.886	0.000
(2) Graduates' Employment Statistics	1.92	0.607	104.608	0.000
(3) Occupation to Expected Wages	1.70	0.627	78.342	0.000
(4) HE Programs' Rankings	1.75	0.674	51.932	0.000
(5) New Trending Occupations	1.85	0.691	42.304	0.000
(6) Overseas Employment	**1.43**	0.637	133.080	0.000

Using statistical hypothesis testing, the Mean (μ), Standard Deviation (STD) and Chi-square for each statement are calculated, as shown in Table 7-2 above. All **p-values** are less than the assumption significance level 0.05, indicating **statistical significance**. That is, the observed difference is unlikely to be due to chance, and if we were to repeat the survey with different samples there is a 95% chance, we will get similar results.

Moreover, as visibly noticed earlier in Figure 7-5, all mean values in Table 7-2 except statements (1) and (6) signify no information or uncertainty.

Table 7-3 Graduates' Information Integrity Statistical Summary

Mean	STD	Chi-square	P-value	Inclination/Trend
1.70	0.649	83.0253	0.000	No or Inaccurate Info

To find the overall trend or inclination of responses for this question, the average score is computed, as presented in Table 7-3, the smaller the score the higher the agreement level. The combined mean of the collective statements is (1.70), that is pre-determined as "N" or no information, confirming that utilizing the BI framework will increase the quality of HE careers planning information. Outstandingly similar results for this question were received in the students' survey as well.

The results of the previous question tie in to the following question about *students and graduates' level of satisfaction with the availability of career planning information*. Figure 7-6 below clearly shows that there are more dissatisfied than satisfied respondents and thus further validates.

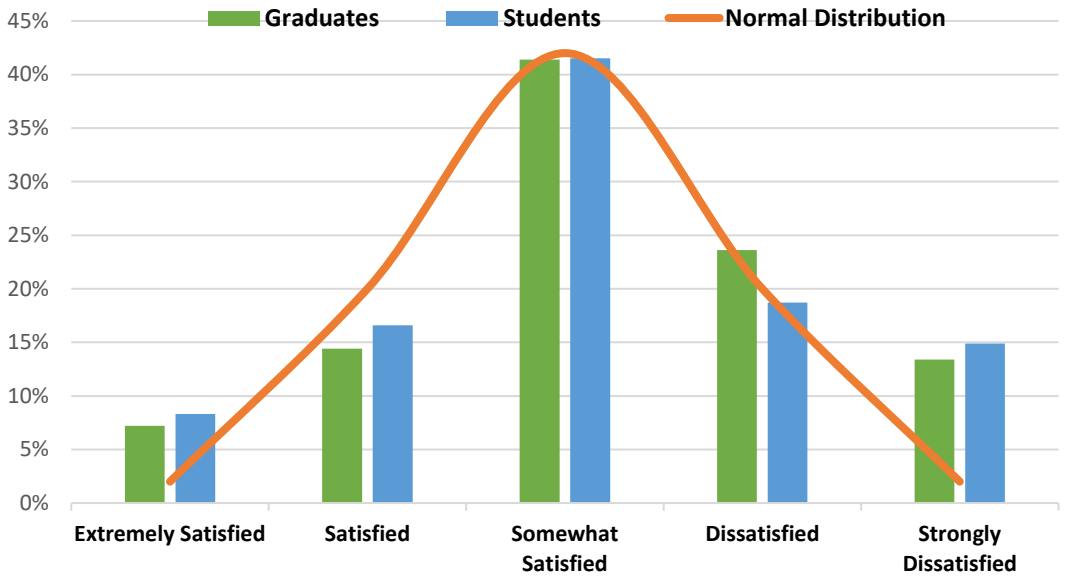

Figure 7-6 Satisfaction with Career Planning Information Availability

Continuing with the quality of decision-support information received and satisfaction levels, **employers** were asked about *their entry-level recruitment planning information, its format, and sources*. Specifically referring to information about HEIs and their programs, ranking, quality, graduation and employment ratios, etc. The survey found that a clear majority (81%) of employers use their organizations' own internal sources

to plan for and recruit entry-level hires. Another significant finding is that, about 50% (Figure 7-7 below) of employers indicated that their top factor when ranking entry-level candidates is the HEI they come from.

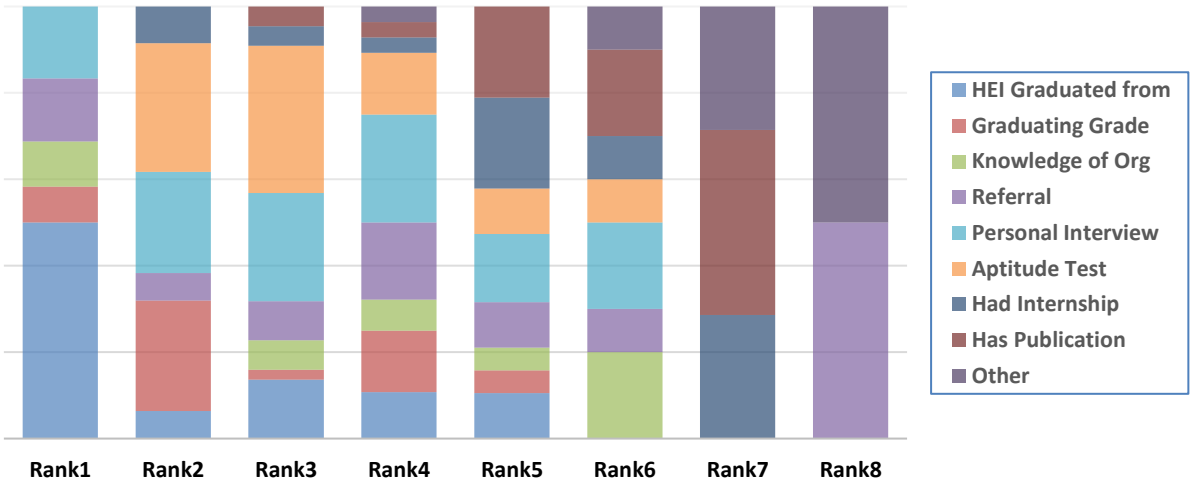

Figure 7-7 Employers' Entry-Level Candidates Ranking

With the absence of a reliable published ranking of HE institutions or and/or their program, employers are forced to rely on other alternative sources. This further demonstrates the utmost importance that HEIs, MHESR and its governing bodies must assign to disseminating comprehensive unbiased information about institutions and programs rankings. As was indicated by survey results, this ranking information is not only essential for admission but for employment as well. The availability of such actual and reliable data to students, graduates, employers and the public in general, will enhance ranking graduates and employment applicants based on concrete information and not perception.

The following Figure 7-8 shows students and graduate's response to the question about the *motivation or reasons why they chose the HE programs they are studying or have studied*.

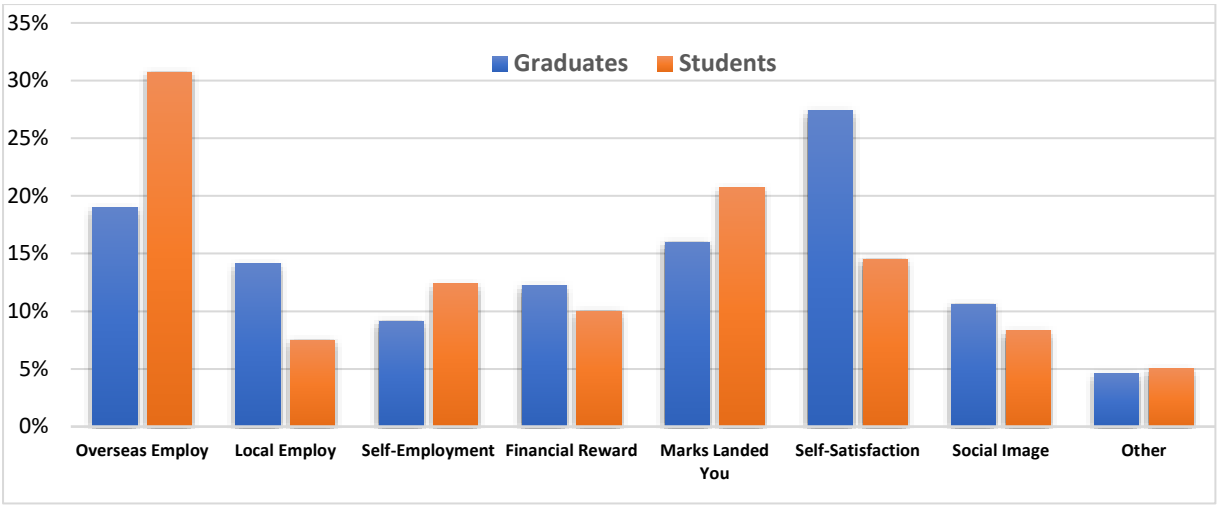

Figure 7-8 Motivation for HE Program Choice

In the case of students, about (30.7%) of questionnaire respondents chose "Overseas Employment" as their top ranked reason for selecting their HE studies program. This was followed by "Your Marks Landed You here" at (20.7%). For graduates, "Self-Satisfaction" at (27.4%) topped their choice, followed by "Overseas Employment" at (19%), and then "Your Marks Landed You here" at (16%). We also notice that the bulk of respondents limited their rankings to four with (67.6%) in the case of students and (70.7%) for graduates.

The high percentage of "Your Marks Landed You here" indicates that both groups of respondents either lacked the appropriate information at decision time or they were misinformed about their program prior to joining. This confirms our Hypothesis that HE studies and career path decisions are made based on imprecise or no information.

To assess effectiveness and reliability of job listing sources, employed graduates were asked about ***how they landed their job*** and (45.6%) chose "Family & Friends" as the top category (Figure 7-9 below).

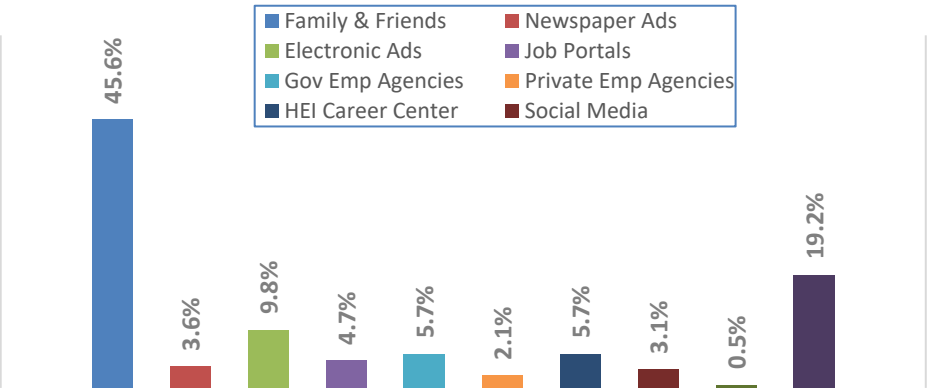

Figure 7-9 Reliability of Jobs' Sources

This fact strongly indicates that the available Job listing sources are ineffective and unreliable. At the same time, this result is in line with the UNDP-ILO study on labor force in Sudan (ILO-UNDP 2014), that found 50% of job-seekers were doing so through relatives and other connections. Also, this is compounded by the survey finding that employers prefer to announce new positions internally in their organization.

To continue with effectiveness and reliability, the following table compares the result of a question ***about the ranking of job listing sources used by respondents***. **Students** were asked *about the sources they "**expect**" to use when they start looking for jobs,* while **graduates** were asked *about the ones they **actually used** in their job-hunt*. Table 6-5 below compares the top five results, out of the ten available options, between students' and graduates' surveys.

Table 7-4 Respondents' Job Listing Sources Comparison

Rank	Students		Graduates	
1	Family & Friends	**47.7%**	Family & Friends	**57.7%**
2	Electronic Ads	22.8%	Electronic Ads	18.6%
3	Job Portals	14.1%	Social Media	12.2%
4	Social Media	10.4%	Newspaper Ads	9.9%
5	Newspaper Ads	8.3%	Other	8.7%

From Table 7-4 above, we notice that:

- The top two ranked sources are identical in the two surveys with a big gap between the top rank "Family & Friends" and the rest.
- Graduates have a stronger opinion than Students in the importance of "Family & Friends" in finding employment.
- Only the top three factors are significant, the rest have noticeably lower insignificant frequencies.
- About 75% of respondents ranked only three answers out of the ten available.
- Government employment agencies did not make the top five for both surveys.

As we noticed earlier, "Family & Friends" was the most important factor in making HE studies decisions –prior to admission– regarding which program and which career to pursue. Here –after graduation– it is still the top factor for landing a job. This situation is logical and only human as individuals tend to **rely** on their social network when there are **no** trustworthy, effective and consistent alternatives. The survey findings evidently demonstrate that information is lacking in both cases. Obviously, a lot needs to be done to improve awareness about employment agencies especially the governmental ones. This finding supports the hypothesis that HE studies and career decisions are not based on real data.

7.3.3 BI Support

The third group of validation factors investigates respondents' attitude and receptiveness towards the use of technology, specifically, in the following question, **employers** were asked *whether they believe that the business intelligence framework assists the ministry of HE and institutions in better planning the alignment of their study programs with labor market*.

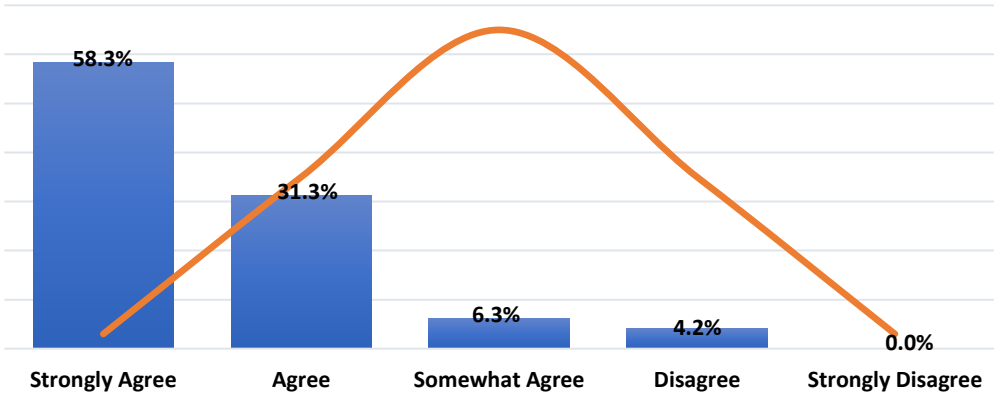

Figure 7-10 Employers' BI Helps MHESR & HEIs Align HE with Markets

The histogram in Figure 7-10 above illustrates employers' survey results showing an overwhelming majority of respondents (89.6%) agreeing with the statement (58.3% + 31.3%). At the same time, disagreement is low at (4.2%) with "Strongly Disagree" at zero, while the rest are neutral.

Table 7-5 Employers' Attitude Towards BI Statistical Summary

Mean	Median	Mode	STD	Variance	Skewness
1.56	1.0	1	0.796	0.634	1.501

To measure the **level of agreement** about the effectiveness of BI, we compute the mean as shown in Table 7-5 above, and it lies in the "Strongly Agree" range, i.e., this answer "strongly" validates the framework's effectiveness in producing the proposed alignment.

Comparable results were obtained when both students and graduates were asked similar questions *about intelligent technologies utilization to aid **HS students** in selecting their desired HE programs and possible future career.*

Table 7-6 BI Helps in Choosing HS Major and HE Study

Respondents	Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree
Graduates	27.4%	35.4%	30.4%	4.6%	2.3%
Students	21.6%	27.4%	38.6%	7.5%	5.0%

Results illustrated in Table 7-6 above, as well as ***HE students*** *in planning their professional careers* (results illustrated in Table 7-7 below). Moreover, corresponding results were obtained when employers were asked *about their institutions' use of intelligent technologies in* ***recruitment and career planning***.

Table7-7 BI Assists HE Students with Career Choices

Respondents	Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree
Graduates	24.7%	41.4%	27.4%	4.2%	2.3%
Students	17.8%	38.2%	32.4%	7.5%	4.1%

When correlating with the questions ***about knowledge of intelligent technologies and organization that use them***, we find that respondents who know what BI and intelligent systems are and know about organizations that utilize them in the country, "Strongly Agree" that they will ***help in career planning and would help MHESR***. Generally speaking, most respondents –even the ones that don't know about BI– either "Agree" or "Somewhat Agree" about this too.

It is clear from the preceding results and discussion that an overwhelming majority of respondents are quite confident that the framework is effective in producing its intended objectives.

7.3.4 Awareness

An investigation of the fourth and final group of factors, is carried out by assessing the impact of seven preselected influencing features affecting the alignment of HE and the labor market. These seven features are combined in a matrix as shown in Table 7-8 below that lays out the results of graduates' statistical analysis. A five-point Likert scale was used to measure each one's significance.

Figure 7-11 below shows the statistical distribution of the graduates' survey results.

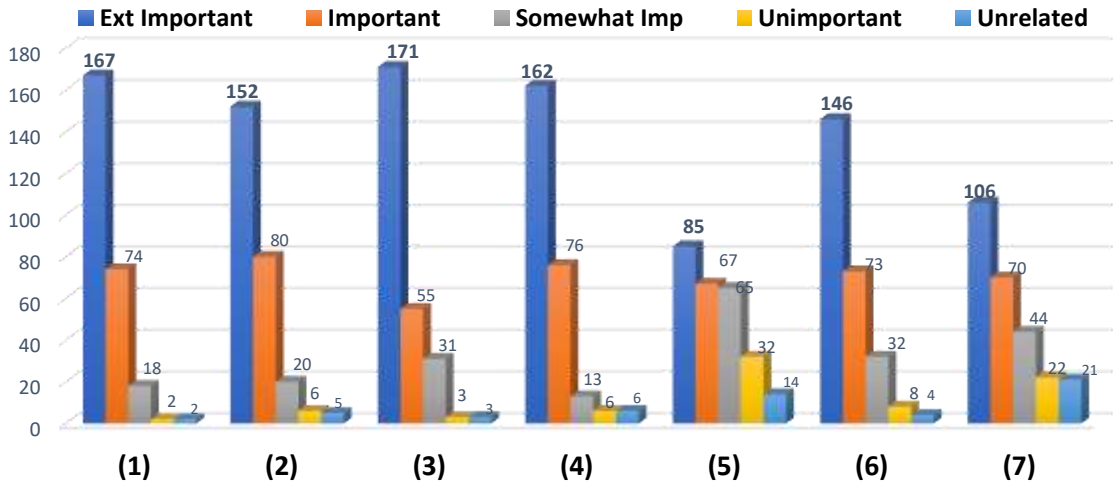

Figure 7-11 Graduates' Features Assessment Frequency Distribution

Furthermore, the same question was directed to the three groups, and the results were similar.

Table 7-8 Graduates' Features Assessment Descriptive Statistics

Factor	Mean	STD	p-value	Classification
1) Access to Labor & Employment Stats	1.47	0.725	0.000	Ext Important
2) Career Advice @HS and HEIs	1.60	0.872	0.000	Ext Important
3) Correlation between HE Progs & Occupations	1.52	0.833	0.000	Ext Important
4) Technology Use to Analyze Labor & HE progs	1.55	0.872	0.000	Ext Important
5) Social Factors	2.33	1.198	0.000	Important
6) Two-way Link between HEIs & Industry	1.67	0.912	0.000	Ext Important
7) Involve Proffesionals in HE Progs & Planning	2.17	1.265	0.000	Important
Average	**1.76**			**Ext Important**

To find the general classification of importance or trend for the matrix as a whole, we use statistical hypothesis testing on each of the seven factors as shown in the table (Chi-square not shown).

The results of the analysis indicate that:

- All p-values are less than the assumption significance level 0.05, indicating statistical significance.
- The average mean is 1.76 that ranks as “Extremely Important”. Therefore, we conclude that graduates have high confidence in these seven factors to strongly influence the alignments of HE output with markets.

A comparison of results from the three survey target groups for this question is shown in Table 7-9 below.

Table 7-9 Respondents’ Influencing Factors Assessment Comparison

Factor	Students		Graduates		Employers	
	Rank	Class	Rank	Class	Rank	Class
{1}	4	Ext Important	1	Ext Important	4	Ext Important
{2}	2	Ext Important	4	Ext Important	1	Ext Important
{3}	3	Ext Important	3	Ext Important	3	Ext Important
{4}	1	Ext Important	2	Ext Important	2	Ext Important
{5}	6	Important	6	Ext Important	6	Ext Important
{6}	7	Important	7	Imp	7	Important
{7}	5	Important	5	Imp	5	Important

Results indicate that all respondents concur that all factors are either “Extremely Important” or “Important”, implying that all seven factors are **efficient** and **effective** in aligning HE output with market needs. Moreover, factor {4} *the use of intelligent technologies to analyze labor market and HE*, was ranked top by two groups and second by the third group.

7.4 Findings Recap

While survey results have shown that the three target groups are electronically savvy, still, as an earlier result indicated, MHESR, HEIs, MLAR and Census Bureau websites and portals are ranked pretty low as sources of career planning information. The explanation, as previous findings have shown, is that these official websites and portals have pretty **low visibility** and possibly their **content** does **not provide** the useful, up-to-date, reliable information. Another fact, is the UNDP-ILO study on labor force in Sudan (ILO-UNDP 2014), found that while 15% of the unemployed were seeking employment in the public sector, only one out of ten would think of approaching the labor office or the perspective employers. Thus, more effort should be directed at enhancing awareness, accessibility as well as content of such important website and portals.

The results also showed that "Family and Friends" play a key role in decision-making due to lack of ***reliable sources***, and this research has verified that the proposed framework provides families as well as students, graduates, and employers alike, with a dependable, consistent, and authentic source to get their information.

Based on all the preceding results, analysis and findings it is concluded that the BI framework will increase efficiency as it reduces the time and effort required to acquire information and improves the information quality, presentation and reliability.

The following are highlights of the overall study's findings:

- The environment is almost ready and receptive for intelligent technologies adoption, including available electronic data, technology savvy stakeholder and organizations.
- Content, presentation and visibility of the following existing information portals need to be drastically improved:
    a. Public employment agencies and MLAR, etc.
    b. HE information sources, such as, MHESR, HEIs, etc.,

- There is substantial support for the use of technologies and BI to support decision-making throughout the examined education-to-employment process ranging from HE admission and career planning to recruitment and talent retention.
- There is strong agreement among stakeholder regarding the importance of this study's identified factors that influence the success of BI adoption.
- Satisfaction is low with the existing process's activities and procedures and expectation are high for the proposed solution.
- Current process's information is unreliable. This leads to:
    a. Almost half of employed graduates land jobs through family and friends.
    b. Employers use their internal knowledge to evaluate candidates.
    c. HE applicants rely on family and friend for career planning.
- Career planning advice and resources must be included in HS and HE curriculums.

CHAPTER EIGHT

Conclusion

8 Conclusion

8.1 Overview

This thesis introduced a framework for aligning HE and its main output with labor market dynamics and outlined a **two-track approach** for its **validation**. It has created a BI implementation model, successfully implemented and evaluated a HE admission data mart as a result of an extensive review of BI technologies, identified essential factors for the successful adoption of the BI model, and empirically examined stakeholders' attitudes and expectations toward its value and advantage. The study utilized an **embedded mixed model research** approach to simultaneously provide a better understanding of the research problem and at the same time collect quantitative and qualitative data to improve and evaluate it.

Based on the framework validation including analysis of the survey results, the findings of this study have substantiated the research hypothesis that adopting BI technologies in the education-to-employment process would yield consistent reliable information, efficient decisions, improved stakeholders' satisfaction, and ultimately better alignment of HE programs and outputs with labor market. Thus, establishing the value, necessity and importance of the research.

8.2 Contribution

The significance of this study is the demonstration of the many improvements that the BI framework brings to the education-to-employment process, by increasing the quality of information, reducing time, improving prediction capacity and increasing efficiency.

Through the implementation of the proposed BI framework, the following contributions are made in this thesis:

- The planned BI framework creates a **focal point** or **body** for the collection and analysis of reliable data from existing resources to gain knowledge and insight from available information. This body should be independent, maybe affiliated to the National Information Center (NIC) and with direct links with all stakeholder outlined in the research.
- The study has validated that essential success factors for BI implementation are **already available** including:
    - Enthusiastic technology savvy education-to-employment process stakeholders.
    - Existing electronic core data from the automated nationwide HE admission and the civil service recruitment schemes.
- The planned framework improves the sharing of existing information, transparency, collective planning and the pooling of resources.
- It is envisaged that the proposed solution will be implemented as a free access web portal, available to all stakeholder with no restriction on their pertinent information.
- The BI solution provides visual, easy to read and understand presentation of information. This is a big improvement on the current situation.
- The planned solution provides HE policymakers and employers with the capabilities of utilizing data for running impact analysis and gaining strategic insight. Thus, they can develop plans and policies based on real actionable information reflecting on employability, HE programs and economy and focusing where it matters. Examples of such information are, admission to graduation ratios, HE programs ranking, HE programs admission and employment trends, etc.

- The planned BI framework will be a valuable source of career guidance information for students and graduate so they can:
    - Have a better vision of the various employment contexts in which they can apply their academic knowledge.
    - Reduce the dependence on some of the old subjective methods of making decisions, e.g., “Family and Friends”. In fact, it could well be used to enrich families’ knowledge, involvement and experience.

Furthermore, and consistent with the mixed model research approach applied, the identification of the essential characteristic factors for the successful BI adoption is among the main outcomes of this study. The study has also shown that in the absence of reliable, and objective information, decisions are often based on non-substantiated information derived from unreliable alternative sources, which in turn lead to dissatisfaction with the whole education-to-employment process.

There are many challenges facing BI implementations including the cost and who would pay for it, misunderstanding of the concept of BI systems and what they are intended to serve, data availability, governance, security, and accuracy issues. Another challenge is that the formation of a central body (DW) to gather and link data could create friction among stakeholders and or data owners. Despite these challenges, the BI technologies investigation and survey results have revealed that many organizations in Sudan are already **utilizing BI** in some capacity with more prevalence in the banking sector.

8.3 Future Research

As directions for future work and a natural extension of this research is to explore expanding this BI framework to include other aspects of the education-to-employment process or HE in general, for example, administration, HE cost, Faculty and their contributions, strategic and short-term planning, etc. Additional data marts could be incorporated in the future to cover the many aspects discussed above. This illustrates the power of the Kimball approach and reaffirms the decision to utilize it as it will facilitate such expansion.

It is also possible to investigate other applications and benefits stemming from having the consolidated data resulting from the BI framework.

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Appendix-A The Three Survey Questionnaires

A.1: Students

Section I: Background (Personal) Information

	Issues	Ask about	Conclude on
1	Age Group	Age when: Admitted to HEI: ①16-17 ②18-19 ③20-21 ④22-23 ⑤ >23 Now: ①20-21 ②22-23 ③24-25 ④26-27 ⑤ >27	Influence of age on student/graduate decision-making.
2	Years for graduation	How many years left for your graduation? ①<1 ②2 ③3 ④4 ⑤5	Influence of year of study left on student's decision-making.
3	Gender	①Male ②Female	
4	Access to technology	Do you own or use a? {Put a ☑ by correct answer(s)} ①PC ②Laptop ③Tab ④Smartphone ⑤Non-Smartphone ⑥TV ⑦Radio	Level of technology and internet use as a source of info.
5	Sources of News	Rank your Sources of News in general ①Social media ②TV ③Radio ④Internet ⑤ Newspapers ⑥Family & Friends ⑦Other	The most popular media outlet to communicate to students/graduates.
6	Study Discipline	In which of the following MHESR categories is your study program? ①Economics & Social Studies ②Humanities ③Education ④Agriculture ⑤Health ⑥Science ⑦CS & IT ⑧Engineering ⑨Other	Group students/graduates based on MHESR program categories.
7	HEI Type	①Public ②Private	Impact of this factor on and relation to other factors
8	HEI Location	①Capital ②States	Impact of this factor on and relation to other factors
9	Motivation for HE	What was your motive for choosing the program you are studying? {Rank these} ①Overseas Employment ②Local Employment ③Self Employment ④Financial Reward ⑤Your marks landed you there ⑥Self-Satisfaction ⑦Social Image ⑧Other	Correlation between HE studies and economic opportunities. Factors influencing HEI program choice.

10	Career advice	Does the High School you graduated from have a Career and Employment Assistance Center? ①Yes ②No	
11	Internship or Summer Employment	Did you or do you intend to take an internship or work during summer breaks? ①Yes ②No	
12	Knowledge about official employment agencies	Did you know about: {Put a ☑ by correct answer(s)}? ①National Compulsory Service ②Fed Civil Service Employment Commission ③MLAR ④States Civil Service Employment Commission ⑤Nat Grads Self-Employment Fund ⑥Employment Agencies ⑦Employment Portals or Website	Gauge knowledge about official civil service and overseas employment agencies.

Section II: Students' Current Situation & Expectation about Study-Program & Labor Market

	Issues	Ask about	Conclude on
1	Source of HE studies programs and possible career path Info	When applying for HE admission, what were the sources of info that helped shape your opinion about Study Programs & possible future jobs? {Rank these} ①Family-Friends ②High School Career Center ③MHESR websites ④MLAR websites ⑤Social media ⑥HEI websites ⑦No Source	The corelation between HE programs, market needs info, and career opportunities and career paths info.
2	Integrity and completeness of HE programs' & career planning info	Did any of the above info sources provide you with: a) "Degrees to Occupations" correlation? ①**Y** ②N ③Don't Know b) Graduates' employment statistics? ①**Y** ②N ③Don't Know c) "Occupations to Expected Wages" data? ①**Y** ②N ③Don't Know d) HE programs rankings, e.g., employability, graduation rates, etc. ①**Y** ②N ③Don't Know e) "New Trending Occupations"? ①**Y** ②N ③Don't Know f) "Overseas Employment" data? ①**Y** ②N ③Don't Know	Was the Info Precise, Complete, and Accurate? Did it cover all angles and was satisfactory?
3	Usability of career planning info	In what format was the data you received from your source(s)? {Put a ☑ by correct answer(s)} ①Word-of-Mouth ②Text ③Graphs & Charts ④Tables & Listings ⑤Other	Usability accesses if the information is readable, well-presented and visualized, nd accessible to all.
4	Availability of HE progs & career path info	Are you satisfied with the HE programs & possible career path info you found? ①Extremely ②Satisfied ③Somewhat ④Dissatisfied ⑤Strongly Dissatisfied	Evaluating the visibility and availability of HE programs & possible career path info.
5	Planning Job search	When do you intend to start your professional job search? ①After graduation ②After finishing Compulsory Service ③During final year ④Two years before graduation ⑤Other	Influence of year of study left on student's decision-making.
6	Expected source of Jobs' Listing	When you start looking for employment, which of the following sources of jobs' listing you intend to use? {Rank based on importance} ①Family-Friends ②Newspaper Ads ③Electronic Ads ④Job Portals ⑤Government Placement Agencies ⑥ Private Placement Agencies ⑦HEI Career Center ⑧Social media ⑨ TV & Radio⑩Other	The best media outlet to communicate to students/graduates as it relates to Q3 in Background section.

7	Study relevance to market	Given what you know now, is your study program related to market? ①**Y** ②N ③Don't Know	Read with Q4 & Q5 in Background we could conclude on study program's relevance to market demand. Also, read with Q4 in Background it provides insight into reliability of the entire info sources that support decision-making
8	Satisfaction with discipline and possible career path	Given where you are and what you know now, are you satisfied with choices you made of the discipline you are studying and possible career path? ①Extremely ②Satisfied ③Somewhat ④Dissatisfied ⑤Strongly Dissatisfied	Accessing choices made with the available info input, their viability and longevity. When combined with Q4, Q5 and Q6 in Background section we could possibly conclude on reliability and usability of info sources.

Section III: Students' Awareness about BI and its Attributes

	Issues	Ask about	Conclude on
1	Knowledge about Data Warehouse	A Data Warehouse could be used for? {Put a ☑ by correct answer(s)} ①Historical Data ②Data Integration ③Analytics ④ Reporting ⑤Knowledge discovery ⑥Planning ⑦All the above	Evaluate awareness about BI components and terminology
2	Verify BI knowledge	BI systems are "Intelligent Solutions" that build trends from historical and real time data? ①**Y** ②N ③Don't Know	Evaluate BI awareness and perception in general
3	Source of info about BI	Where did you learn about BI systems? {Put a ☑ by correct answer(s)} ①HEI Class ②Internet Search ③ Social Media ④ Friends ⑤ Other ⑥Don't know it	Evaluate the most popular media outlet when read in conjunction with Q3 in Background section.
4	Knowledge of organizations that use BI and DWs in Sudan	Do you know of any organization that uses BI and DWs in Sudan? {Put a ☑ by correct answer(s)} ①Military ②Banks ③HEIs ④MHESR ⑤ Other ⑥Don't Know Any	Evaluate prevalence of BI in Sudan in general
5	BI utilization to assist High School students' in decision-making	Do you agree that a BI system that shows a correlation between HEI degrees, possible occupations, wages and compensation would have helped you when you chose your High School major, HEI and program? ①Strongly Agree ②Agree ③Somewhat Agree ④Disagree ⑤Strongly Disagree	Investigate BI utilization in evaluating HEI and program of study choices
6	BI utilization in assisting HE students and graduates to relate their career choices to Markets	Do you agree that a BI system that shows HEIs graduates' employment trends would have helped you make your field-of-study and career choices? ①Strongly Agree ②Agree ③Somewhat Agree ④Disagree ⑤Strongly Disagree	Investigate BI utilization in career development and program of study choices as they relate to market demand
7	The use of smart technologies to relate HE programs to Markets	Do you agree HEI's and MHESR should use technology solutions for market investigation and forecast including BI systems to assist in developing study programs that are better aligned with market demand? ①Strongly Agree ②Agree ③Somewhat Agree ④Disagree ⑤Strongly Disagree	Investigate BI utilization in HE programs development as they relate to market demand

Section IV: Factors Influencing HE alignment with labor market

Rank based on importance:

Factor	① Extremely Important	② Important	③ Somewhat Important	④ Unimportant	⑤ Unrelated
1. Accessibility of Labor Economics & Employment Statistics through a central office or website/portal					
2. Offering Career Advice in High School and at HEIs					
3. Clear correlation between HE "Degrees" and possible "Occupations"					
4. Use of Intelligent Technology solutions for market investigation and forecast in HE and making results available to students					
5. Social Factors (e.g. family and/or society priorities for certain fields-of-study)					
6. Strong "two-way" linkage between HE and Industry (e.g., internship, joint research, continuous education, etc.)					
7. Entrepreneurs and professionals' involvement in HE programs' planning and curricula development					

A.2: Graduates

Section I: Background (Personal) Information

	Issues	Ask about	Conclude on
1	Age Group	Age when: Admitted to HEI: ①16-17 ②18-19 ③20-21 ④22-23 ⑤ >23 Graduated: ①22-23 ②24-25 ③26-27 ④28-29 ⑤ >29 Now: ①20-23 ②24-27 ③29-31 ④32-34 ⑤ >34	Influence of age on student/graduate decision making.
2	Years since graduation	How many years since you graduated? ①<1 ②2 ③3 ④4 ⑤5 ⑥ 5>&<8	When read with Q6 and Q12 below, it could provide insight into study relevance and demand.
3	Gender	①Male ②Female	
4	Access to technology	Do you own or use a? {Put a ☑ by correct answer(s)} ①PC ②Laptop ③Tab ④Smartphone ⑤Non-Smartphone ⑥TV ⑦Radio	Level of technology and internet use as a source of info.
5	News Sources	Rank your Sources of News in general ①Social media ②TV ③Radio ④Internet ⑤ Newspapers ⑥Family & Friends ⑦Other	The most popular media outlet to communicate to students/graduates.
6	Study Discipline	In which of the following MHESR categories is your study program? ①Economics & Social Studies ②Humanities ③Education ④Agriculture ⑤Health ⑥Science ⑦CS & IT ⑧Engineering ⑨Other	Group students/graduates based on MHESR program categories.
7	HEI Type	①Public ②Private	Impact of this factor on and relation to other factors
8	HEI Place	①Capital ②States ③Overseas	Impact of this factor on and relation to other factors
9	Motivation for HE	What was your motive for choosing the program you are studying? (Rank these) ①Overseas employment ②Local employment ③Self Employment ④Financial reward ⑤Your marks landed you there ⑥Self-Satisfaction ⑦Social Image ⑧Other	Correlation between HE studies and economic opportunities. Factors influencing HEI program choice.

10	Career advice	Does the HEI you graduated from have a Career and Employment Assistance Center? ①Yes ②No	
11	Internship or Summer Employment	While you were studying, did you take an Internship or work during Summer breaks? ①Yes ②No	
12	Employment Status	What is your current employment status? ①Unemployed ②Employed in Private Sector ③Temp in Private Sector ④Employed in Public Sector ⑤Temp in Public Sector ⑥Self-employed ⑦ Self-Employment Fund	Study program/field relevance to market.
13	Employment agencies utilization	Did you register with: {Put a ☑ by correct answer(s)}? ①National Compulsory Service ②Fed Civil Service Employment Commission ③MLAR ④States Civil Service Employment Commission ⑤Nat Grads Self-Employment Fund ⑥Employment Agencies ⑦Employment Portals or Website ⑧HEI Career Center ⑨Other	Gauge knowledge about official civil service and overseas employment agencies.

Section II: Graduates' Current Situation & Expectation about Study-Program & Labor Market

	Issues	Ask about	Conclude on
1	Source of HE studies programs and possible career path Info	When applying for HE admission, what were the sources of info that helped shape your opinion about Study Programs & possible future jobs? {Rank these} ①Family-Friends ②High School Career Center ③MHESR websites ④MLAR websites ⑤Social media ⑥HEI websites⑦No Source	The corelation between HE programs, market needs info, and career opportunities and career paths info.
2	Integrity and completeness of career planning info	Did any of the above info sources provide you with:	Was the Info Precise, Complete, and Accurate? Did it cover all angles and was satisfactory?
		g) "Degrees to Occupations" correlation? ①**Y** ②N ③Don't Know	
		h) Graduates' employment statistics? ①**Y** ②N ③Don't Know	
		i) "Occupations to Expected Wages" data? ①**Y** ②N ③Don't Know	
		j) HE programs rankings, e.g., employability, graduation rates, etc. ①**Y** ②N ③Don't Know	
		k) "New Trending Occupations"? ①**Y** ②N ③Don't Know	
		l) "Overseas Employment" data? ①**Y** ②N ③Don't Know	
3	Usability of career planning info	In what format was the data you received from your source(s)? {Put a ☑ by correct answer(s)} ①Word-of-Mouth ②Text ③Graphs & Charts ④Tables & Listings ⑤Other	Usability accesses if the information is readable, well-presented and visualized, or accessible to all.
4	Availability of career planning info	Are you satisfied with the career planning info you found? ①Extremely ②Satisfied ③Somewhat ④Dissatisfied ⑤Strongly Dissatisfied	Evaluating the visibility and availability of career path info.
5	Source of Jobs' Listing	While looking for employment, what are the sources of jobs' listing you used? {Rank based on Importance} ①Family-Friends ②Newspaper Ads ③Electronic Ads ④Job Portals ⑤Government Placement Agencies ⑥ Private Placement Agencies ⑦HEI Career Center ⑧Social media ⑨ TV & Radio⑩Other	The best media outlet to communicate to students/graduates as it relates to Q3 in Background section.
6	Reliability of Jobs' Listing Info	Answer ONLY if employed, how did you land your job? ①Family-Friends ②Newspaper Ads ③Electronic Ads ④Job Portals ⑤Government Placement Agencies ⑥ Private Placement Agencies ⑦HEI Career Center ⑧Social media ⑨ TV & Radio⑩Other	Effective means of securing employment and their relation to sources of info.
7	Availability of Jobs' Listings	While looking for employment, were/are you satisfied with the availability and level of jobs' listings you found?	Evaluating the visibility and availability of jobs' Listings and employment info.

		①Extremely ②Satisfied ③Somewhat ④Dissatisfied ⑤Strongly Dissatisfied	
8	Job relevance to study	Answer ONLY if employed, is your job related to your field-of-study? ①**Y** ②N ③Don't Know	Read with Q4 & Q5 in Background we could conclude on field-of-study's relevance to market demand & the likelihood of finding related employment. Also, read with Q4 in Background it provides insight into reliability of the entire info sources supporting decision-making processes.
9	Satisfaction with study and career choice	Given what you know now, are you satisfied with career choice you made (the discipline you studied and career path)? ①Extremely ②Satisfied ③Somewhat ④Dissatisfied ⑤Strongly Dissatisfied	Accessing choices made with the available info input, their viability and longevity. When combined with Q4, Q5 and Q6 in Background section we could possibly conclude on reliability and usability of info sources.

Section III: Graduates' Awareness about BI and its Attributes

	Issues	Ask about	Conclude on
1	Knowledge about Data Warehouse	A Data Warehouse could be used for? {Put a ☑ by correct answer(s)} ①Historical Data ②Data Integration ③Analytics ④ Reporting ⑤Knowledge discovery ⑥Planning ⑦All the above	Evaluate awareness about BI components and terminology
2	Verify BI knowledge	BI systems are "Intelligent Solutions" that build trends from historical and real time data? ①**Y** ②N ③Don't Know	Evaluate BI awareness and perception in general
3	Source of info about BI	Where did you learn about BI systems? {Put a ☑ by correct answer(s)} ①HEI Class ②Internet Search ③ Social Media ④ Friends ⑤ Other ⑥Don't know it	Evaluate the most popular media outlet when read in conjunction with Q3 in Background section.
4	Knowledge of organizations that use BI and DWs in Sudan	Do you know of any organization that uses BI and DWs in Sudan? {Put a ☑ by correct answer(s)} ①Military ②Banks ③HEIs ④MHESR ⑤ Other ⑥Don't Know Any	Evaluate prevalence of BI in Sudan in general
5	BI utilization to assist High School students' in decision making	Do you agree that a BI system that shows a correlation between HEI degrees, possible occupations, wages and compensation would have helped you when you chose your High School major, HEI and program? ①Strongly Agree ②Agree ③Somewhat Agree ④Disagree ⑤Strongly Disagree	Investigate BI utilization in evaluating HEI and program of study choices
6	BI utilization in assisting HE students and graduates to relate their career choices to Markets	Do you agree that a BI system that shows HEIs graduates' employment trends would have helped you make your field-of-study and career choices? ①Strongly Agree ②Agree ③Somewhat Agree ④Disagree ⑤Strongly Disagree	Investigate BI utilization in career development and program of study choices as they relate to market demand
7	The use of smart technologies to relate HE programs to Markets	Do you agree HEI's and MHESR should use technology solutions for market investigation and forecast including BI systems to assist in developing study programs that are better aligned with market demand?	Investigate BI utilization in HE programs development as they relate to market demand

		①Strongly Agree ②Agree ③Somewhat Agree ④Disagree ⑤Strongly Disagree	

Section IV: Factors Influencing HE alignment with labor market

Rank based on importance:

Factor	① Extremely Important	② Important	③ Somewhat Important	④ Unimportant	⑤ Unrelated
8. Accessibility of Labor Economics & Employment Statistics through a central office or website/portal					
9. Offering Career Advice in High School and at HEIs					
10. Clear correlation between HE "Degrees" and possible "Occupations"					
11. Use of Intelligent Technology solutions for market investigation and forecast in HE and making results available to students					
12. Social Factors (e.g. family and/or society priorities for certain fields-of-study)					
13. Strong "two-way" linkage between HE and Industry (e.g., internship, joint research, continuous education, etc.)					
14. Entrepreneurs and professionals' involvement in HE programs' planning and curricula development					

A.3: Employers

Section I: Background Information

	Issues	Ask about	Conclude on
1	Organization size	Roughly, how many employees does your institution have: ①<10 ②11-50 ③51-100 ④>100	Measure the influence of organization size on technology assisted decision-making (only 2% of orgs employ >100).
2	Technology prevalence at institution	Does your institution have or use? {put a ☑ by correct answer(s)} ①Computers ②LAN ③WAN ④Mobile Internet ⑤Website ⑥Web Portal ⑦None	Level of technology and internet use as both a source and outlet of info as these correlates to decision-making.
3	How long in business	How long has your organization been in business? ①<1 ②2-5 ③6-10 ④>10	Influence of how long organization has been in business on technology assisted decision-making.
4	Organization SECTOR type (Int. classification)	How do you categorize your organization? ①Governmental ②Semi-Government ③Public ④Private ⑤Mixed ⑥Cooperative ⑦Other	Gauge the influence of organization sector on technology assisted decision-making. (LFS 53% work private or fam)
5	Organization recognition of HE significance	Does your organization encourage staff in any way (incentive or otherwise) to: {put a ☑ by correct answer(s)}? ①Sit in HE Boards ②Teach @HEI ③Study for HE degree ④None	Assess the organization's value for HE studies and correlate it to Q1 thru Q4.
6	Organization support for HE	Does your organization: {put a ☑ by correct answer(s)} ①Sponsor any HEI or program ②Have joint HE collaboration project ③Support HEI Recruitment Center ④Organize HE recruitment Fair ⑤None	Evaluate the organization's links to HE programs as a means to foster better recruitment and alignment with organization goals.
7	Study Discipline	Rank your organization's most hires in the last 5 years out of these MHESR categories? ①Economics & Social Studies ②Humanities ③Education ④Agriculture ⑤Health ⑥Science ⑦CS & IT ⑧Engineering ⑨Other	Group new hires based on MHESR 9 program categories as a measure market demand.

8	Internship or Summer Employment	Does your organization have an internship or students' summer employment program? ①**Y** ②N ③Don't Know	Availability of Internship and/or Summer employment. When read with Q5 above it could provide insight into organization's commitment to HE.
9	New hire Training	Does your organization have a STRUCTURED training path for new entry-level hires? ①**Y** ②N ③Don't Know	New-hire training when read with Q8 above provides insight into organization's value for HE studies.

Section II: Employers' Current Situation & Expectation about Labor Market

	Issues	Ask about	Conclude on
1	Source of entry-level recruitment planning Info	What sources of info about HE graduates does your organization use to plan its entry-level recruitment policy? {rank these} ①Organization's own sources ②MHESR & its websites ③MLAR & its websites ④HEI & their websites ⑤HEI Career Centers ⑥Social media ⑦Central Bureaus of Statistics ⑧No Source	The correlation between HE programs, organization needs, & career opportunities and paths info. (e.g., of recruitment planning info: which HE progs have better quality grads, what progs are offered by which HEIs, what aspects about grads the org is prioritizing, etc.)
2	Integrity and completeness of entry-level recruitment planning info	Does any of the above info sources provide you with: a) HE Degrees to Progs Correlation data? ①**Y** ②N ③Don't Know b) HE Graduates Employment data? ①**Y** ②N ③Don't Know c) Occupations & Expected Wages data? ①**Y** ②N ③Don't Know d) HE progs rankings, e.g., employability, grad rate, etc. ①**Y** ②N ③Don't Know e) New Trending Occupations? ①**Y** ②N ③Don't Know	Completeness and accuracy of info flowing INTO the organization? Did it cover all angles and was satisfactory? (e.g., which HE progs to hire from & what degrees to look for, etc.)
3	Usability of recruitment planning info	In what format was the data you received from your source(s)? {put a ☑ by correct answer(s)} ①Word-of-Mouth ②Text ③Graphs & Charts ④Tables & Listings ⑤Other	Usability. Accesses if the information is readable, well-presented, visualized, and accessible to all.
4	Availability of entry-level recruitment planning info	Are you satisfied with the career planning info you found? ①Extremely ②Satisfied ③Somewhat ④Dissatisfied ⑤Strongly Dissatisfied	Evaluating the visibility and availability of recruitment planning info. Recruitment planning info has DIRECT bearing on organization's hiring-decisions.
5	Media outlets for entry-level jobs' Listing	What are the preferred media outlets for your organization's entry-level jobs listing? {rank these} ①Internal @organization ②Organization website ③Newspaper Ads ④Job Portals ⑤Government Placement Agencies ⑥Private Placement Agencies ⑦HEI Career Center ⑧Social media ⑨ TV & Radio ⑩Other	The best media outlet to advertise entry-level positions to students/graduates as it relates to Q2 in Background section. (info going OUT of the org is divided into general info about org AND job listing info)
6	Reliability of outlets for entry-level jobs' listing	Rank these outlets based on numbers employed in the last 5 years. ①Internal @organization ②Organization website ③Newspaper Ads ④Job Portals ⑤Government Placement Agencies ⑥Private Placement Agencies ⑦HEI Career Center ⑧Social media ⑨ TV & Radio ⑩Other	Explore the effectiveness of the used outlets in securing employment.

7	Media outlets for promoting organization achievements & goals	What are the media outlets utilized by your organization to better inform prospective candidates and the public about its achievements? {rank these} ①Employees ②Organization website ③Newspapers ④HEI Career Center ⑤Social media ⑥TV & Radio ⑦Career Fairs ⑧Other	The best media outlet to communicate organization achievements and results to the public and prospective candidates as it relates to Q5 in Background section.
8	Visibility of organization info to candidates	Are you satisfied with the level of knowledge about the organization, its achievements & goals by entry-level applicants? ①Extremely ②Satisfied ③Somewhat ④Dissatisfied ⑤Strongly Dissatisfied	Evaluating the visibility and availability of info about organization to prospective candidates and how that influences employment.
9	Ranking candidates	How do you rank your entry-level applicants? {rank these} ①HEI graduated from ②Graduating Grade ③Knowledge of organization ④Referral ⑤Personal Interview⑥Aptitude test ⑦Had Internship ⑧Has Publication ⑨Other	Weighing the factors that influence organization's hiring-decisions as they relate to organization sources and outlets of info.

Section III: Employers' Awareness about BI and its Attributes

	Issues	Ask about	Conclude on
1	Knowledge about Data Warehouse	A Data Warehouse could be used for? {put a ☑ by correct answer(s)} ①Historical Data ②Data Integration ③Analytics ④ Reporting ⑤Knowledge discovery ⑥Planning ⑦All the above	Evaluate awareness about BI components and terminology.
2	Verify BI knowledge	BI systems are "Intelligent Solutions" that build trends from historical and real time data? ①**Y** ②N ③Don't Know	Evaluate BI awareness and perception in general.
3	Organization BI utilization	Does your organization utilize any "Intelligent Solutions"? ①**Y** ②N ③Don't Know	Organization use of BI
4	Source of info about BI	Where did you learn about BI systems? {put a ☑ by correct answer(s)} ①HEI Class ②Online search ③ Social Media ④ Friends ⑤ Other ⑥Don't know it	Evaluate the most popular media outlet when read in conjunction with Q4 in Background section.
5	Knowledge of organizations that use BI and DWs in Sudan	Do you know of any organization that uses BI and DWs in Sudan? {put a ☑ by correct answer(s)} ①Military ②Banks ③HEIs ④MHESR ⑤ Other ⑥Don't Know Any	Evaluate prevalence of BI in Sudan in general.
6	Central (MHESR, MLAR & States data) BI utilization to assist organization recruitment	Do you agree that a BI system that correlates data about HE graduates, degrees, labor market indicators, and tracks the progress of entry-level hires would have helped your organizations in recruiting and retaining best talents? ①Strongly Agree ②Agree ③Somewhat Agree ④Disagree ⑤Strongly Disagree	Study the anticipated effect of utilizing a central BI system that receives data from MHESR, MLAR, States, CBS, etc., in organization's recruitment of best talents.
7	The use of smart technologies to relate HE programs to Markets	Do you agree HEI's and MHESR should use technology solutions for market investigation and forecast including BI systems to assist in developing study programs that are better aligned with market demand? ①Strongly Agree ②Agree ③Somewhat Agree ④Disagree ⑤Strongly Disagree	Consider BI utilization in HE programs development and planning as they relate to market demand.

Section IV: Factors Influencing HE alignment with labor market

Rank based on importance:

Factor	① Extremely Important	② Important	③ Somewhat Important	④ Unimportant	⑤ Unrelated
15. Accessibility of Labor Economics & Employment Statistics through a central office or website/portal					
16. Offering Career Advice in High School and at HEIs					
17. Clear correlation between HE "Degrees" and possible "Occupations"					
18. Use of Intelligent Technology solutions for market investigation and forecast in HE and making results available to students					
19. Social Factors (e.g. family and/or society priorities for certain fields-of-study)					
20. Strong "two-way" linkage between HE and Industry (e.g., internship, joint research, continuous education, etc.)					
21. Entrepreneurs and professionals' involvement in HE programs' planning and curricula development					

Appendix-B Students' Survey Analysis (ToC)

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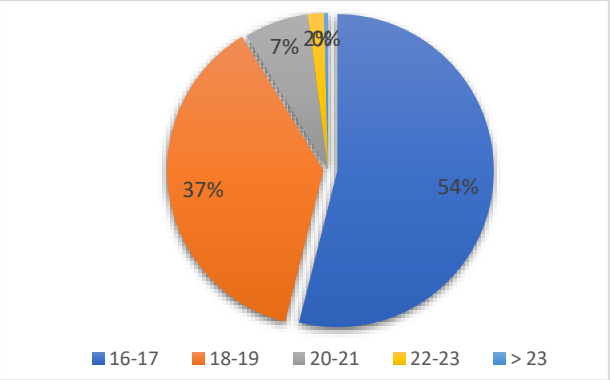
Section-1: Basic Information

Q1: Age at Admission to HEI

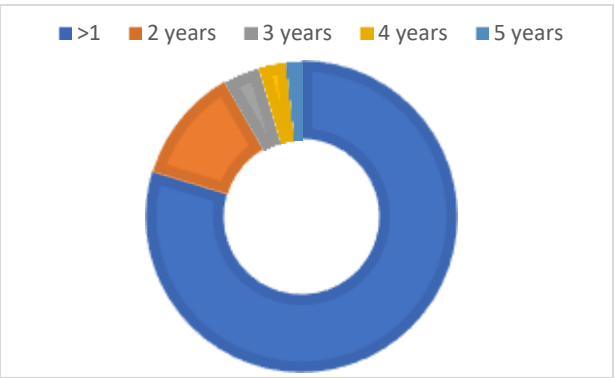
Age Group	Frequency	Percent
16-17	130	53.9%
18-19	90	37.3%
20-21	16	6.6%
22-23	4	1.7%
> 23	1	0.4%
		100%



An overwhelming majority of questionnaire respondents were admitted to a HEI when they were between 16-19 years of age (91.2%) {16-17 (53.9%) + 18-19 (37.3%)}. In section-2, we will explore what do students at this tender age use as sources of information about HE studies and possible careers. Do they rely on their Family to help with their study discipline and career decisions or do they have other sources.!

Q2: Years Until Graduation

Years	Frequency	Percent
>1	192	79.7%
2 years	29	12.0%
3 years	9	3.7%
4 years	7	2.9%
5 years	4	1.7%
		100%



Most questionnaire respondents had one (79.7%) or two (12%) years left to graduate. This is in line with the intended Target Group (Students that are about to graduate and look for employment).

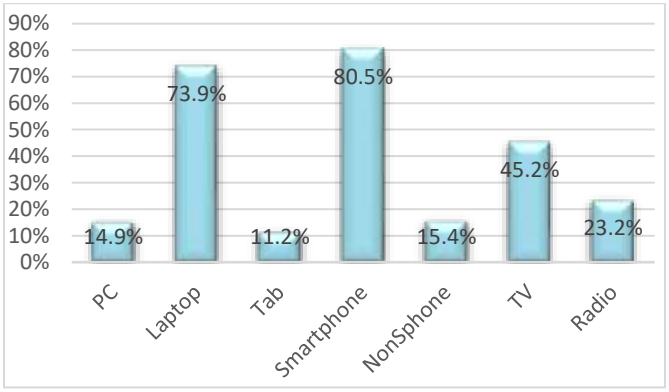
Q3: Gender

Gender	Frequency	Percent
Male	90	37.3%
Female	151	62.7%
		100%

The majority of respondents are female (62.7%). This is consistent with the overall enrollment in HEIs.

Q4: Access to Technology: Do you have or use any of the following?

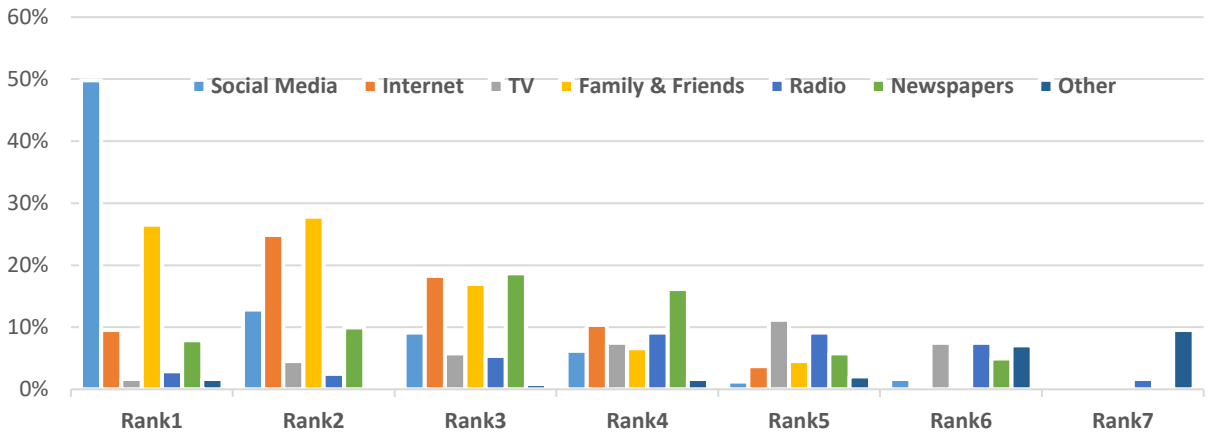
Category	Frequency	Percent
PC	36	14.9%
Laptop	178	73.9%
Tab	27	11.2%
Smartphone	194	80.5%
Non-smartphone	37	15.4%
TV	109	45.2%
Radio	56	23.2%



Smartphones are top followed by laptops. This shows that respondents are technology savvy.

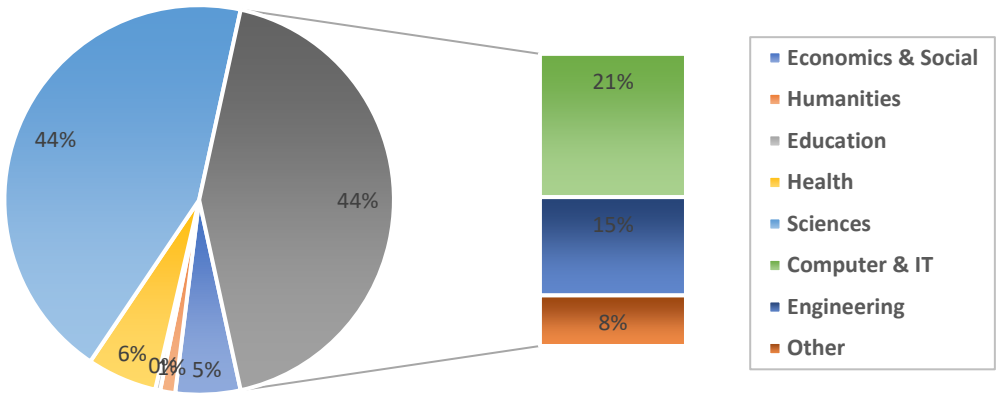
Q5: Students' News Sources Rank

	News Source	Rank1	Rank2	Rank3	Rank4	Rank5	Rank6	Rank7
1	Social Media	120	31	22	15	3	4	1
2	Internet	23	60	44	25	9	0	0
3	TV	4	11	14	18	27	18	0
4	Family & Friends	64	67	41	16	11	0	0
5	Radio	7	6	13	22	22	18	4
6	Newspapers	19	24	45	39	14	12	0
7	Other	4	1	2	4	5	17	23



Social Media is the top source of news followed by Family and Friends, Online Internet news, and then Printed Newspapers, TV and Radio. These TOP sources here are good medium candidates to communicate information to Students. This result together with Q4 (Access to Technology) indicates that electronic information and "Family and Friends" are the preferred means for Students.

Q6: Field of Study Distribution



It is clear that the Science respondents are the top group and this is due to their accessibly for the surveyor, but obviously all study programs are adequately represented in the survey sample.

Q7: Higher Education Institutions Type

HEI Type	Frequency	Percent
Public	155	64.3%
Private	86	35.7%

Private HEI respondents constitute (35.7%) of the overall survey sample. This is a nice balance that reflects and is consistent with the HEI community overall.

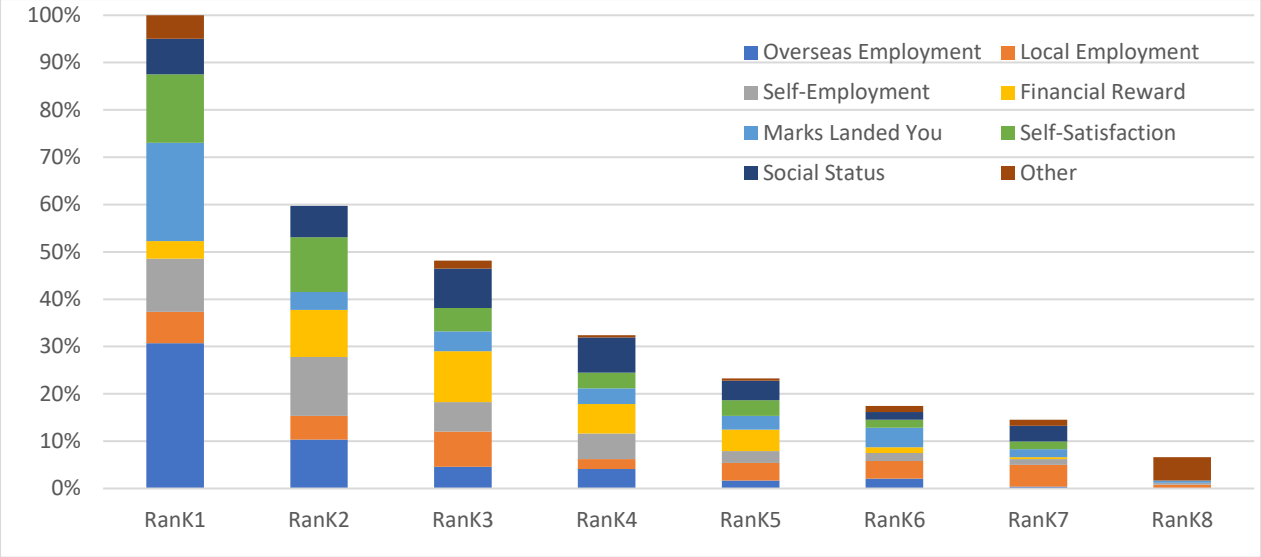
Q8: Higher Education Institutions Location

HEI State	Frequency	Percent
Khartoum	187	77.6%
Other State	54	22.4%

This shows that the survey sample strikes a good balance between respondents who study in the capital Khartoum (77.6%) and the ones who study in other states (22.4%).

Q9: Motivation for Study Program Rank

Reason	RanK1	RanK2	RanK3	RanK4	RanK5	RanK6	RanK7	RanK8
Overseas Employment	30.7%	10.4%	4.6%	4.1%	1.7%	2.1%	0.4%	0.0%
Local Employment	6.6%	5.0%	7.5%	2.1%	3.7%	3.7%	4.6%	0.8%
Self-Employment	11.2%	12.4%	6.2%	5.4%	2.5%	1.7%	1.2%	0.4%
Financial Reward	3.7%	10.0%	10.8%	6.2%	4.6%	1.2%	0.4%	0.0%
Marks Landed You	20.7%	3.7%	4.1%	3.3%	2.9%	4.1%	1.7%	0.4%
Self-Satisfaction	14.5%	11.6%	5.0%	3.3%	3.3%	1.7%	1.7%	0.0%
Social Image	7.5%	6.6%	8.3%	7.5%	4.1%	1.7%	3.3%	0.0%
Other	5.0%	0.0%	1.7%	0.4%	0.4%	1.2%	1.2%	5.0%
No Rank	0.0%	40.2%	51.9%	67.6%	76.8%	82.6%	85.5%	93.4%



Compare this with Graduates Motivation.

About (30.7%) of questionnaire respondents chose "Overseas Employment" as their top ranked reason for selecting their HE studies program. This was followed by "Your Marks Landed You here" at (20.7%). While (14.5%) selected "Self-Satisfaction" and (12.4%) selected "Self-Employment". We also notice that the bulk of respondents limited their rankings to four with (67.6%).
The high percentage of "Your Marks Landed You here" indicates that students either lacked the appropriate information at decision time or they were misinformed about their program prior to joining. This confirms our Hypothesis that HE studies and career path decisions are made based on imprecise or no information.

Q10: High School offer Career Planning or Employment Assistance?

	Frequency	Percent
Yes	37	15.35%
No	204	58.65%
		100%

Majority (58.6%) of respondents did not get any career planning or employment assistance.

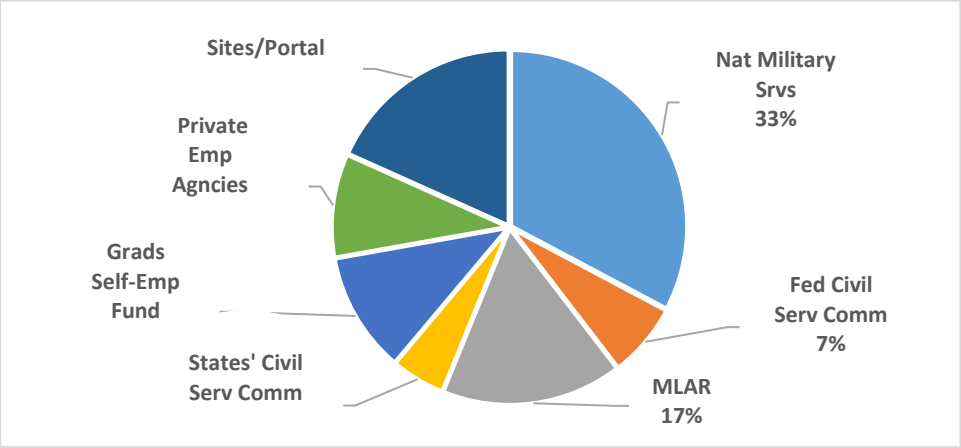
Q11: Plan on Internship or Work during Summer

	Frequency	Percent
Yes	151	62.7%
No	90	37.3%
		100%

Majority (62.7%) of respondents plan on doing an Internship or Work during the Summer.

How does this fit with EMPLOYERS? Do they offer such programs? Do they prefer hiring graduates who had Internship or work experience?

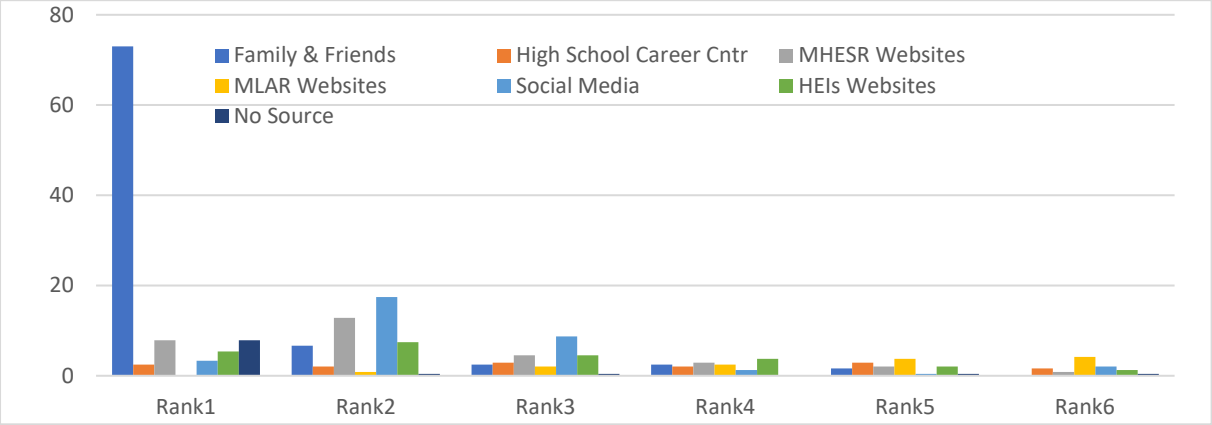
Q12: Knowledge about Official Employment Agencies



The top rank “National Military Service” is not an employment agency and when compared to the rest there is a big gap (first rank at 33% and second at 18%). It is vividly obvious that a lot needs to be done to increase visibility of employment agencies especially the governmental ones. This supports our hypothesis about the lack of employment and career planning information.

Section-2: Current Situation and Expectation

Q1: HE Studies and Career Planning Info Sources' Rank



A large majority (73%) of respondents chose "Family & Friends" as their one-and-only information source. Social Media is a distant second choice at (17.4%) followed by MHESR website at (12.9%). (74.3%) of respondents chose only 3 information sources. This confirms the hypothesis that HE studies decisions are not made based on study program information let alone labor market information.

Q2: HE Studies and Career Info Sources' Attributes

This question is divided into sub-questions, it intends to measure the level of agreement of respondents with statements about their information sources' integrity and comprehensiveness in reference to study programs and career planning data. We want to measure if the Information they receive cover the outlined subcategories.

A Likert scale is used here with answers {①Yes ②No ③Don't Know}. The way to analyze this type of questions is by calculating the Mean, Standard Deviation (STD) and Chi-square for each question and then calculating the average score and figuring out where it lies on the scale. The smaller the score (closer to ONE) the higher the agreement level.

Sub-Questions Frequencies' Distribution and Percent

	Statement	Frequency			Percent		
		Y	N	D	Y	N	D
1	Degrees to Occupations Correlation	143	63	35	59.3%	26.1%	14.5%
2	Graduates' Employment Statistics	55	149	37	22.8%	57.7%	19.5%
3	Occupations to Expected Wages" Data	118	88	35	49.0%	36.5%	14.5%
4	HE Programs Rankings	102	90	49	42.3%	37.3%	20.3%
5	New Trending Occupations	88	113	40	36.5%	46.9%	16.6%
6	Overseas Employment	168	53	20	69.7%	22.0%	8.3%

From the frequency table above, we notice that most respondents' replies for all the six statements were concentrated between "Y" and "N" with the "D" response receiving the

lesser share of responses. For example, for statement (1), replies "Y" and "N" together received 85.4% and "D" received only 14.5%. This indicates that respondents have a clear and strong opinion about their responses and that they are not inclined to "D" (not-know). Statement (6) received the highest overall frequency of 168 "Y" or 69.7%, followed by statement (2) with 149 "N" or 57.7%.

The frequency total of replies "N" and "D" for all statements is more than reply "Y" expect for statement (1) and (6). For example, for statement (4), replies "N" and "D" together received 57.6% and "Y" received only 42.3%. So, respondents either have received no information or they do not know except for Statements (1) and (6). This is a strong indication that most of the HE programs and career planning information received by respondents is imprecise, incomplete, and inaccurate. This confirms our hypothesis.

Sub-Questions' Descriptive Statistics

Statement		Mean μ	Median	Mode	STD	Chi-square	DF	P value	Inclination
1	Degrees to Occupations Correlation	1.55	1.00	1	.735	78.207	2	.000	Strong Info
2	Graduates' Employment Statistics	1.97	2.00	2	.651	64.664	2	.000	No or Inaccurate
3	Occupations to Expected Wages" Data	1.66	2.00	1	.720	43.975	2	.000	No or Inaccurate
4	HE Programs' Rankings	1.78	2.00	1	.762	19.228	2	.000	No or Inaccurate
5	New Trending Occupations	1.80	2.00	2	.702	34.266	2	.000	No or Inaccurate
6	Overseas Employment	1.39	1.00	1	.636	150.282	2	.000	Stronger Info

{ranges/values=2/3 =0.6; then ranges are:1-1.6, 1.7-2.2, 2.3-2.8}

From the table above Descriptive Statistics table, we observe that:

- All the p-values are less than the assumption significance level 0.05, indicating statistically significant differences in the distribution of respondents' replies to the different response options (Y, N, D). That is, the observed difference is unlikely to be due to chance, and if we were to repeat the survey with different samples there is a 95% chance we will get similar results.
- Furthermore, from the table, all mean values for all statements are between 1.39 – 1.97
- STD values are between 0.636 – 0.762, this indicates the homogeneity of respondents' responses

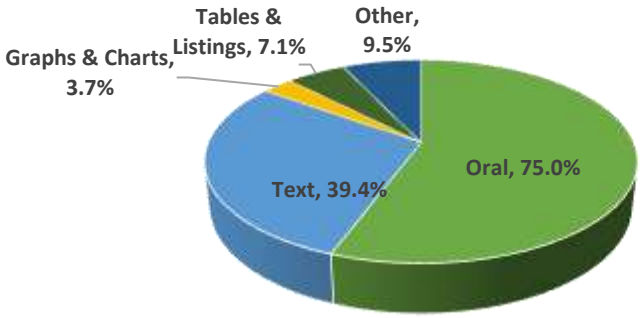
To find the overall trend or inclination of responses for this question as a whole (with all its sub-questions or statements), we calculate the average from the above Descriptive Statistics table as seen in the table below.

Mean	STD	Chi-square	DF	P value	Inclination
1.69	0.701	65.10367	2	0.000	No or Inaccurate

From this summary table above, we can see that the combined **mean** of all the collective statements is (1.69), which is pre-determined as "N" or No Information, therefore we confirm the hypothesis that the HE programs and career planning information received by respondents is imprecise, incomplete, and inaccurate.

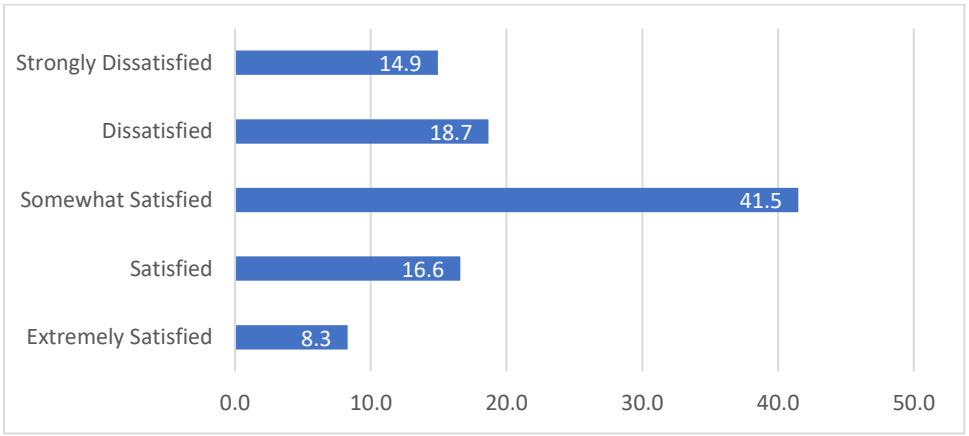
Q3: Format of Data Received

Data Format	Freq Percent	Mean	Median	Mode	STD	Variance
Oral	75.0%	0.71	1.00	1	0.457	0.209
Text	39.4%	0.39	0.00	0	0.490	0.240
Graphs & Charts	3.7%	0.04	0.00	0	0.190	0.036
Tables & Listings	7.1%	0.07	0.00	0	0.257	0.066
Other	9.5%	0.10	0.00	0	0.294	0.087



The majority (75%) of respondents indicated that they have received their HE studies and possible career planning information in verbal or "Oral" format. This was followed by "Text" at (39.4%). The rest of data formats were minimal. This result together with the response to Q1 about information sources, clearly shows that students receive most of their information about HE studies and possible careers by word-of-mouth and from relatives and friends.

Q4: Satisfaction with Career Planning Info Availability

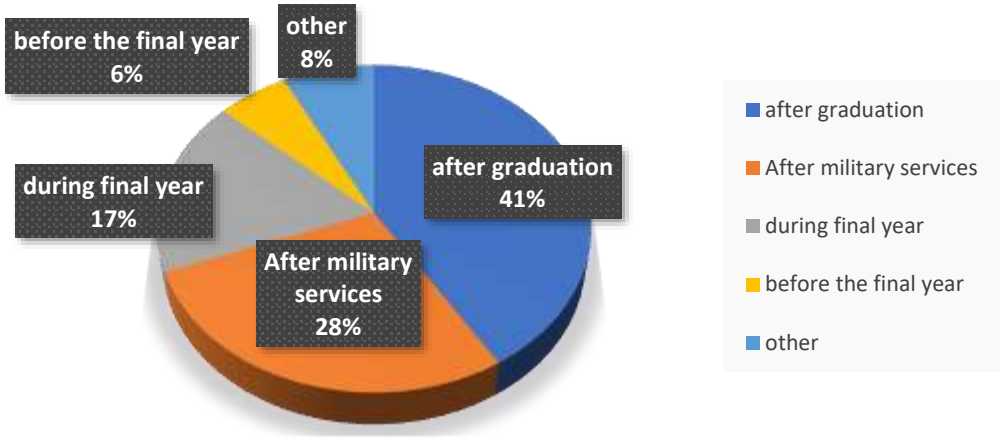


Here a Likert scale is used here with answers {①Extremely Satisfied ②Satisfied ③Somewhat Satisfied ④Dissatisfied ⑤Strongly Dissatisfied}. We calculate the Mean, Median, and Mode to find out the direction or trend of responses (see table below).

Mean	Median	Mode	STD	Variance
3.15	3.00	3	3.124	1.264

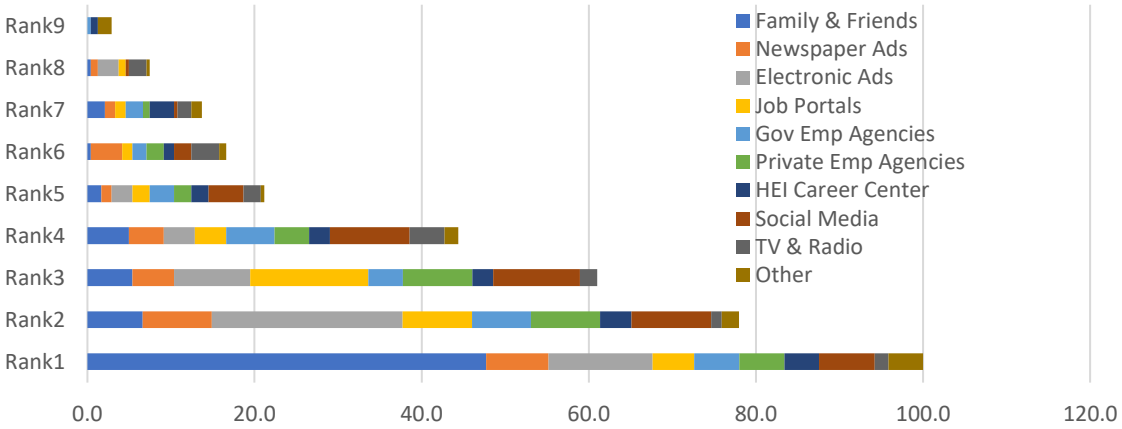
As we see in the table above, the **Mean** > **Median** > M**ode**, this statistically implies that the distribution is skewed to the right, i.e., most respondents are inclined towards Dissatisfaction with career planning information availability. This result highlights the need for a system that presents precise and accurate information in an easy to use and understand format.

Q5: When to Start Looking for Employment



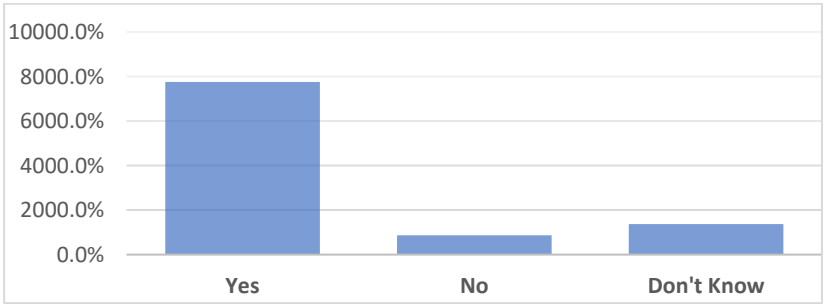
Most respondents (69%) want to start their job-hunt after graduation, with (28%) indicating they want to start after graduating and completing the compulsory military service and (41%) after graduation.

Q6: Expected Job Listing Sources' Rank



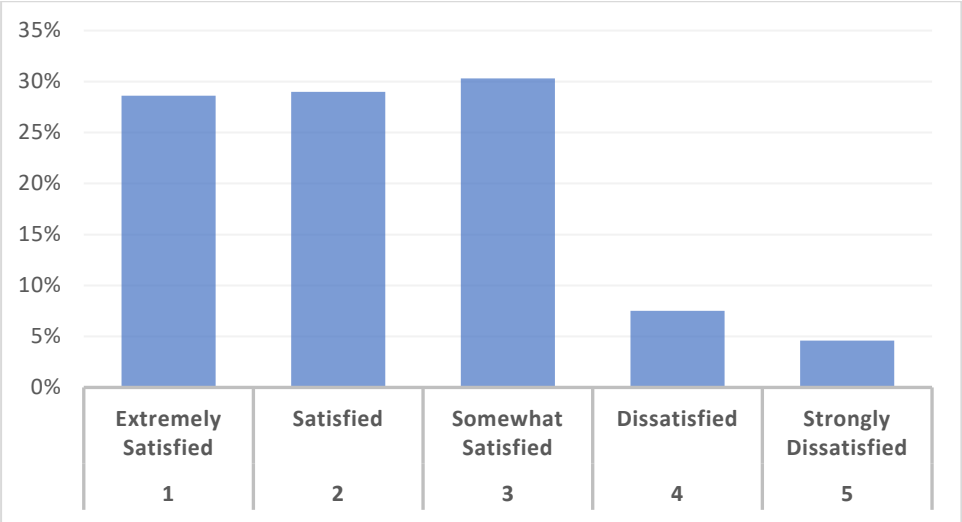
47.7% of respondents ranked "Family & Friends" as their top expected source for finding and landing a job. As we saw in Q1 of this section (HE Studies and Career Planning Info Sources), "Family & Friends" is the most important factor in making HE studies decisions prior to admission and here it is the top networking factor for landing a job. This agrees with the hypothesis that HE studies and possible career decisions are not based on real data.

Q7: Study Relevance to Market



A big majority (77.6%) of respondents believe that their study is related to labor markets. This result together with the response to Q1 about information sources and Q2 about received data format, clearly confirms that the main source of students' relevant information is relatives and friends and the main medium is by word-of-mouth. Hence, we can confirm the hypothesis that the HE programs and career planning information received by respondents is imprecise, incomplete, and inaccurate.

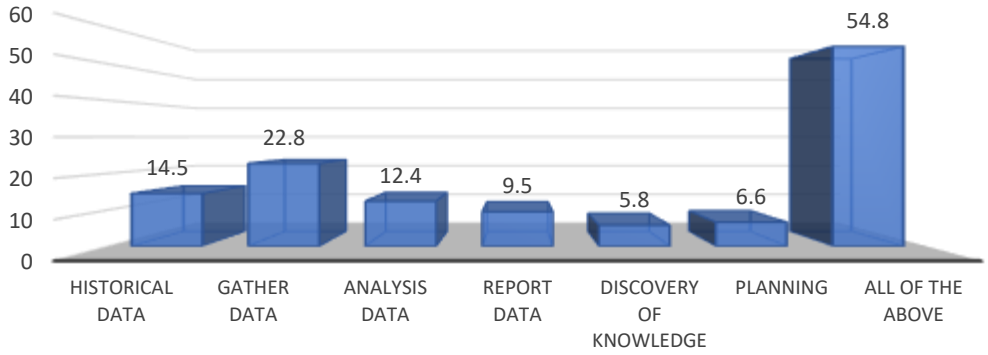
Q8: Satisfied with your Study and Possible Career Path



Here most of the replies lie between "Extremely Satisfied" and "Somewhat Satisfied" with far fewer (12.1%) voices of dissatisfaction. It is a bit strange if we correlate this with Q9 of section-1 (Motivation for Study Program Selection), where 20.7% say that they did not choose their program of study, rather, they just landed there! A possible explanation is that once students are in the program, they learn more about it and the possible career path that it leads to, then they accept, adapt and like it in spite of not having chosen it to begin with. One could argue that lack of information prior to admission has obscured students' judgement and once they are enrolled and learn more information, they tend to appreciate and accept it. This highlights the importance of having reliable sources of information and does reinforce the hypothesis that utilizing a BI solution offers dependable information that is easy to use and understand and thus facilitates aligning HE output with market demand.

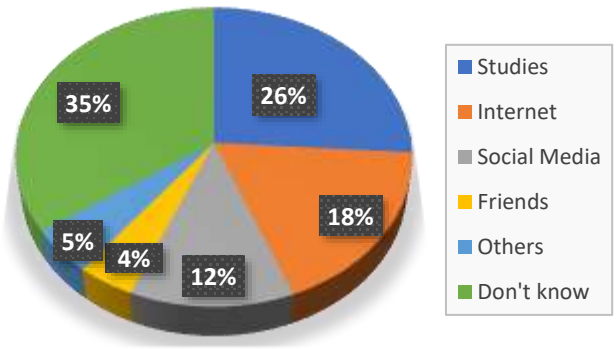
Section-3: Students' Awareness about BI

Q1: Knowledge about Data Warehouse



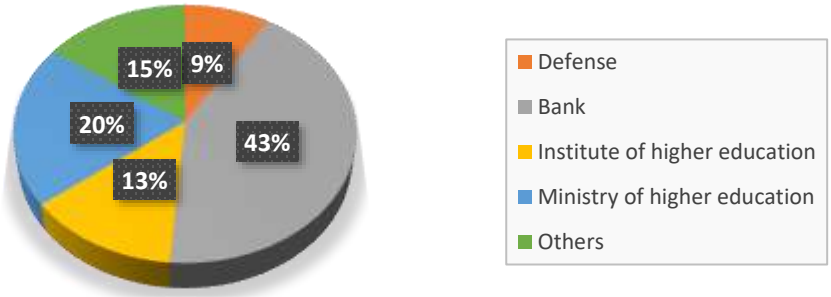
More than half the respondents (54.8%) identified all attributes of Data Warehouses, while (45.2%) identified one or more attributes. This question is designed to provide information to respondents at the same time that we solicit their response.

Q2: Sources of Knowledge about BI



Most respondents (65%) already know about BI with their knowledge attributed to different sources as seen in the chart above. Of this majority, "Social Media" at (18%) is only second to "Studies". This is similar to Q1 of section-2 (HE Studies and Career Information Sources), where "Social Media" is a significant source too.

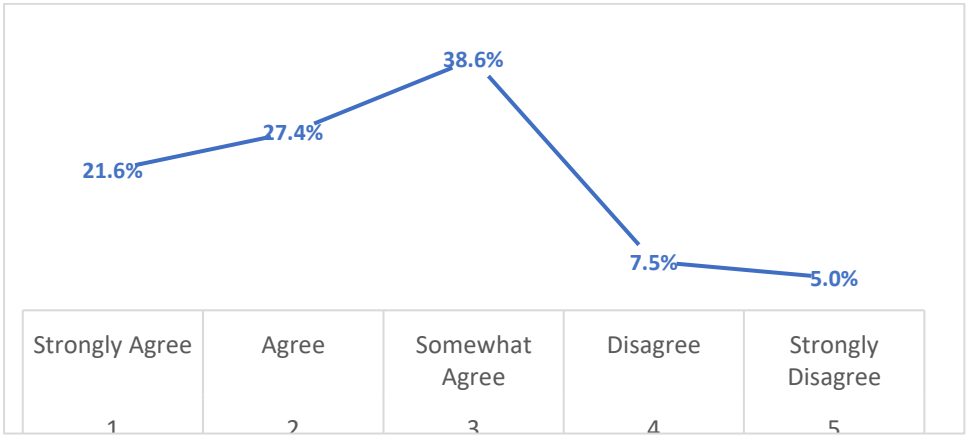
Q4: Knowledge of Organizations that Use BI



Q5, Q6, & Q7: BI Helps Align HE Programs with Market

Questions 5, 6, and 7 in the section are about gauging respondents' level of agreement that BI systems help with regards to the relation between higher education programs and the labor market. A Likert scale is used with the following range of values {①Strongly Agree ②Agree ③Somewhat Agree ④Disagree ⑤Strongly Disagree}. To analyze these questions, for each one we total the frequency distribution and then calculate the Mean, Median, and Mode. We then figure out where the mean value lies in the range and to which direction are the responses inclined. We do this for each of the three questions.

Q5: BI Assists High School Students Choose Major & HE Program

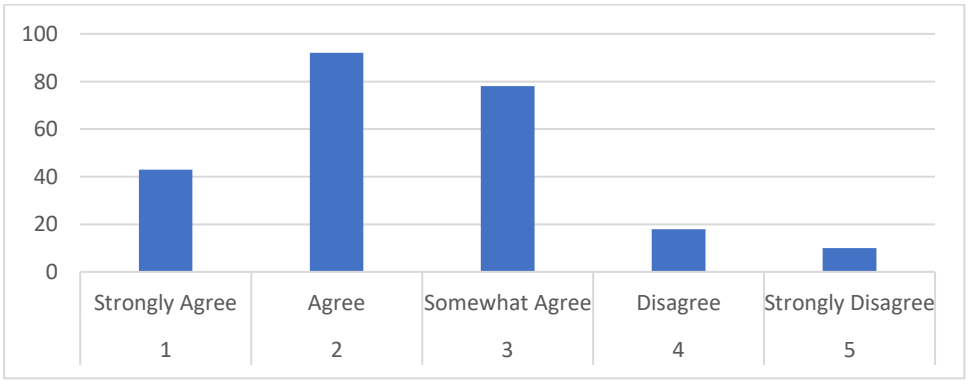


From the chart above, we notice that almost half of respondents (49%) agree with the statement with (21.6%) "Strongly Agree" and (27.4%) "Agree". At the same time disagreement is at (12.5%) with "Disagree" at (7.5%) and "Strongly Disagree" at (5%). The above two observations are a positive indication of agreement with the hypothesis that BI assists high school students in deciding about HE studies and career planning.

Mean	Median	Mode	STD	Variance	Skewness
2.47	3	3	1.065	1.133	0.354

The **mean** at 2.47 lies between "Agree" & "Somewhat Agree", i.e., most respondents are inclined towards agreement with the statement.

Q6: BI Helps HE Students with Career Choices

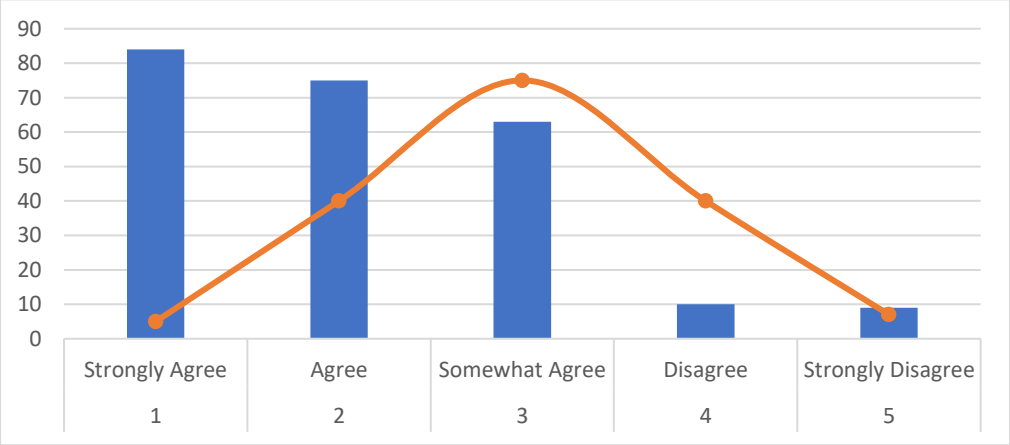


More than half of respondents (56%) agree with the statement with (17.8%) "Strongly Agree" and (38.2%) "Agree". At the same time disagreement is at (11.6%) -less than previous question- with "Disagree" at (7.5%) and "Strongly Disagree" at (4.1%). The above two observations are a positive indication that there is agreement with the hypothesis that BI supports HE students in deciding about programs of study and in career planning.

Mean	Median	Mode	STD	Variance	Skewness
2.42	2	2	1.001	1.003	0.538

Unlike Q5 above, here the **Mean** > **Median** > M**ode**, this implies that the distribution is skewed to the right, i.e., most respondents are inclined towards agreement with the statement. The **mean** at 2.42 lies between "Agree" & "Somewhat Agree", i.e., most respondents are inclined towards agreement with the statement but here they are closer to "Strongly Agree" than in the previous question.

Q7: BI Helps MHESR & HEIs align Programs with Market



Most respondents (66%) agree with the statement with (34.9%) "Strongly Agree" and (31.3%) "Agree". At the same time disagreement is at (7.8%) -less than previous question- with "Disagree" at (4.1%) and "Strongly Disagree" at (3.7%). The above two observations are a positive indication that there is agreement with the hypothesis that BI supports aligning HE output with labor markets.

Mean	Median	Mode	STD	Variance	Skewness
2.1	2	1	1.051	1.105	0.781

Similar to Q6 above, the **Mean** > **Median** > M**ode**, this implies that the distribution is skewed to the right, i.e., most respondents are inclined towards agreement with the statement. The **mean** at 2.1 lies between "Strongly Agree" & "Agree", i.e., most respondents are inclined towards agreement with the statement but here they are closer to "Strongly Agree" than in the previous question.

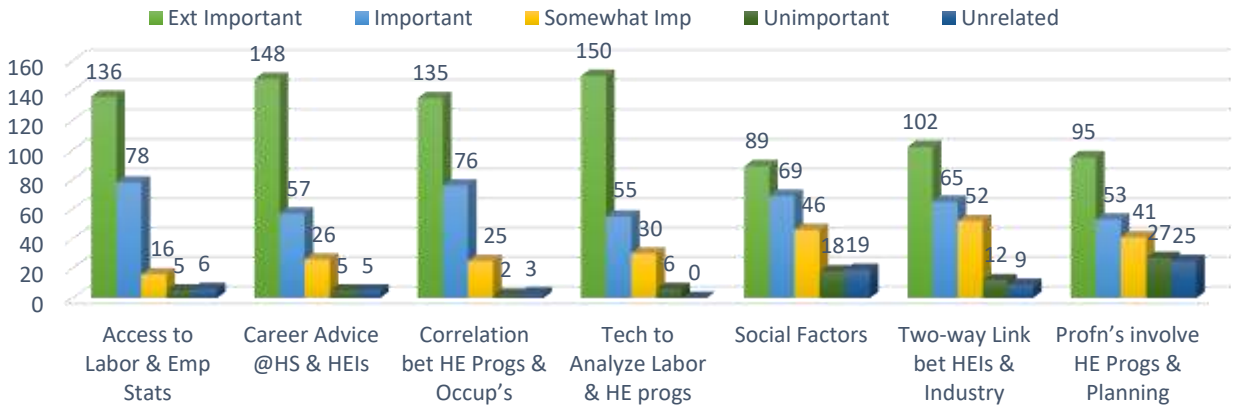
The above analysis for question 5,6 and 7 indicates that respondents believe utilizing BI will assist in aligning HE output with labor market. In addition, while they have confidence that BI utilization is beneficial overall, they indicated that it is more helpful to MHESR and HEIs than to students.

Section-4: Factors Influencing HE Alignment with Labor Market

Factors affecting the alignment of HE programs and the labor market are presented in a matrix with each sub-question presented as a Likert Scale as follows, {①Extremely Important ②Important ③Somewhat Important ④Unimportant ⑤Unrelated}.

Frequency Distribution and Percent

	Factors Influencing Alignment between HE Programs & Labor Market	Frequency					Percent				
		Ext Imp	Imp	Some Imp	Unimportant	Unrelated	Ext Imp	Imp	Some Imp	Unimportant	Unrelated
1	Access to Labor & Emp Stats	136	78	16	5	6	56.4	32.4	6.6	2.1	2.5
2	Career Advice @HS & HEIs	148	57	26	5	5	61.4	23.7	10.8	2.1	2.1
3	Correlation bet HE Progs & Occup's	135	76	25	2	3	56.0	31.5	12.4	0.8	1.2
4	Tech to Analyze Labor & HE progs	150	55	30	6	0	62.2	22.8	12.4	2.5	0
5	Social Factors	89	69	46	18	19	36.9	28.6	19.1	7.5	7.9
6	Two-way Link bet HEIs & Industry	102	65	52	12	9	42.3	27.4	21.6	5	3.7
7	Profn's involve HE Progs & Planning	95	53	41	27	25	39.4	22	17	11.2	10.4



The total frequencies for responses "Unrelated" and "Unimportant" is much lesser than the rest of the responses for all statements. This indicates that all seven statements are strong factors in aligning HE output with markets. In fact, most respondents' replies for all statements were concentrated between "Extremely Important" and "Important". Statement (4) received the highest overall frequency of 150 "Extremely Important" or 62.2%, followed by statement (2) with 61.4% and statement (1) with 56.4% then statement (3) with 56%.

To find the "general" direction or Classification of importance for each sub-question in the matrix, we calculate the Mean, STD, P-Value, Chi-square for each one as in the table below.

The possible ranges are {range/values= 4/5 =0.8; then ranges are:1-1.8, 1.9-2.6, 2.7-3.4, 3.5-4.2}

Factor		Mean	Median	Mode	STD	Variance	Range	Classification
1	Access to Labor & Emp Stats	1.61	1.00	1	.897	.805	5	Ext Imp
2	Career Advice @HS & HEIs	1.59	1.00	1	.918	.843	5	Ext Imp
3	Correlation bet HE Progs & Occup's	1.59	1.00	1	.812	.659	5	Ext Imp
4	Tech to Analyze Labor & HE progs	1.55	1.00	1	.811	.657	4	Ext Imp
5	Social Factors	2.19	2.00	1	1.233	1.519	5	Unimportant
6	Two-way Link bet HEIs & Industry	2.00	2.00	1	1.094	1.196	5	Important
7	Profn's involve HE Progs & Planning	2.30	2.00	1	1.371	1.879	5	Important
	Average	1.83	1.43	1	1.02	1.08	4.86	Important

We notice in the table above that the range for statement (4) is FOUR, unlike the rest of the statements. This is due to the fact that it received ZERO "Unrelated" frequencies as evident in the Frequencies Distribution table.

From the mean values in the table we can see that the top four statements lean toward "Extremely Important" and the bottom two towards "Important". Therefore, they are vital factors in aligning HE output with markets with statement (4) being ranked the top or utmost significant. To distinguish the second from third ranks who have to look at the full fraction part of the mean for statements (2) and (3) as both are 1.59. Statement (2) slightly edges statement (3) and this means statement (1) is ranked fourth. Statement (5) is the only one that is inclined towards "Unimportant".

All of these above results offer strong support and validate the hypothesis that BI helps in aligning HE output with markets.

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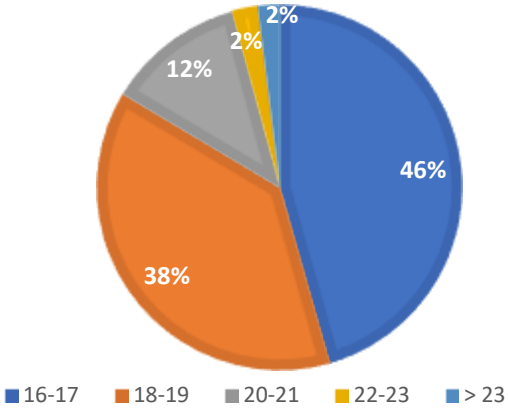
Section-1: Basic Information

Q1.1: Age at Admission to HEIs

Age Group	Frequency	Percent
16-17	120	45.6%
18-19	100	38.0%
20-21	32	12.2%
22-23	6	2.3%
> 23	5	1.9%
		100%

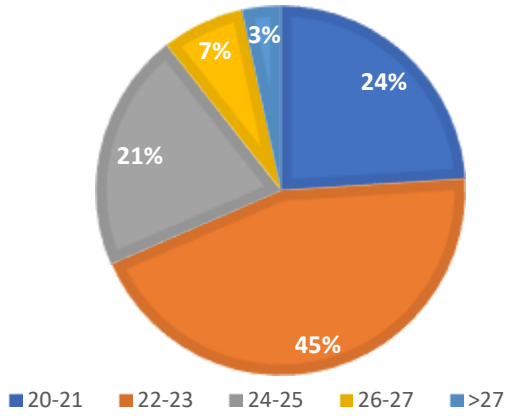


An overwhelming majority of questionnaire respondents were admitted to a HEIs when they were between 16-19 years of age (83.6%) {16-17 (45.6%) 18-19 (38%)}.

In section-2, we will explore what sources of information graduates used to learn about HE programs and possible careers when they were applying for HE admission. Do they rely on their families to help with their study discipline and career decisions or do they have other sources? It is interesting to corelate that with the result of this question regarding the significance of age at admission!

Q1.2: Age at Graduation

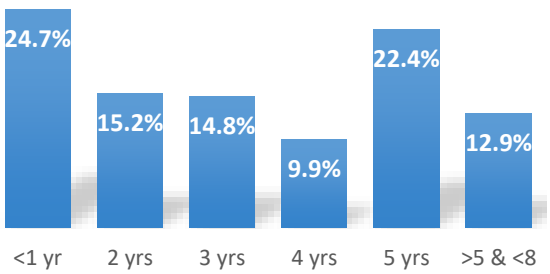
Age Group	Frequency	Percent
20-21	63	24.0%
22-23	117	44.5%
24-25	55	20.9%
26-27	19	7.2%
>27	9	3.4%
		100%



The majority of students (89%) graduate when they are between the ages of 20-25.

Q2: Years Since Graduation

Years	Frequency	Percent
<1	65	24.7%
2	40	15.2%
3	39	14.8%
4	26	9.9%
5	59	22.4%
>5 & <8	34	12.9%
		100%



Most respondents (87.1%) have graduated before five years or less. This is consistent with the target group of recent graduates.

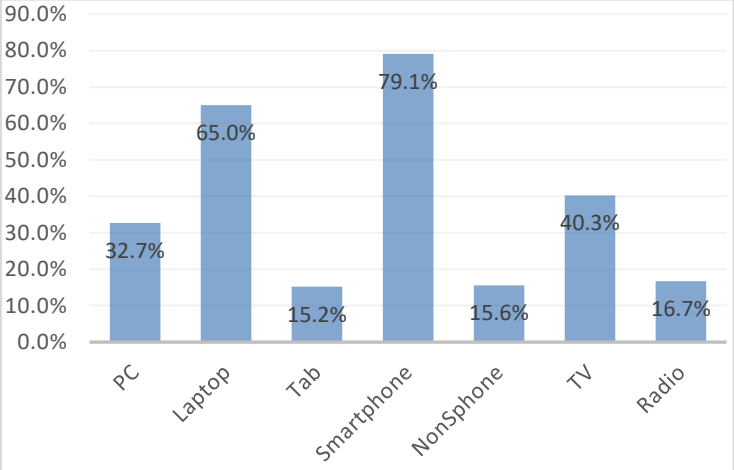
Q3: Gender

Gender	Frequency	Percent
Male	125	47.5%
Female	138	52.5%
		100%

The majority of respondents are female as this echoes the overall enrollment in HEIs.

Q4: Access to Technology

Category	Frequency	Percent
PC	86	32.7%
Laptop	171	65.0%
Tab	40	15.2%
Smartphone	208	79.1%
Non-smartphone	41	15.6%
TV	106	40.3%
Radio	44	16.7%



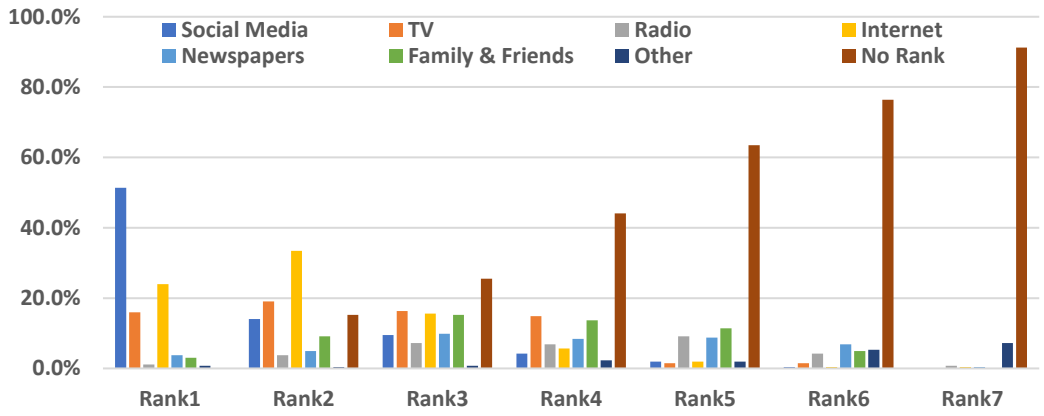
In this question, respondents were asked to select the communication equipment they own or use.

Most respondents chose more than one device, and consistent with students' survey results, Smartphones are top followed by laptops and then TV. It is interesting to note that the use of laptops is more than PCs and Tabs combined. This result demonstrates that most respondents are technology savvy.

Q5: Graduates' News Sources Rank

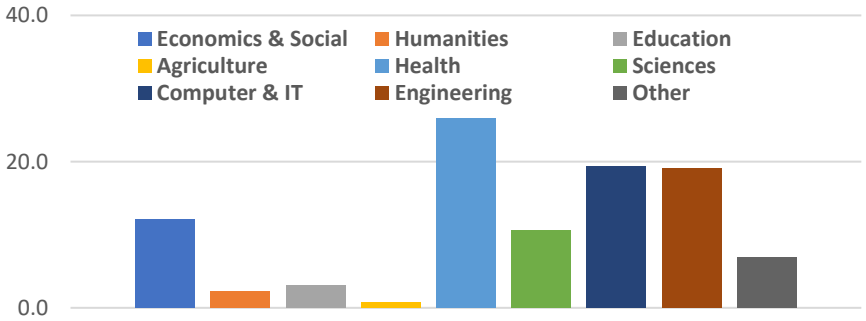
	News Source	Rank1	Rank2	Rank3	Rank4	Rank5	Rank6	Rank7
1	Social Media	135	37	25	11	5	1	0
2	TV	42	50	43	39	4	4	0
3	Radio	3	10	19	18	24	11	2
4	Internet	63	88	41	15	5	1	1
5	Newspapers	10	13	26	22	23	18	1
6	Family & Friends	8	24	40	36	30	13	0
7	Other	2	1	2	6	5	14	19
8	No Rank	0	40	67	116	167	201	240

Respondents were asked to choose their sources of news in general. Social Media tops the list followed by Online Internet news, TV, then Family and Friends. These TOP sources are excellent candidates for communicating information to graduates. We also notice that printed newspapers rank as low as fifth but still it precedes Radio. The "No Rank" category is counted based on respondents selecting or not the rank in question. From that, we notice about 75% of respondents have selected three sources only.



These findings together with those of the previous question (Access to Technology) indicate that electronic information and "Social Media" are the preferred means of communicating and consuming information by graduates.

Q6: Field of Study Distribution



It is clear that all study programs as categorized by the MHESR are adequately represented in the survey sample while "Health" studies respondents are the top group, followed by "Computer & IT", then "Engineering".

Q7: HEI Public/Private Classification

HEI Type	Frequency	Percent
Public	157	59.7%
Private	106	40.3%
		100%

Private HEI respondents constitute (40.3%) of the overall survey sample. This is a nice balance that reflects and is consistent with the HEI community overall.

Q8: HEI Location

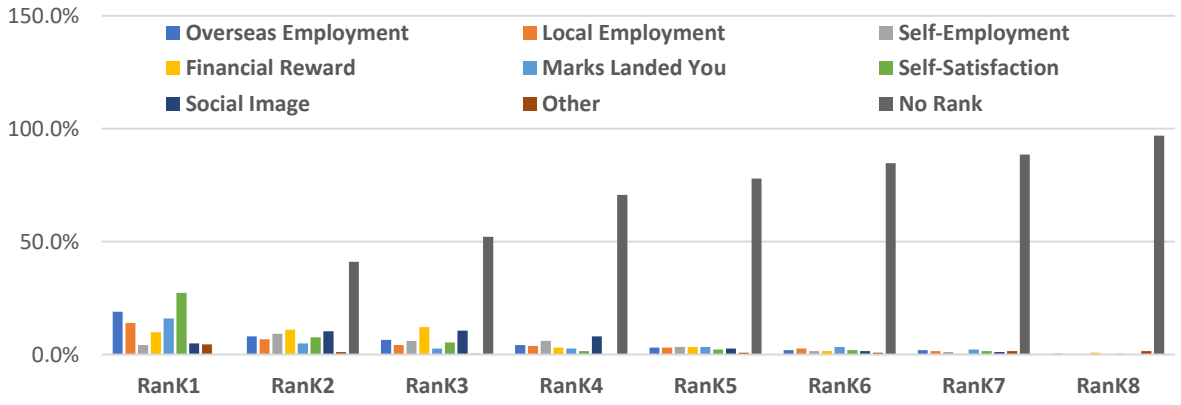
HEI State	Frequency	Percent
Khartoum	218	82.9%
Other State	40	15.2%
Overseas	5	1.9%
		100%

Most respondents have graduated from HEI in the capital Khartoum (82.9%). We also notice that there are some who have graduated from out of the country.

Q9: Motivation for Study Program Rank

Respondents were asked to rank the reasons that lead them to choose the program they studied. Results are shown in the table and chart below. The "No Rank" category is counted based on respondents selecting or not the rank in question.

	Reason	RanK1	RanK2	RanK3	RanK4	RanK5	RanK6	RanK7	RanK8
1	Overseas Employment	19.0%	8.0%	6.5%	4.2%	3.0%	1.9%	1.9%	0.4%
2	Local Employment	14.1%	6.8%	4.2%	3.8%	3.0%	2.7%	1.5%	0.0%
3	Self-Employment	4.2%	9.1%	6.1%	6.1%	3.4%	1.5%	1.1%	0.0%
4	Financial Reward	9.9%	11.0%	12.2%	3.0%	3.4%	1.5%	0.4%	0.8%
5	Marks Landed You	16.0%	4.9%	2.7%	2.7%	3.4%	3.4%	2.3%	0.0%
6	Self-Satisfaction	27.4%	7.6%	5.3%	1.5%	2.3%	1.9%	1.5%	0.4%
7	Social Image	4.9%	10.3%	10.6%	8.0%	2.7%	1.5%	1.1%	0.0%
8	Other	4.6%	1.1%	0.4%	0.0%	0.8%	0.8%	1.5%	1.5%
0	No Rank	0.0%	41.1%	52.1%	70.7%	77.9%	84.8%	88.6%	97.0%



The following table compares the results of the Students' and Graduates' surveys.

Rank	Students		Graduates	
1	Overseas Employment	30.7%	Self-Satisfaction	27.4%
2	Marks Landed You	20.7%	Overseas Employment	19.0%
3	Self-Satisfaction	14.5%	Marks Landed You	16.0%
4	Self-Employment	12.4%	Local Employment	14.1%
5	Local Employment	7.5%	Financial Reward	11.0%

From the above chart and tables, we observe the following:

- The top four reasons comprise the majority in both surveys.
- Succeeding the top four reasons, the rest of the responses are insignificant with no big disparity and even spread.
- "Your Marks Landed You here" ranks high among graduates as well as among students suggesting two things:
  - low level of satisfaction with career choices made,
  - lack of decision support information whether HE programs or possible career information.
- "Local Employment" ranks low in both cases which indicates that awareness about local employment opportunities must be improved.

These results support the hypothesis that BI provides accurate HE studies and career path information to enhance decision-making.

Q10: Career Assistance Center Availability

	Frequency	Percent
Yes	79	30%
No	184	70%
		100%

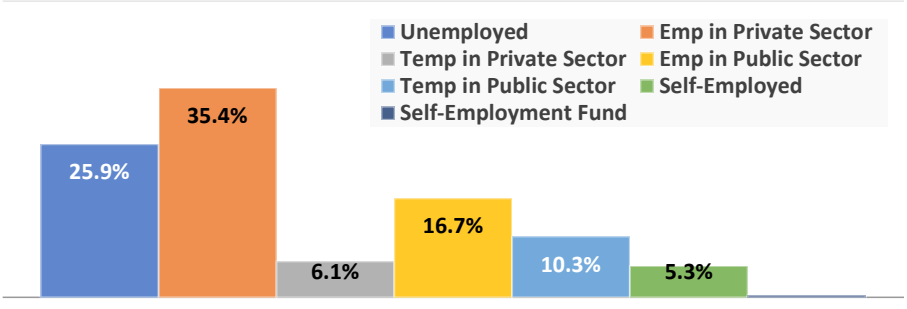
There is no "Career and Employment Assistance Center" in the majority of respondents' institutions. We will cross-reference this result with section-4 of the survey where we ask respondents to rank the importance of such centers in High Schools and HEIs.

Q11: Internship or Summer Work

	Frequency	Percent
Yes	133	50.6%
No	130	49.4%
		100%

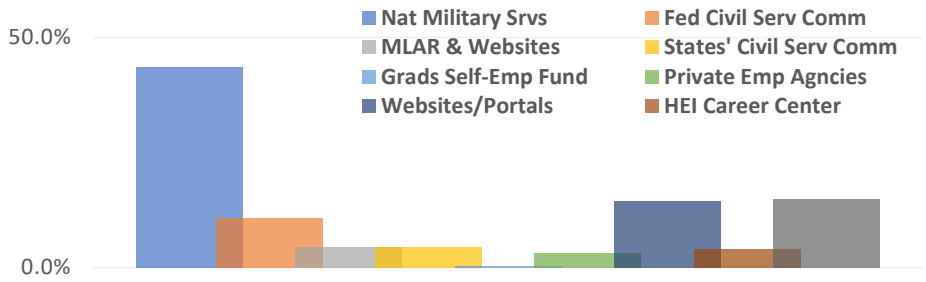
Here it is an even split between graduates who had internships or worked during Summers while they were studying, and the ones who didn't. In the students' survey (62.7%) of respondents said they plan on doing an Internship or Work during the Summer. How does this fit with Employers? Do they offer such programs? Do they prefer hiring graduates who had Internship or Summer work experience? We will explore these issues in the Employers' survey results.

Q12: Employment Status



Most respondents are employed in the private sector, followed by the unemployed at (25.9%). This unemployment percentage is consistent with the figures released by the Ministry of Labor and Administrative Reform (MLAR) in its latest Labor Force Survey (LFS). Public sector respondents represent (16.7%), and public sector temporary employed respondents at (10.3%).

Q13: Employment Agencies Utilization



The following table compares results between Students' and Graduates' surveys.

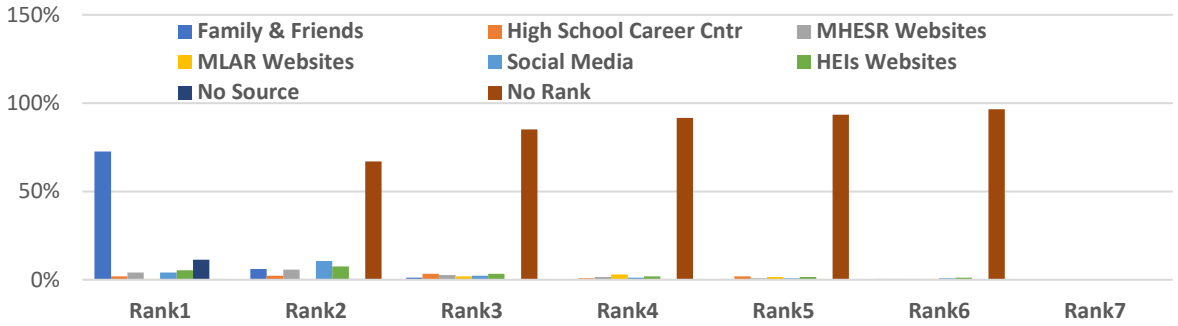
Rank	Students		Graduates	
1	Nat Military Service	33.0%	Nat Military Service	43.5%
2	Websites/Portals	18.0%	Other	14.8%
3	MLAR & Websites	17.0 %	Websites/Portals	14.4%
4	Grads Self-Emp Fund	11.0%	Fed Civil Serv Comm	10.8%
5	Private Emp Agencies	9.0%	MLAR & Websites	4.5 %

Students were asked if they knew about the agencies in question, while graduates were asked if they have registered with or utilized their services. There is a big gap between the top rank "National Military Service" -actually not an employment agency- and the rest. "HEI Career Center" ranked pretty low as expected since we saw in the result of Q10, above in this section, that most HEIs do not offer any employment and career assistance service.

It is clear that a lot needs to be done to increase both graduates' and students' awareness about employment agencies especially the governmental ones. This is ironic as according to latest LFS, government is the largest employer and creator of new jobs. The results of this question validate our hypothesis about the lack of employment and career planning information.

Section-2: Current Situation and Expectation

Q1: HE Studies and Career Planning Info Sources' Rank



Here Graduates were asked the same question like Students, that is to rank the information sources that helped shape their opinion about HE studies programs and possible future jobs when they were applying for HE admission.

Almost identical to the Students' survey result, a large majority (73%) of respondents chose "Family & Friends" as their one-and-only information source. "No Source" is a distant second choice at (11.4%), meaning that (88.6%) chose only two responses with "Social Media" being that choice. The most striking observation here is that, all factors other than "Family & Friends" seem to have little or no significance as is clear in the chart above.

This confirms the hypothesis that HE studies decisions are not made based on study program information let alone on labor market information.

Q2: Integrity of HE Studies and Career Information

This question tries to gauge the comprehensiveness and integrity of the sources selected by respondents in the previous question. It is divided into six sub-questions or statements and intends to measure the level of agreement of respondents with the statements. The statements cover different aspects of HE studies programs and career planning information. We want to measure if the Information they receive covers the outlined subcategories.

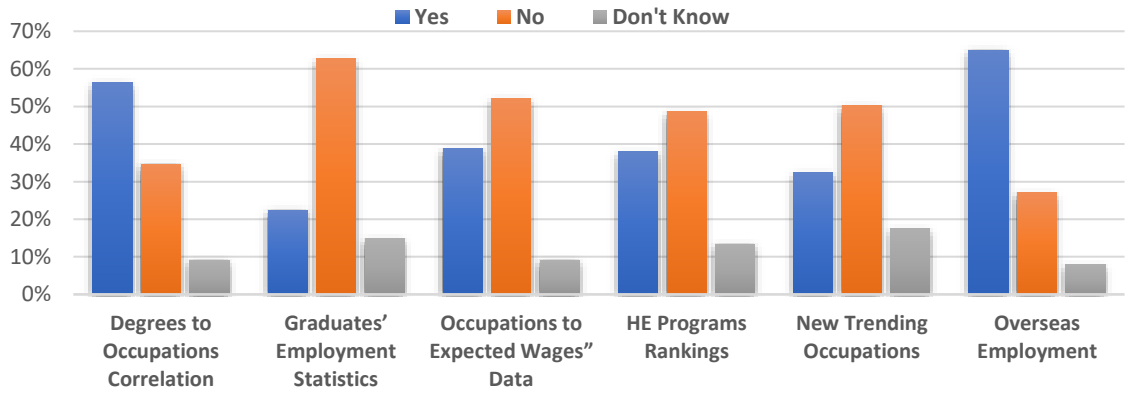
A three-points Likert scale is used here with answers {①Yes ②No ③Don't Know}. To analyze this type of questions we use statistical hypothesis testing by calculating the Mean, Standard Deviation (STD) and Chi-square for each question. Then we calculate the average score and figuring out where it lies on the scale. The smaller the score (closer to ONE or Yes) the higher the agreement level.

Frequency Distribution and Percent

	Statement	Frequency			Percent		
		Y	N	D	Y	N	D
1	HE Degrees to Occupations Correlation	148	91	24	56.3%	34.6%	9.1%
2	HE Graduates' Employment Statistics	59	165	39	22.4%	62.7%	14.8%
3	Occupations to Expected Wages Data	102	137	24	39.8%	52.1%	9.1%
4	HE Programs Rankings	100	128	35	38.0%	48.7%	13.3%
5	New Trending Occupations	85	132	46	32.3%	50.2%	17.5%
6	Overseas Employment	171	71	21	65.0%	27.0%	8.0%

From the frequency table above and the chart below, we notice that:

- Most replies for all the six statements were concentrated between "Y" and "N" with "D" receiving the lesser share of responses. For example, for statement (1), replies "Y" and "N" together received 90.9% while "D" received only 9.1%. This indicates that respondents have a clear and strong opinion about their responses and that they are not inclined to "not-know".
- Statement (6) received the highest overall frequency of 171 "Y" or 65%, followed by statement (2) with 165 "N" or 62.7%.



- The frequency total of replies "N" and "D" for all statements is more than reply "Y" except for statement (1) and (6). For example, for statement (4), replies "N" and "D" together received 62% while "Y" received only 38%. So, respondents either have received no information or they do not know except for Statements (1) and (6) where they are certain.

Descriptive Statistics

Statement		Mean μ	Median	Mode	STD	Chi-square	DF	P value	Inclination
1	Degrees to Occupations Correlation	1.53	1.00	1	.658	87.886	2	.000	Strong Info
2	Graduates' Employment Statistics	1.92	2.00	2	.607	104.608	2	.000	No or Inaccurate
3	Occupations to Expected Wages" Data	1.70	2.00	2	.627	78.342	2	.000	No or Inaccurate
4	HE Programs' Rankings	1.75	2.00	2	.674	51.932	2	.000	No or Inaccurate
5	New Trending Occupations	1.85	2.00	2	.691	42.304	2	.000	No or Inaccurate
6	Overseas Employment	1.43	1.00	1	.637	133.080	2	.000	Stronger Info

{interval equals ranges/values=2/3 =0.6; then possible ranges are:1-1.6, 1.7-2.2, 2.3-2.8}

From the descriptive statistics table above, we observe that:

- All the p-values are less than the assumption significance level 0.05, indicating statistically significant differences in the distribution of respondents' replies to the different response options (Y, N, D). That is, the observed difference is unlikely to be due to chance, and if we were to repeat the survey with different samples there is a 95% chance we will get similar results.
- STD values are between 0.607 – 0.691, this indicates the homogeneity of respondents' answers.

To find the overall trend or inclination of responses for this question as a whole (with all its sub-questions or statements), we calculate the average from the above descriptive statistics table as shown in the summary table below.

Mean	STD	Chi-square	DF	P value	Inclination
1.70	0.649	83.0253	2	0.000	No or Inaccurate

From the above table, we can see that the combined **mean** of all the collective statements is (1.70), which is pre-determined as "N" or No Information, therefore this confirms our hypothesis that the HE programs and career planning information received by respondents lacks integrity and is incomplete, and inaccurate.

Q3: Format of Data Received

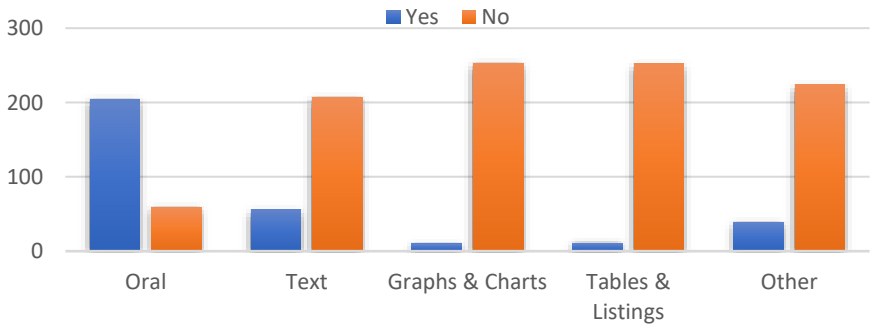
This question accesses if the information received is readable, well-presented and visualized. To decode its data, we use a binary scale with responses {⓪No ①Yes} for each of the possible six answers. Subsequently, to analyze the results, we calculate the Mean, Standard Deviation (STD) and Chi-square for each of the answers as shown in the table below. Then we calculate the average score to figure out where it lies on the scale, closer to zero (No) or one (Yes).

{interval equals ranges/values=1/2 =0.5; then possible ranges are:0-0.5, 0.6-1.1}

Data Format	Percent	Yes	No	Mean	Median	Mode	STD	Variance	Inclination
Oral	77.6%	204	59	0.78	1.00	1	0.418	0.175	Avail Info
Text	21.3%	56	207	0.21	0.00	0	0.410	0.168	No Info
Graphs & Charts	3.8%	10	253	0.04	0.00	0	0.192	0.037	No Info
Tables & Listings	4.2%	11	252	0.04	0.00	0	0.201	0.040	No Info
Other	14.8%	39	224	0.15	0.00	0	0.356	0.127	No Info
Average				**0.24**					

From the table above, we can see that:

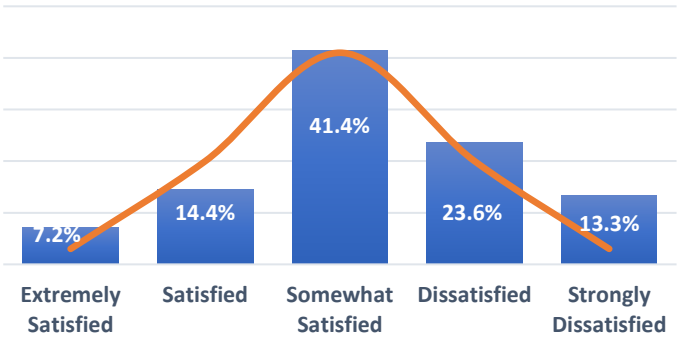
- All mean values for all responses are between 0.04 – 0.78
- STD values are between 0.192 – 0.418, this indicates the dispersion of respondents' answers.
- The combined **mean** of all the collective responses is (0.24), which is pre-determined as "N" or No Information. Therefore, we conclude that HE programs and career planning information -even when they are available- lack readability, visualization and usability overall.



Furthermore, from the chart above, we see the majority of respondents (77.6%) indicated that they have received their HE studies and possible career planning information in verbal or "Oral" format. This was followed by "Text" at (21.3%). Additionally, the data formats "Graphs & Charts" and "Tables & Listings" received the lowest frequencies meaning respondents rarely or never attained data in these formats.

Q4: Satisfaction with Career Planning Info Availability

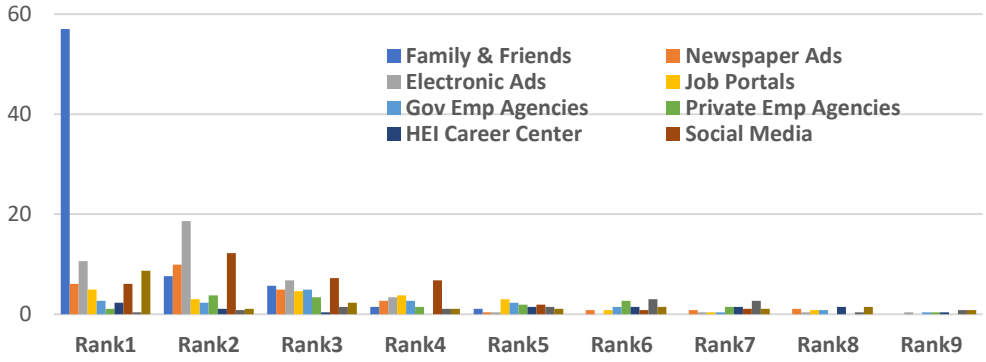
Here a five-points Likert scale is used to measure the level of respondents' satisfaction as follows, {①Extremely Satisfied ②Satisfied ③Somewhat Satisfied ④Dissatisfied ⑤Strongly Dissatisfied}. We plotted the frequencies histogram with the Normal distribution curve superimposed as shown below.



As shown in the chart above, 36.9% (13.3% + 23.6%) of respondents are Dissatisfied compared to 21.6% (7.2% + 14.4%) who are Satisfied, while 41.5% are Neutral. It is clear that the distribution is skewed to the left, i.e., most respondents are inclined towards Dissatisfaction with career planning information availability.

This result highlights the need for a system that presents precise and accurate information in an easy to use and understand format.

Q5: Job Listing Sources' Rank



In the case of the students' survey, we asked respondents about the job listing sources they "expect" to use when they start looking for jobs. Here we ask graduates about the sources they actually used in their job-hunt. The chart above shows the frequency distribution percentages and ranks.

The following table compares results between Students' and Graduates' surveys.

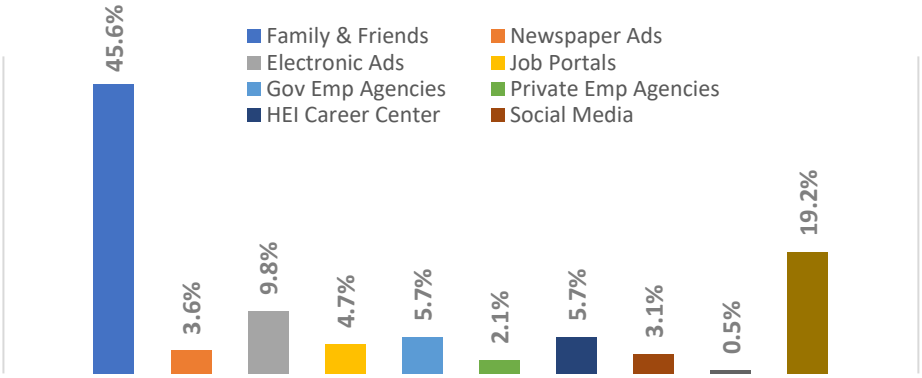
Rank	Students		Graduates	
1	Family & Friends	47.7%	Family & Friends	57.7%
2	Electronic Ads	22.8%	Electronic Ads	18.6%
3	Job Portals	14.1%	Social Media	12.2%
4	Social Media	10.4%	Newspaper Ads	9.9%
5	Newspaper Ads	8.3%	Other	8.7%

From the chart and tables above, we notice that:

- The top two ranked sources are identical in the two surveys with a big gap between the top rank "Family & Friends" and the rest.
- Graduates have a stronger opinion than Students in the importance of "Family & Friends" in finding employment.
- Only the top three factors are significant, the rest have noticeably lower insignificant frequencies.
- About 75% of respondents ranked only three answers out of the ten available.
- "Government Employment Agencies" did not make the top five for both surveys.

As we saw in Q1 of this section (HE Studies and Career Planning Info Sources), "Family & Friends" was the most important factor in making HE studies decisions -prior to admission- regarding which program and which career to pursue; and here -after graduation- it is the top factor for landing a job. Obviously, a lot needs to be done to improve awareness about employment agencies especially the governmental ones. This supports the hypothesis that HE studies and possible career decisions are not based on real data.

Q6: Reliability of Job Listings' Sources

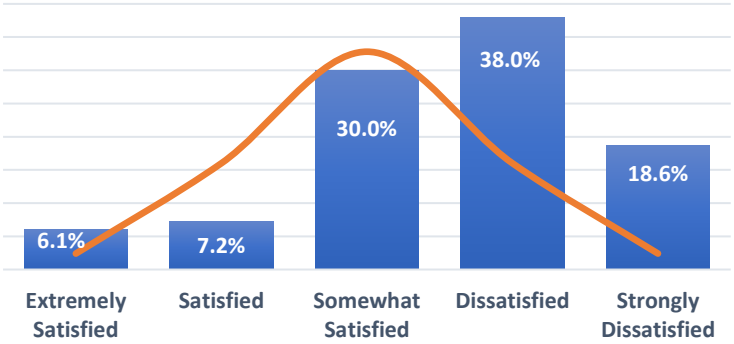


This question was directed only to employed respondents about how they secured their job. Employed respondents accounted for (73.4%) the rest were unemployed which is consistent with the labor market as per the latest LFS. From the graph above, we see that (45.6%) landed their jobs through "Family & Friends" as top category. Followed by "Other" at (19.2%) and then "Electronic Ads" at (9.8%). The top three categories constitute (74.6%) of employed respondents and there is a big gap between the top rank "Family & Friends" and the rest.

As we saw in previous questions' results, "Family & Friends" is the most important factor here too. This supports the hypothesis that the available Job listing sources are ineffective and unreliable.

Q7: Satisfaction with Jobs' Listings Availability

A five-points Likert scale is used to measure the level of respondents' satisfaction as follows, {①Extremely Satisfied ②Satisfied ③Somewhat Satisfied ④Dissatisfied ⑤Strongly Dissatisfied}. We plotted the frequencies histogram with the Normal distribution curve superimposed as shown below.



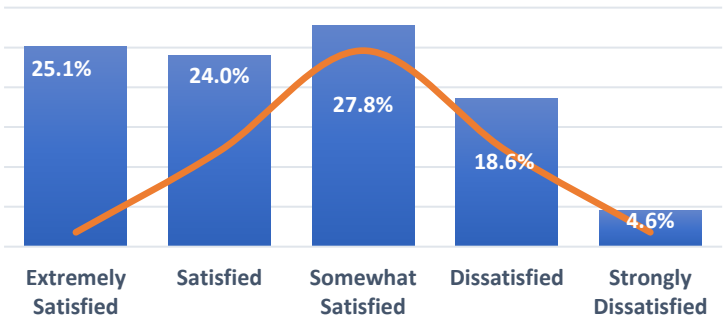
From the chart above, 56.6% (18.6% + 38.0%) of respondents are Dissatisfied as compared to 13.3% who are Satisfied (6.1% + 7.2%) while 30.0% are Neutral. It is visible that the distribution is skewed to the left, i.e., most respondents are inclined towards Dissatisfaction with Job listings' availability. This result highlights the need for a system that presents precise and accurate information in an easy-to-use and understand format.

Q8: Job Relevance to Study

Related	Frequency	Emp Percent	Overall Percent
Yes	137	71%	52.1%
No	56	29%	21.3%
Unemployed	70		26.6%

The majority (71%) of employed respondents believe that their field of study is related to labor markets.

Q9: Satisfaction with Study and Career Choices

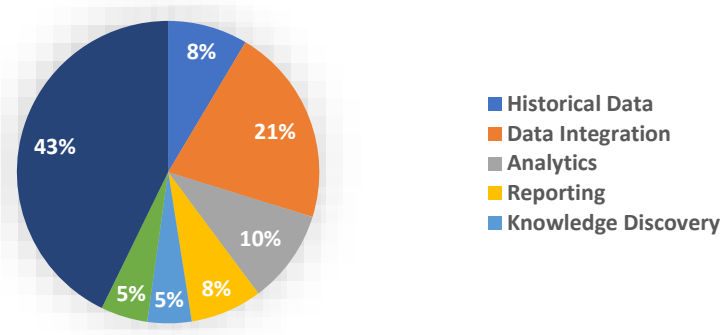


As shown in the histogram above, far less respondents 23.2% (4.6% **+** 18.6%) are Dissatisfied as compared to 49.1% who are Satisfied (25.1% **+** 24.0%) while 27.8% are Neutral. It is clear that the distribution is skewed to the right, i.e., most respondents are inclined towards Satisfaction with the study and career choices they made.

For further understanding, we correlate this result with that of Q9 in section-1 (Motivation for Study Program Selection), where 16% of respondents said that they did not choose their study program, rather, they just landed there! A possible explanation for this discrepancy is that respondents accept and adapt to their program of study and its possible career path once they get admitted as they learn more in spite of not having chosen it to begin with. Lack of information prior to admission has obscured their judgement and once they are enrolled and learn more information, they tend to appreciate and then like their study program.
This highlights the importance of having reliable sources of information and does reinforce the hypothesis that utilizing a BI solution offers dependable information that is easy to use and understand and thus facilitates aligning HE output with market demand.

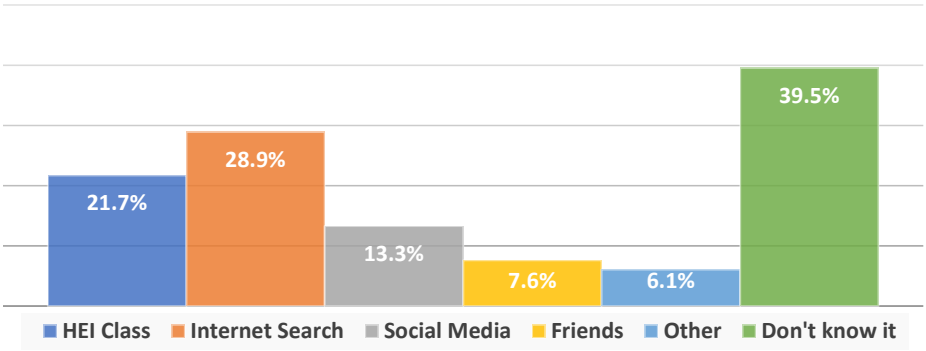
Section-3: Graduates' Awareness about BI

Q1: Knowledge about Data Warehouse



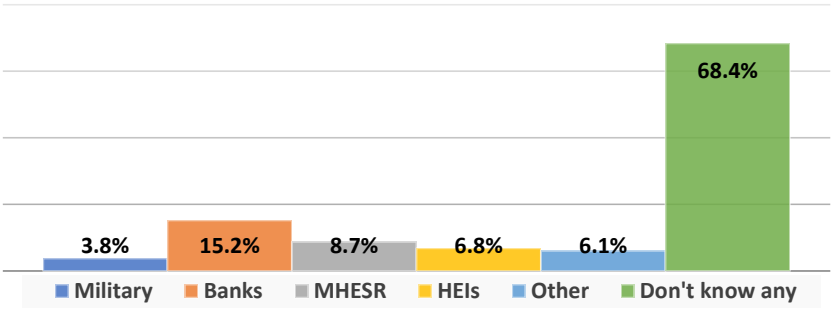
Close to half the respondents (43%) identified all attributes of Data Warehouses. This question is designed to provide information to respondents while we solicit their feedback.

Q3: Sources of Knowledge about BI



Most respondents (61.5%) already know about BI with their knowledge attributed to different sources as seen in the chart above. Of this majority, "Social Media" at (13.3%) is third, while "Studies" is second and "Internet Search" tops the list. This is similar to Q1 of section-2 (HE Studies and Career Information Sources), where "Social Media" is an important source too.

Q4: Knowledge of Organizations that Use BI

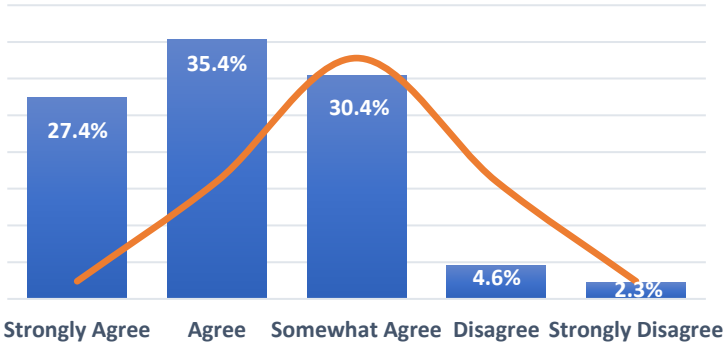


Most respondents are not aware of organizations that utilize BI. But of the respondents that know of such organizations, Banks top the list at 15.2% followed by MHESR at 8.7%.

Q5, Q6, & Q7: BI Helps Align HE Programs with Market

The following questions 5, 6, and 7 in this section are about gauging respondents' level of agreement that BI systems help to explore the relation between higher education programs and the labor market. A five-points Likert scale is used with the following range of values {①Strongly Agree ②Agree ③Somewhat Agree ④Disagree ⑤Strongly Disagree}. To analyze these questions, we use statistical hypothesis testing by calculating the frequency distribution and then computing the Mean, Median, STD and Variance. We then figure out where the mean value lies in the range and to which direction are the responses inclined. We do this for each of the three questions.

Q5: BI Assists High School Students Choose Major & HE Program

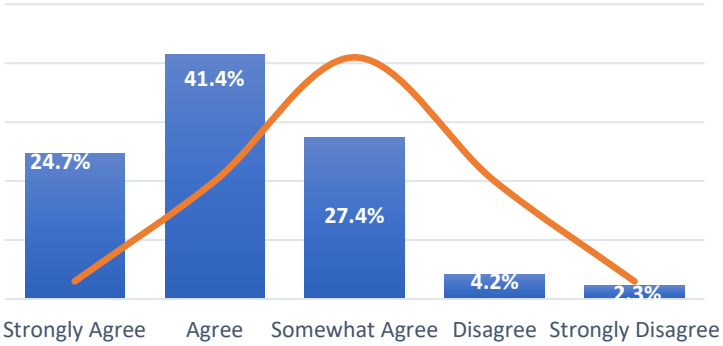


From the histogram above, we notice that the majority of respondents (62.7%) agree with the statement with (27.4%) "Strongly Agree" and (35.4%) "Agree". At the same time disagreement is pretty low at (6.9%) with "Disagree" at (4.6%) and "Strongly Disagree" at (2.3%). The presence of the overlaid standard distribution curve enables us to clearly see that this distribution is skewed to the right, i.e., most respondents are inclined towards satisfaction with the statement.

Mean	Median	Mode	STD	Variance	Skewness
2.19	2.00	2	0.966	0.933	0.532

The interval for the five-point scale equals range/values= 4/5 =0.8. Then the possible range of values are: 1-1.8, 1.9-2.7, 2.8-3.6, 3.7-4.5, 4.6-5.4
Furthermore, from the summary table above, the **mean** lies between "Strongly Agree" and "Agree" on the scale, i.e., most respondents are inclined towards agreement with the statement. Therefore, the above observations and findings indicate agreement with the hypothesis that BI assists high school students in deciding about HE studies and career planning.

Q6: BI Helps HE Students with Career Choices

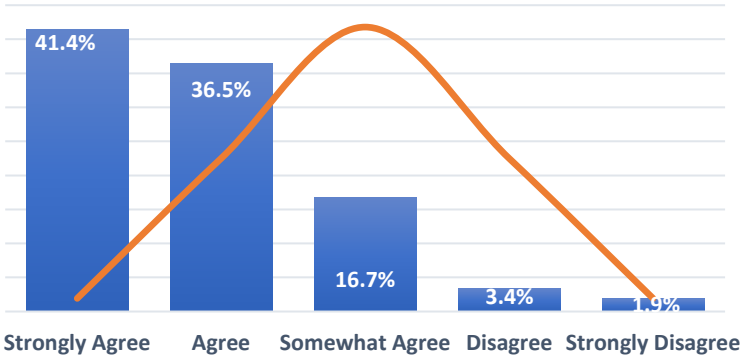


We see that the histogram above is remarkably similar to that of the previous question. Here too we notice that the majority of respondents agree with the statement; precisely at (66.1%) they are more than the previous question. At the same time disagreement at (6.5%) is lower than previous question. Also, the distribution is skewed to the right, with most respondents are inclined towards satisfaction with the statement.

Mean	Median	Mode	STD	Variance	Skewness
2.18	2	2	0.930	0.865	0.641

From the table above, the **mean** at lies between "Strongly Agree" and "Agree", i.e., most respondents are in agreement with the statement but here they are closer to "Strongly Agree" than in the previous question.

Q7: BI Supports MHESR & HEIs to align Programs with Market



From the histogram above, we notice that an overwhelming majority of respondents (77.9%) agree with the statement with (41.4%) "Strongly Agree" and (36.5%) "Agree". At the same time disagreement is pretty low at (5.4%) with "Disagree" at (3.4%) and "Strongly Disagree" at (1.9%). The distribution is skewed to the right, indicating that most respondents are inclined towards satisfaction with the statement. The above two observations are a positive indication that there is agreement with the hypothesis that BI supports HE students in deciding about programs of study and in career planning.

Mean	Median	Mode	STD	Variance	Skewness
1.8	2	1	0.937	0.878	1.058

The summary table above shows that the **mean** lies in the "Strongly Agree" range, i.e., most respondents are inclined towards strong agreement with the statement.

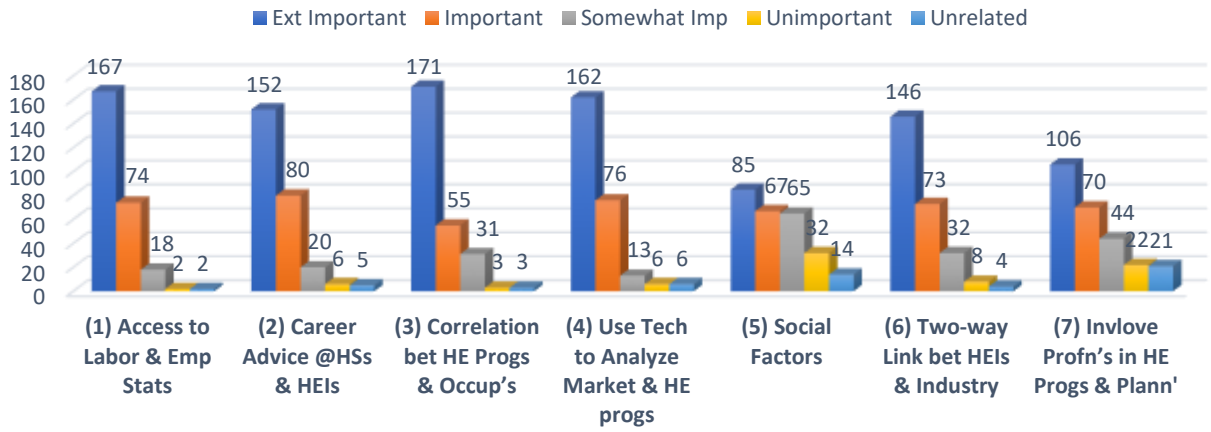
The above analysis for question 5,6 and 7 indicates that most respondents agree strongly or agree that utilizing BI will assist in aligning HE output with labor market. Moreover, while they have confidence that BI utilization is beneficial overall, they believe that it is more significant for MHESR and HEIs than to students.

Section-4: Factors Influencing HE Alignment with Labor Market

In this question, factors affecting the alignment of HE programs and the labor market are combined in a matrix with seven factors. We are measuring respondents' level of agreement with each factor by utilizing a five-points Likert Scale as follows, {①Extremely Important ②Important ③Somewhat Important ④Unimportant ⑤Unrelated}. For analysis we use statistical hypothesis testing technique by calculating the frequency distribution and then computing the Mean, Median, STD and Variance.

Frequency Distribution and Percent

	Factors Influencing Alignment between HE Programs & Labor Market	Frequency					Percent				
		Ext Imp	Important	Some Imp	Unimportant	Unrelated	Ext Imp	Important	Some Imp	Unimportant	Unrelated
1	Access to Labor & Emp Stats	167	74	18	2	2	63.5	28.1	6.8	0.8	0.8
2	Career Advice @HS & HEIs	152	80	20	6	5	57.8	30.4	7.6	2.3	1.9
3	Correlation bet HE Progs & Occup's	171	55	31	3	3	65.0	20.9	11.8	1.1	1.1
4	Use Tech to Analyze Market & HE progs	162	76	13	6	6	61.6	28.9	4.9	2.3	2.3
5	Social Factors	85	67	65	32	14	32.3	25.5	24.7	12.2	5.3
6	Two-way Link bet HEIs & Industry	145	74	32	8	4	55.5	27.8	12.2	3.0	1.5
7	Involve Profn's in HE Progs & Plann'	106	70	44	22	21	40.3	26.6	16.7	8.4	8.0



We see clearly see from the table and chart above that:

- Most replies for all factors were concentrated between "Extremely Important" and "Important" except in factor (5).
- The total of responses "Unrelated" and "Unimportant" is pretty low, almost insignificant as compared to the rest of the responses. This is the case for all seven factors, which implies that all factors are significant and substantial in aligning HE output with markets.
- Factor (3) received the highest overall frequency of 171 "Extremely Important" or 65.0%, followed by factors (1) at 63.5%, factor (4) at 61.6%, factor (2) at 57.8% and then factor (6) at 55.5%.

To find the general inclination or classification of importance for each factor in the matrix, we calculate the Mean, STD, P-Value, Chi-square for each one as in the table below.

The possible ranges are {range/values= 4/5 =0.8; then ranges are: 1-1.8, 1.9-2.7, 2.8-3.6, 3.7-4.5, 4.6-5.4}

Factor		Mean	STD	Variance	P value	DF	Classification
1	Access to Labor & Emp Stats	1.47	.725	.525	.000	4	Extremely Imp
2	Career Advice @HS & HEIs	1.60	.872	.760	.000	4	Extremely Imp
3	Correlation bet HE Progs & Occup's	1.52	.833	.693	.000	5	Extremely Imp
4	Use Tech to Analyze Labor & HE progs	1.55	.872	.760	.000	4	Extremely Imp
5	Social Factors	2.33	1.198	1.435	.000	4	Important
6	Two-way Link bet HEIs & Industry	1.67	0.912	0.832	.000	5	Extremely Imp
7	Involve Profn's in HE Progs & Plann'	2.17	1.265	1.600	.000	4	Important
	Average	**1.76**	0.95	0.94			Extremely Imp

From the descriptive statistics table above, we observe that:

- All the p-values are less than the assumption significance level 0.05, indicating statistically significant differences in the distribution of respondents' replies to the different response options. That is, the observed difference is unlikely to be due to chance, and if we were to repeat the survey with different samples there is a 95% chance we will get similar results.
- From the mean values in the table we can see that the first four factors and factor (6) were all ranked as "Extremely Important" by respondents, while factors (5) and (7) ranked as "Important".
- The average mean is 1.76 that ranks as "Extremely Important". Therefore, all factors strongly influence aligning HE output with markets.

The following table compares the results of Students' and Graduates' surveys and their classifications.

Rank	Students			Graduates		
1	**(4)** Use Tech to Analyze Labor & HE progs	1.55	**Ex-Imp**	**(1)** Access to Labor & Emp Stats	1.47	**Ex-Imp**
2	**(2)** Career Advice @HS & HEIs	1.59	**Ex-Imp**	**(3)** Correlation bet HE Progs & Occup's	1.52	**Ex-Imp**
3	**(3)** Correlation bet HE Progs & Occup's	1.59	**Ex-Imp**	**(4)** Use Tech to Analyze Labor & HE progs	1.55	**Ex-Imp**
4	**(1)** Access to Labor & Emp Stats	1.61	**Ex-Imp**	**(2)** Career Advice @HS & HEIs	1.60	**Ex-Imp**
5	**(6)** Two-way Link bet HEIs & Industry	2.00	**Imp**	**(6)** Two-way Link bet HEIs & Industry	1.67	**Ex-Imp**
6	**(7)** Involve Profn's in HE Progs & Plann'	2.30	**Imp**	**(7)** Involve Profn's in HE Progs & Plann'	2.17	**Imp**
7	**(5)** Social Factors	2.19	**Imp**	**(5)** Social Factors	2.33	**Imp**

We notice in the two surveys that the bottom three factors are identical in their rank but vary in the degree or level of agreement. The top four represent features that a respectable BI system should facilitate; from access to admission and employment statistics to a good correlation between HE programs and labor market. Even career advice at high schools and HEIs should benefit from it.

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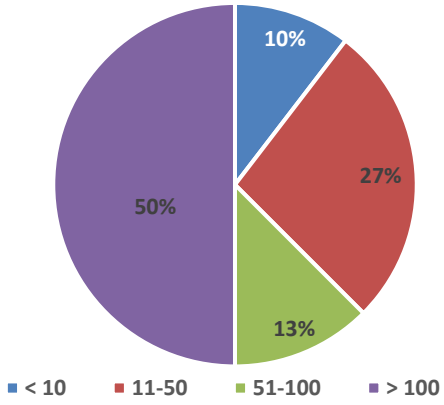
Section-1: Basic Information

Q1: Institution Size

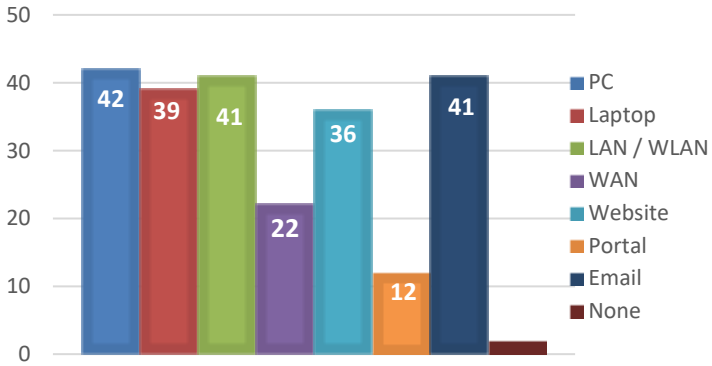
Employees	Frequency	Percent
< 10	5	10.4%
11-50	13	27.1%
51-100	6	12.5%
> 100	24	50.0%
		100%



From the table and pie-chart, we see that the majority of organizations responding to the questionnaire have more than 100 employees.

Q2: Technology Prevalence

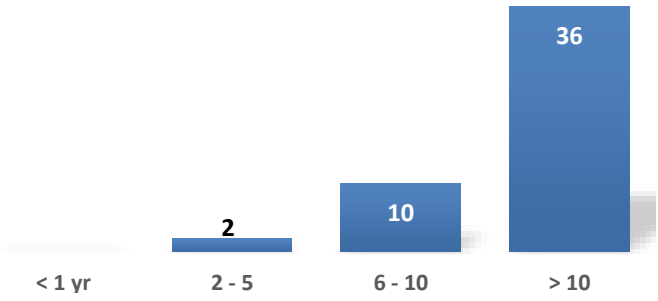
Category	Frequency	Percent
PC	42	17.9%
Laptop	39	16.6%
LAN / WLAN	41	17.4%
WAN	22	9.4%
Website	36	15.3%
Portal	12	5.1%
Email	41	17.4%
None	2	0.9%
		100%



Respondents were asked if their institution owns or uses one or more of the listed technologies. We can see in the chart and table that most organizations are technology savvy with most owning or using PCs, LAN / WLAN, Email, Laptops and websites. Only two out of the 48 surveyed organizations did not have or use any technology. From this result we confirm that an open BI portal accessible via the internet would be easily accessible to most institutions.

Q3: Years in Business

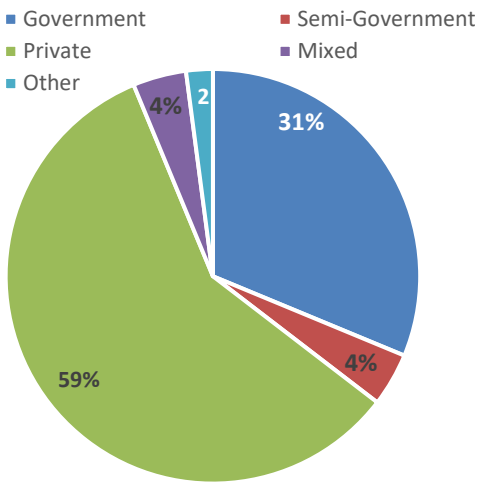
Years	Frequency	Percent
< 1	0	0%
2 - 5	2	4.2%
6 - 10	10	20.8%
> 10	36	75%
		100%



An overwhelming majority of responding institutions (75%) have been in business for over 10 years.

Q4: Organization Sector Type

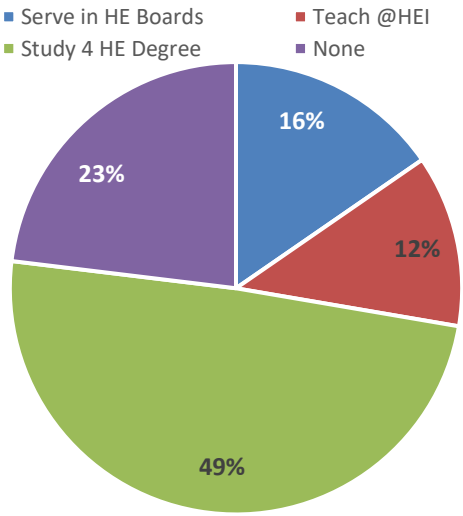
Sector	Frequency	Percent
Governmental	15	31.3%
Semi-Government	2	4.2%
Private	28	58.3%
Mixed	2	4.2%
Other	1	2.1%
		100%



From the chart and table, it is clear that the majority of institutions in the survey sample are private. This result is consistent with the 2011 Labor Force Survey (LFS) conducted by the Ministry of Labor and Administrative Reform (MLAR) in conjunction with the International Labor Organization (ILO) that found 53% of the workforce are employed by private or family owned businesses.

Q5: Recognition of HE Significance

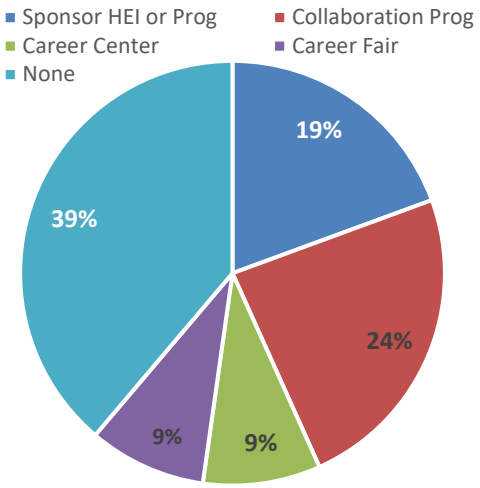
Encourage	Frequency	Percent
Serve in HE Boards	10	15.4%
Teach @HEI	8	12.3%
Study 4 HE Degree	32	49.2%
None	15	23.1%
		100%



As we see in the table and chart, about half of the responding institutions recognize the significance of HE by encouraging their staff to study for HE degrees and around (16%) serve as HE boards' members. But then again, about a quarter (23%) do not provide any incentive or encouragement.

Q6: Support for Higher Education

Category	Frequency	Percent
Sponsor HEI or Prog	13	19.4%
Collaboration Prog	16	23.9%
Career Center	6	9.0%
Career Fair	6	9.0%
None	26	38.8%
		100%

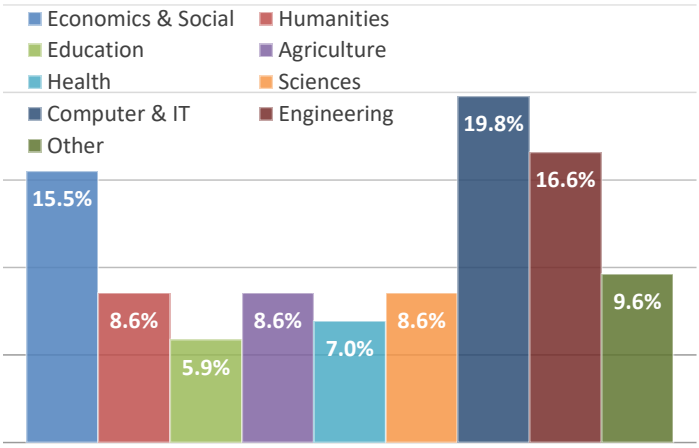


Respondents were asked if they support HE programs, research, career center or fairs in any way; financially or through collaboration. They were asked to select one or more of the support categories.

The chart shows that the majority of responding institutions (39%) do not support any. On the other hand, the most common means of support offered by organizations for HE is for collaboration programs (24%). At the same time, we see that support for career centers and job fairs is pretty low. This supports the hypothesis that HE graduates recruitment decisions are made with little or no support from real data.

Q7: New Hires' Rank by Discipline

Study Field	Frequency	Percent
Economics & Social	29	15.5%
Humanities	16	8.6%
Education	11	5.9%
Agriculture	16	8.6%
Health	13	7.0%
Sciences	16	8.6%
Computer & IT	37	19.8%
Engineering	31	16.6%
Other	18	9.6%
		100.0



Respondents were asked to rank the total number of their new hires by discipline during the last five years. From the chart, the top three disciplines are Computer and IT followed by Engineering and then Economics and Social studies. It is a good indication that all nine disciplines as categorized by MHESR are adequately represented in the survey sample.

Q8: Internship or Summer Employment

Internship	Frequency	Percent
Yes	18	37.5%
No	30	62.5%
		100%

Most employers (62.5%) do not offer Internship or Summer employment programs for students. This result when read with that of questions five and six above, shows that institution need to dedicate more provisions and resources to supporting HE programs, research and students. In the next section, we will see how institution rank applicants who had internship or worked during Summer.

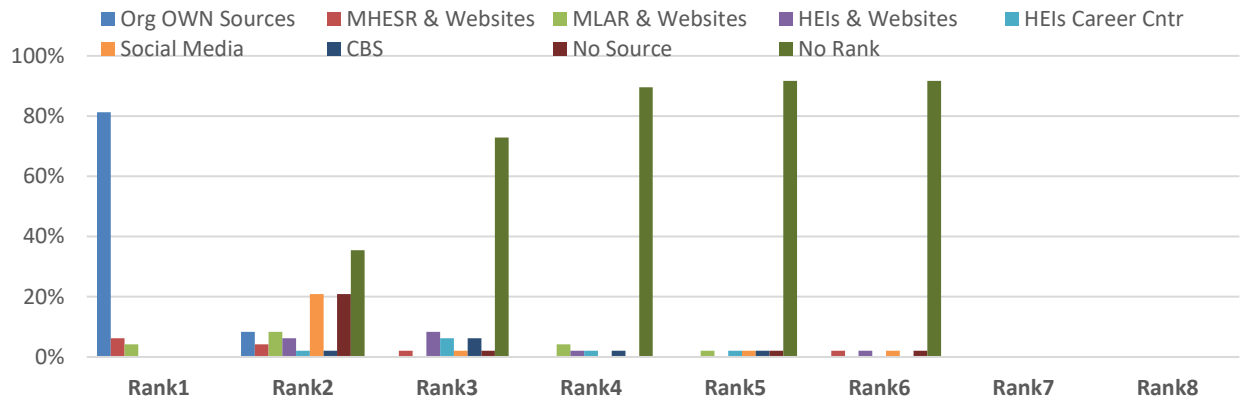
Q9: New Hires' Training

Training	Frequency	Percent
Yes	36	75%
No	12	25%
		100%

The vast majority of employers (75%) do have a structured training program for new hires. This outcome correlated with that of previous questions in this section, demonstrates that employers show greater interest in improving their staff's qualities rather than cultivating potential future hires and enhancing their institutions' visibility.

Section-2: Current Situation and Expectation

Q1: Entry-Level Recruitment Planning Info Sources' Rank



An overwhelming majority (81%) of respondents chose "Organizations' Own Sources" as their one-and-only information source. The second rank "Social Media" is a distant second and in fact it is in a tie with "No Source" response at (20.8%). The observation that stands out here is that all responses other than "Organizations' Own Sources" seem to have little or no significance as is clear in the chart above.

This confirms the hypothesis that Employers' hiring and recruitment planning decisions are not made based on information about HE study programs, institutions or labor market information. It is worth noting that about (65%) of respondents chose only two sources of information with "Own Sources" as number one and "No Source" as number two.

Q2: Integrity of Entry-Level Recruitment Planning Information

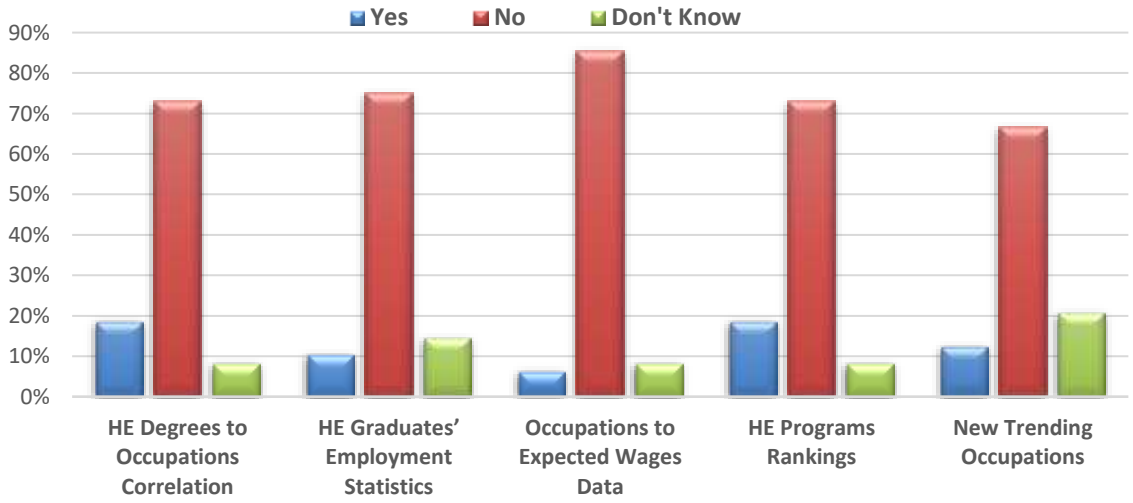
This question is divided into five sub-questions, it intends to measure the level of agreement of respondents with the five statements about their information sources' integrity and comprehensiveness in reference to recruitment planning data. We want to measure if the Information they receive covers the outlined subcategories.

A three-points Likert scale is used here with answers {①Yes ②No ③Don't Know}. The way to analyze this type of question is by utilizing statistical hypothesis testing. We calculate the Mean, Standard Deviation (STD) and Chi-square for each of the five sub-questions as is shown in the descriptive statistics table below. Then we compute the average score and figure out where it lies on the scale. The smaller the score (closer to ONE) the higher the agreement level.

Frequencies' Distribution and Percent Table

	Statement	Frequency			Percent		
		Y	N	D	Y	N	D
1	Degrees to Occupations Correlation	9	35	4	18.8%	72.9%	8.3%
2	Graduates' Employment Statistics	5	36	7	10.4%	75.0%	14.6%
3	Occupations to Expected Wages" Data	3	41	4	6.3%	85.4%	8.3%
4	HE Programs Rankings	9	35	4	18.8%	72.9%	8.3%
5	New Trending Occupations	6	32	10	12.5%	66.7%	20.8%

From the frequency table above, we notice that all respondents' replies for the whole five statements were concentrated in the "N" response indicating that respondents have a clear and strong opinion about their lack of information. Statement (3) received the highest overall frequency of 41 "N" or 85%, followed by statement (2) with 36 "N" or 75%.



The chart above illustrates that replies “Y” and “D” are visibly insignificant compared to reply “N” for all statements. This result strongly indicates that all of the entry-level recruitment and career planning information received by respondents is incomplete.

Descriptive Statistics Table

Statement		Mean μ	Median	Mode	STD	Chi-square	DF	P value	Trend
1	Degrees to Occupations Correlation	1.90	2.00	2	.515	34.625	2	.000	No Info
2	Graduates’ Employment Statistics	2.04	2.00	2	.504	37.625	2	.000	No Info
3	Occupations to Expected Wages Data	2.02	2.00	2	.385	58.625	2	.000	No Info
4	HE Programs’ Rankings	1.90	2.00	2	.515	34.625	2	.000	No Info
5	New Trending Occupations	2.08	2.00	2	.577	24.500	2	.000	No Info

{interval equals ranges/values=2/3 =0.6; then possible ranges are:1-1.6, 1.7-2.2, 2.3-2.8}

From the table above, we observe that:

- All the p-values are less than the assumption significance level 0.05, so we reject the null-hypothesis. We accept the alternative hypothesis that there are statistically significant differences in the distribution of respondents' replies to the different response options (Y, N, D). That is, the observed difference is unlikely to be due to chance, and if we were to repeat the survey with different samples there is a 95% chance we will get similar results.
- Furthermore, from the table, all mean values for all statements are between 1.9 – 2.08
- STD values are between 0.385 – 0.577, this indicates the homogeneity of respondents' answers.

To find the overall trend or inclination of responses for this question as a whole (with all its sub-questions or statements), we calculate the average from the above table as shown below.

	Mean	STD	Chi-square	DF	P value	Inclination
Average	1.99	0.499	83.0000	2	0.000	No Info

From this summary table above, we can see that the combined **mean** of all the collective statements is (1.99), which is pre-determined as “N” or No Information, therefore we confirm the hypothesis that the HE programs and career planning information received by respondents lacks integrity and is imprecise, incomplete, and inaccurate. This confirms our hypothesis.

Q3: Format of Data Received

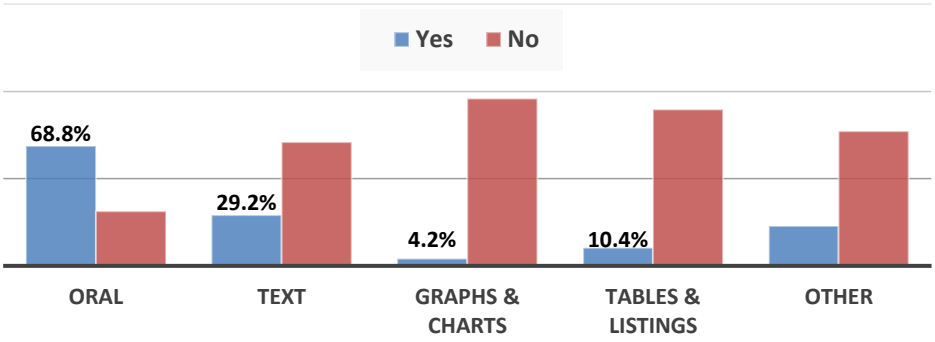
To decode this question’s data, we use a binary scale with responses {⓪No ①Yes} for each of the possible six answers. Subsequently, to analyze the results, we use statistical significance testing by calculating the Mean, STD and Chi-square for each of the answers as in the table below. Then we compute the average score to figure out where it lies on the scale, closer to zero (No) or one (Yes).

The scale increment is calculated as follows {range/values= 1/2 =0.5}. Then the possible range of values is: {0-0.5, 0.6-1.1}.

Data Format	"Y" Percent	Yes	No	Mean	P value	DF	STD	Variance	Inclination
Oral	68.8%	33	15	0.69	.009	1	0.468	0.219	Avail Info
Text	29.2%	14	34	0.29	.004	1	0.459	0.211	No Info
Graphs & Charts	4.2%	2	46	0.04	.000	1	0.202	0.041	No Info
Tables & Listings	10.4%	5	43	0.10	.000	1	0.309	0.095	No Info
Other	22.9%	11	37	0.23	.000	1	0.425	0.180	No Info
Average				**0.27**					

From the statistics table above, we see that:

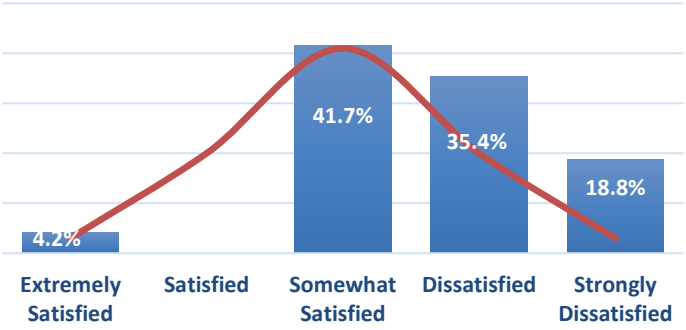
- All mean values for all responses are between 0.04 – 0.69
- STD values are between 0.202 – 0.468, this indicates the dispersion of respondents' answers.
- The combined **mean** of all the collective responses is (0.27), which is pre-determined as "N" or No Information.



Furthermore, from the chart above, we see the majority (68.8%) of respondents indicated that they have received their entry-level recruitment planning information in verbal or "Oral" format. This was followed by "Text" at (29.2%). The rest of data formats were minimal and insignificant. Additionally, the data formats "Graphs & Charts" and "Tables & Listings" received the lowest frequencies meaning respondents rarely or never attained data in these formats. Therefore, we conclude that HE programs and career planning information -even when it is available- lacks readability, visualization and usability overall.

Q4: Satisfaction with Entry-Level Recruitment Planning Info Availability

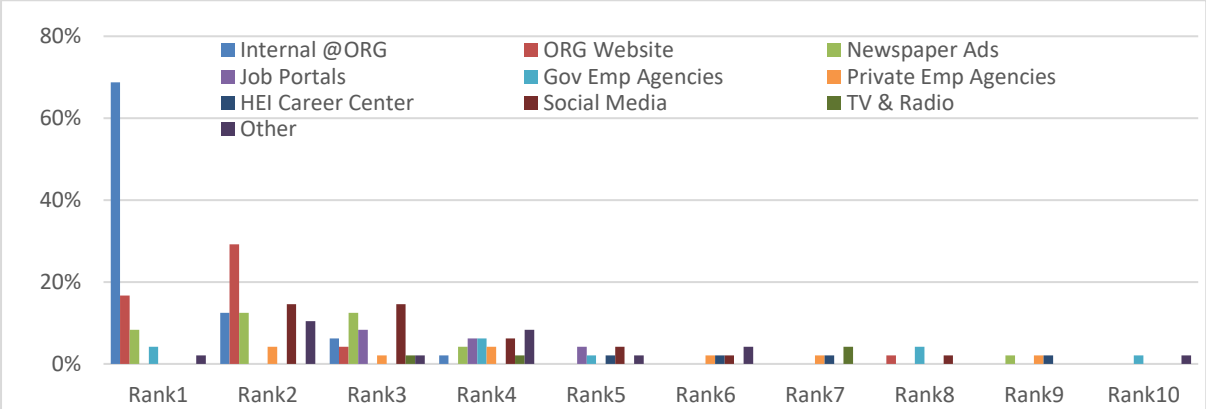
A five-points Likert scale is used to measure the level of respondents' satisfaction with recruitment planning information availability as follows, {①Extremely Satisfied ②Satisfied ③Somewhat Satisfied ④Dissatisfied ⑤Strongly Dissatisfied}. We have plotted the frequencies histogram shown below based on results.



As shown in the chart above, 54.2% (35.4% + 18.8%) of respondents are "Dissatisfied" compared to 4.2% (4.2% + 0%) who are "Satisfied", while 41.7% are "Neutral". It is clear that the distribution is skewed to the left, that is to say that most respondents are inclined towards Dissatisfaction with career planning information availability.

This result highlights the need for a system that presents precise and accurate information in an easy to use and understand format.

Q5: Preferred Outlets for Entry-Level Jobs Listing



We asked respondents to rank the entry-level jobs listing outlets they utilized based on their frequency of use or preference. The above histogram displays the frequency distribution graphically while the following table shows the top four ranked outlets.

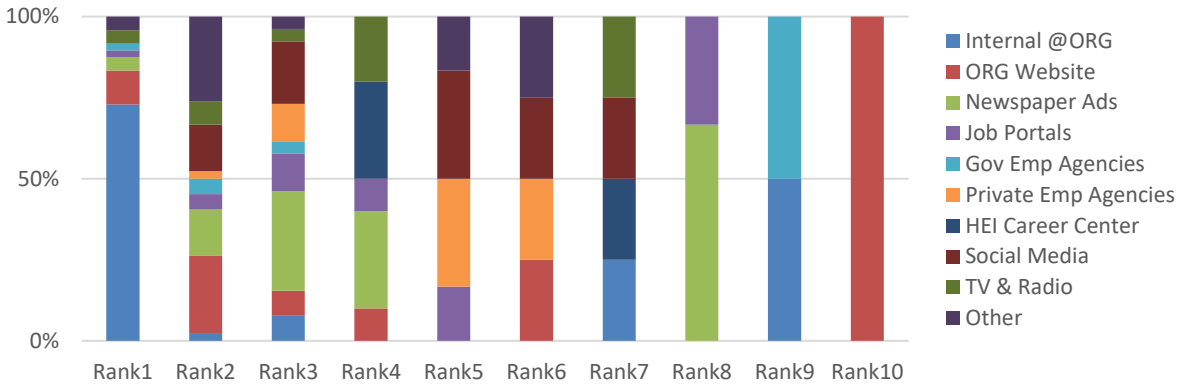
Rank	Outlet	
1	Internal @ORG	68.8%
2	ORG Website	29.2%
3	Social Media	14.6%
4	Newspaper Ads	12.5%

From the table and graph, it is clear that most organizations prefer to advertise entry-level jobs internally. Also, there is a big gap between the top rank and the second on the list "Organization's Website". Also, from the graph we observe that the gap between the top for outlets and the rest is huge. The rest of the outlets have noticeably lower insignificant frequencies. On top of this, about 71% of respondents ranked only four answers out of the ten available.

As we saw in Q1 of this section (Entry-Level Recruitment Planning Info Sources), "Organizations' Own Sources" was the most important factor for institutions when creating entry-level recruitment plans. This shows that most organizations prefer to depend on themselves internally for both the planning of recruitment and the advertisement for entry-level openings. The reasons behind this; as we saw in the results of the previous questions about data availability, data format and data integrity; is that the required data is either unavailable, unusable or unreliable or all. To complete the hiring process circle, the next question aims to investigate the effectiveness of institutions' outlets in securing employment

of fresh graduates. These findings outlined above support the hypothesis that HE graduates recruitment decisions are made with little or no support from real data.

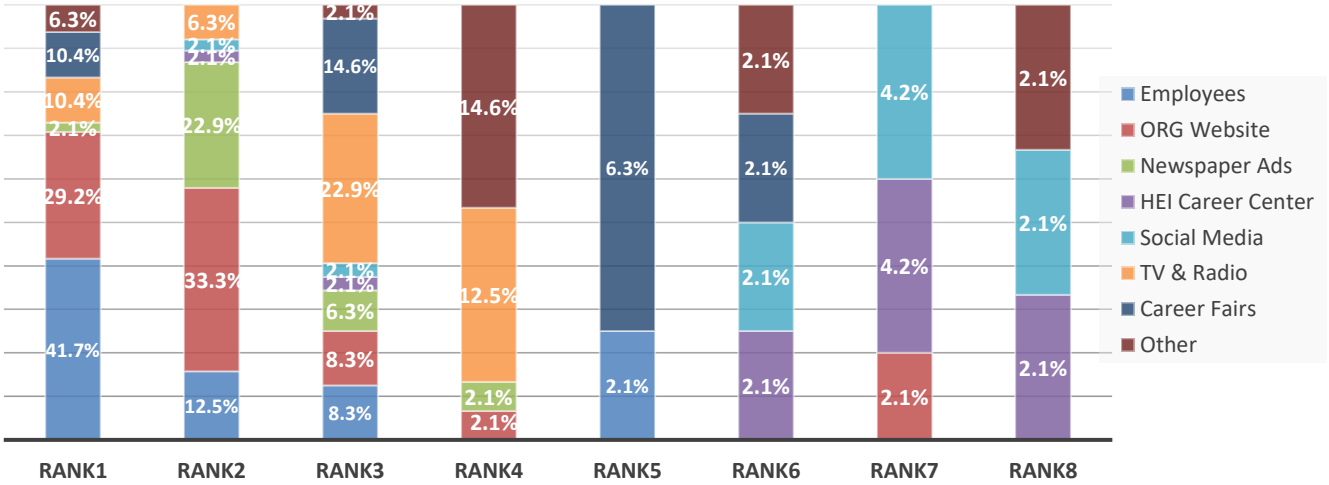
Q6: Reliability of Entry-Level Jobs' Listing Outlets



Employers were asked to rank outlets based on the number of entry-level candidates employed during the last five years. From the graph above, we see that the vast majority of entry-level positions (72.39%) were filled "Internally at Organization" as top category. Followed by "Organization Website", then "Newspaper Ads" and "Social Media". Additionally, it is clear that there is a big gap between the top rank "Internal @ORG" and the rest.

As we saw in previous results, institutions' entry-level positions hiring practices including their choice of jobs advertisement outlets as in this question, reduce graduates' awareness about available jobs and also their own visibility.

Q7: Preferred Media Outlets to Promote Achievements



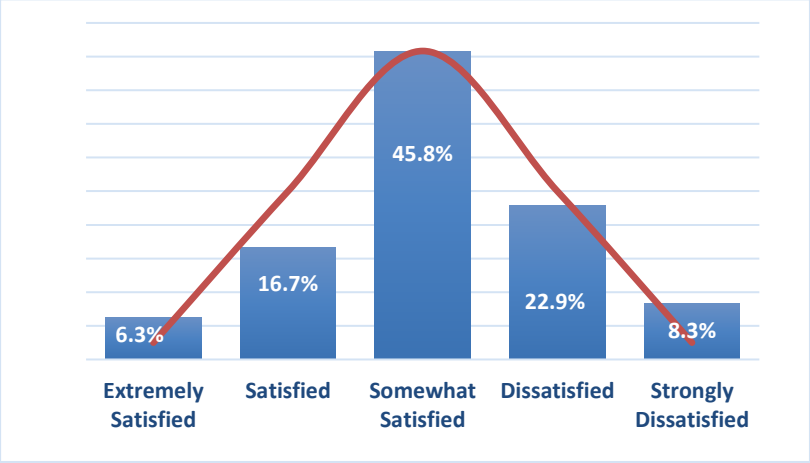
Employers were asked to rank their preferred media outlets for communicating their institutions' achievements and goals to the public in general and to prospective employees. From the chart above, we see that the majority of respondents chose "Employees" as their

top means of showing their accomplishments, this is followed by “Organization’s Website”, “Newspapers”, and then “TV & Radio”.

As in previous questions, institutions again chose to showcase their achievement internally or through their own employees.

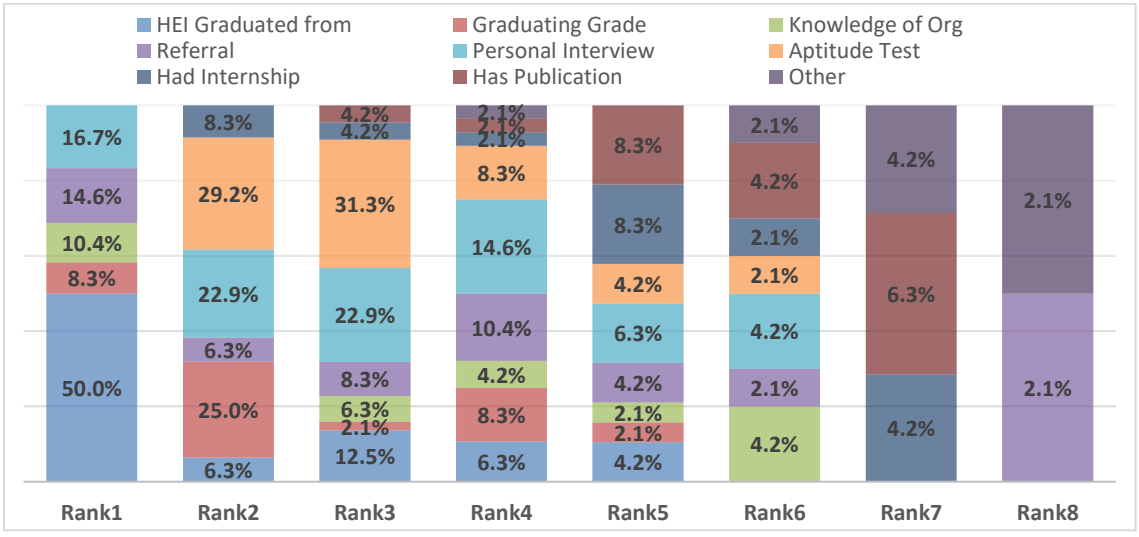
Q8: Satisfaction with Organization Visibility

Employers were asked if they are satisfied with the level of knowledge about their institution, its achievements and goals among entry-level applicants. A five-points Likert scale is used to measure the level of respondents’ satisfaction as follows, {①Extremely Satisfied ②Satisfied ③Somewhat Satisfied ④Dissatisfied ⑤Strongly Dissatisfied}. We plot the frequencies histogram as shown below.



As shown in the chart above, 31.3% (22.9% + 8.3%) of respondents are Dissatisfied as compared to 22.9% who are Satisfied (6.3% + 16.7%) while 45.8% are Neutral. It is clear that the distribution is skewed to the left, i.e., most respondents are inclined towards Dissatisfaction with their institution’s visibility.

Q9: Entry-Level Candidates Ranking



In this question, we are weighing the factors that influence organization's hiring-decisions as they relate to organization information sources and outlets of communication. Employers were asked about how they rank entry-level positions' candidates.

As shown in the histogram above, the number one entry-level hiring factor is "HEI Graduated from" with 50% of respondents selecting it. This clearly demonstrates the utmost importance that HEIs and MHESR must assign to disseminating reliable information about their programs, rankings, quality, employed graduates' numbers, etc. The availability of such real data to students, graduates, employers and the public in general, should enhance judging HEIs and their graduates based on concrete information and not perception.

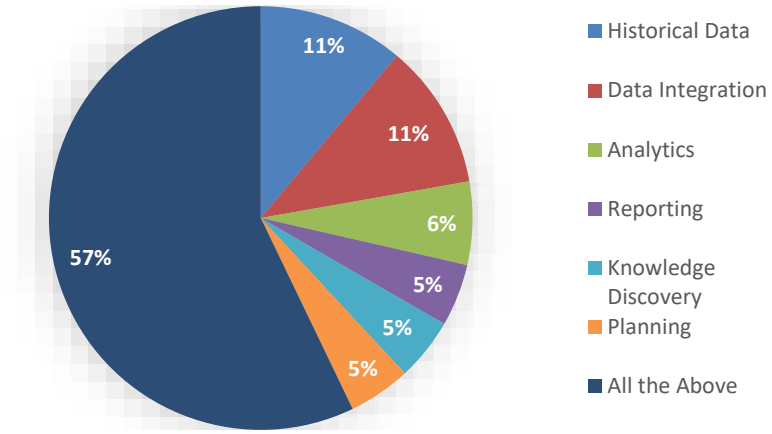
The number two rank is "Aptitude Test", followed by "Graduating Grade", "Personal Interview" and at number five is "Referral". "Had Internship" ranked at number seven, right behind "Knowledge of Organization".

Therefore overall, employers prefer graduates from well reputed HEIs with excellent grades that score well in their aptitude test and preferably referred to the institution or have some sort of connection to the institution. Having had an Internship does not play a major role in the hiring decision.

This result is consistent with results of both questions eight and nine of Section One; Q8 regarding institutions offering Internships or Summer work for student and Q9 regarding employers offering structured training to new entry-level hires.

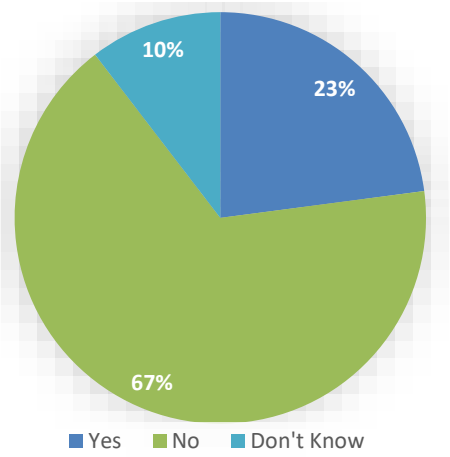
Section-3: Employers' Awareness about BI

Q1: Knowledge about Data Warehouse



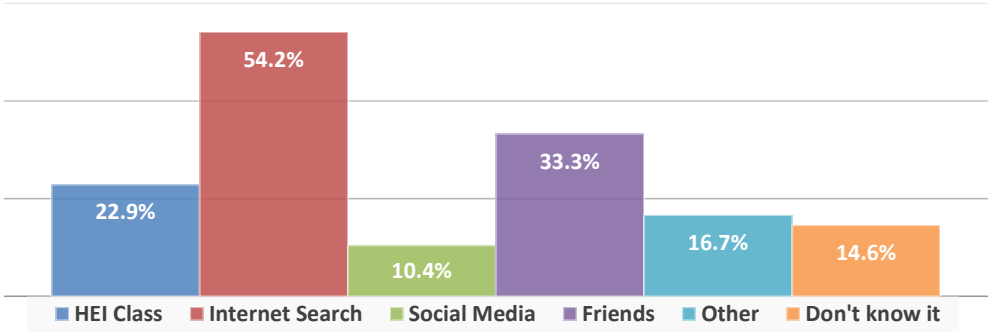
The majority of respondents (57%) identified all attributes of Data Warehouses. So, there is reasonable knowledge about intelligent systems and their capabilities among organizations, in fact more than among students and graduates. This question is designed to provide information to respondents while we solicit their feedback.

Q3: Intelligent Solutions Utilization



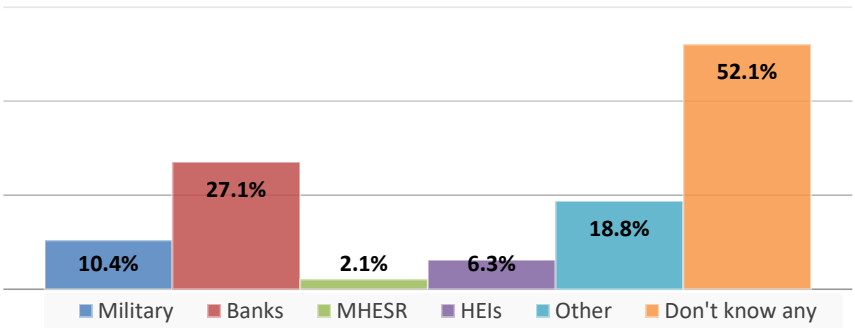
From the chart above, it is clear that most of the surveyed institutions do not use any intelligent and/or BI solutions.

Q4: Sources of Knowledge about BI



Most respondents (81.4%) already know about BI, with their knowledge attributed to different sources as seen in the chart above. The majority attribute their knowledge to "Internet Search" at (54.2%).

Q5: Knowledge of Organizations that Use BI



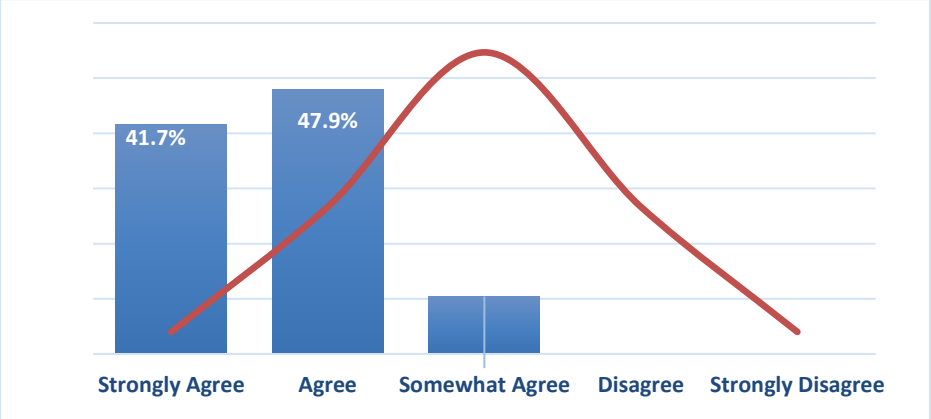
Most respondents are not aware of organizations that utilize BI. But from the respondents that know of such organizations, “Banks” top the list followed by “Other” and then “Military”.

Questions 6 and 7: BI Helps Align HE Programs with Market

Both questions 6, and 7 in the section are about gauging respondents’ level of agreement that BI systems help to explore the relation between higher education programs and the labor market. A five-points Likert scale is used with the following range of values {①Strongly Agree ②Agree ③Somewhat Agree ④Disagree ⑤Strongly Disagree}.

To analyze these questions, we calculate the frequency distribution and then compute the Mean, Median, and Mode. We then figure out where the mean value lies in the range and to which direction are the responses inclined. We do this for each of the three questions.

Q6: BI Assists Institution in Recruitment and Career Planning

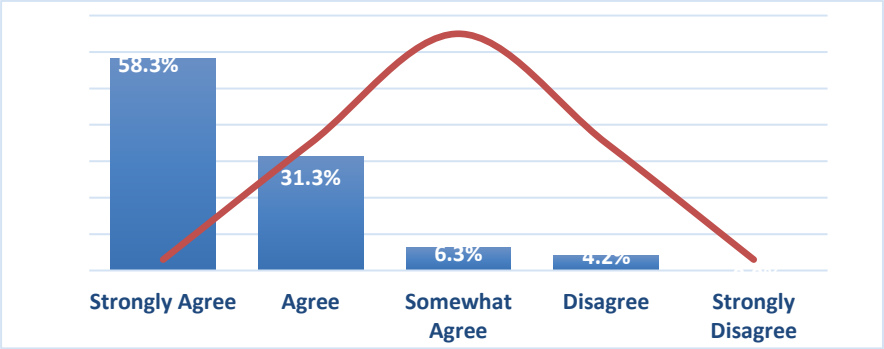


From the histogram above, we clearly see that the vast majority of respondents (89.6%) agree with the statement with (41.7%) “Strongly Agree” and (47.9%) “Agree”. At the same time disagreement does not exist, with both “Disagree” and “Strongly Disagree” at zero. It is visible that the distribution is skewed to the right, i.e., most respondents are inclined towards strong agreement with the statement.

Mean	Median	Mode	STD	Variance	Skewness
1.69	2.00	2	0.657	0.432	0.430

Moreover, from the table above, the **mean** lies in the “Strongly Agree” range, this implies that most respondents are tend to strongly agree with the statement. The above two observations are a positive indication that there is agreement with the hypothesis that BI supports HE students in deciding about programs of study and in career planning.

Q7: BI Supports MHESR & HEIs align Programs with Market



From the histogram above, we notice that an overwhelming majority of respondents (86.9%) agree with the statement with (58.3%) "Strongly Agree" and (31.3%) "Agree". At the same time, disagreement is pretty low at (4.2%) with "Strongly Disagree" at zero. The distribution is visibly skewed to the right, this means that most respondents strongly agree with the statement.

Mean	Median	Mode	STD	Variance	Skewness
1.56	1.00	1	0.796	0.634	1.501

From the table above, the **mean** is already predefined as "Strongly Agree", i.e., most respondents are inclined towards strong agreement with the statement.

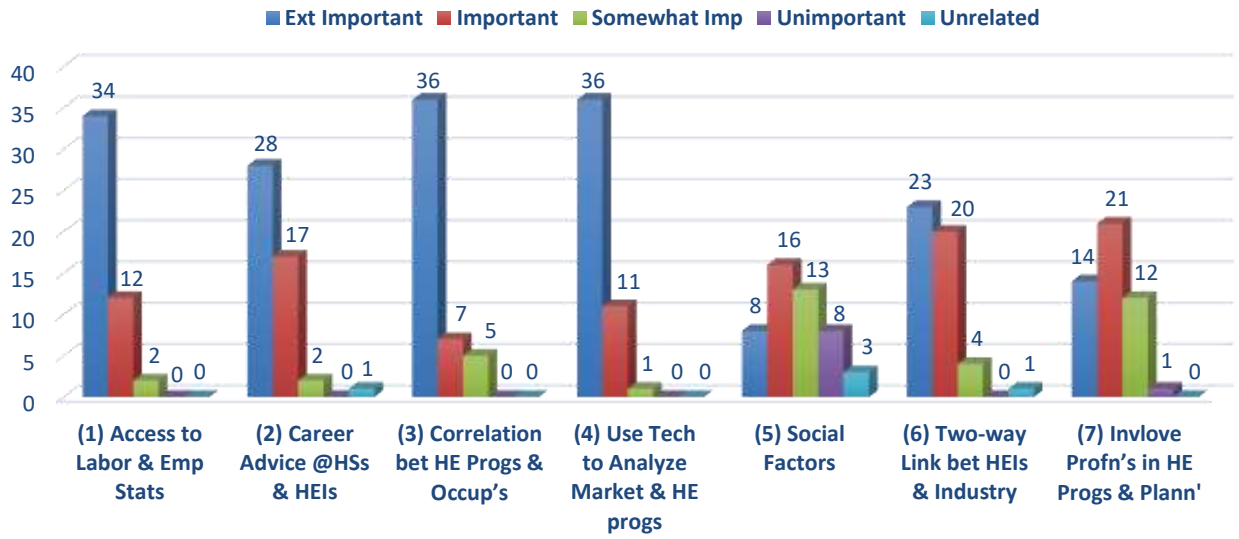
The above analysis for question 6 and 7 indicates that most respondents agree strongly that utilizing BI will assist in aligning HE output with labor market.

Section-4: Factors Influencing HE Alignment with Labor Market

In this question, factors affecting the alignment of HE programs with the labor market are combined in a matrix with seven factors. The goal is to measure respondents' level of agreement with each factor by utilizing a five-points Likert scale as follows, {①Extremely Important ②Important ③Somewhat Important ④Unimportant ⑤Unrelated}.

Frequency Distribution and Percent

	Factors Influencing Alignment between HE Programs & Labor Market	Frequency					Percent				
		Ext Imp	Important	Some Imp	Unimportant	Unrelated	Ext Imp	Important	Some Imp	Unimportant	Unrelated
1	Access to Labor & Emp Stats	34	12	2	0	0	70.8	25.0	4.2	0.0	0.0
2	Career Advice @HS & HEIs	28	17	2	0	1	58.3	35.4	4.2	0.0	2.1
3	Correlation bet HE Progs & Occup's	36	7	5	0	0	75.0	14.6	10.4	0.0	0.0
4	Use Tech to Analyze Market & HE progs	36	11	1	0	0	75.0	22.9	2.1	0.0	0.0
5	Social Factors	8	16	13	8	3	16.7	33.3	27.1	16.7	6.3
6	Two-way Link bet HEIs & Industry	23	20	4	0	1	47.9	41.7	8.3	0.0	2.1
7	Involve Profn's in HE Progs & Plann'	14	21	12	1	0	29.2	43.8	25.0	2.1	0.0



We clearly see from the table and chart above, that:

- Most replies for all factors were concentrated between "Extremely Important" and "Important".
- The total of "Unimportant" and "Unrelated" responses is pretty low, almost insignificant as compared to the rest of the responses. This is the case for all seven factors, which implies that all are strong factors in aligning HE output with markets.
- Both factors (3) and (4) received the highest overall frequency of 36 "Extremely Important" or 75%, followed by factor (1) with 70.8%, then factor (2) with 58.3% and then factor (6) with 47.9%.

To find the general direction or classification of importance for each factor in the matrix, we calculate the Mean, STD, P-Value and Chi-square for each one as in the table below.

Factor		Mean	STD	Variance	P value	DF	Classification
1	Access to Labor & Employment Stats	1.33	0.559	0.312	.000	2	Extremely Imp
2	Career Advice @HS & HEIs	1.52	0.772	0.595	.000	3	Extremely Imp
3	Correlation bet HE degrees & Occupations	1.33	0.663	0.440	.000	2	Extremely Imp
4	Use Tech to Analyze Labor & HE programs	1.29	0.504	0.254	.000	2	Extremely Imp
5	Influence of Social Factors	2.63	1.142	1.303	.032	4	Important
6	Two-way Link bet HEIs & Industry	1.67	0.808	0.652	.000	3	Extremely Imp
7	Involve Professionals in HE Progs & Planning	2.00	0.799	0.638	.001	2	Important
	Average	**1.68**					Extremely Imp

The scale increment is calculated as follows {range/values= 4/5 =0.8}. Then the possible range of values: {1-1.8, 1.9-2.7, 2.8-3.6, 3.7-4.5, 4.6-5.4}.

From the descriptive statistics table above, we observe that:

- All the p-values are less than the assumption significance level 0.05, indicating statistically significant differences in the distribution of respondents' replies to the different response options. That is, the observed difference is unlikely to be due to chance, and if we were to repeat the survey with different samples there is a 95% chance, we will get similar results.

- From the mean values in the table we can see that the first four factors and factor (6) were all ranked as "Extremely Important" by respondents, while factors (5) and (7) ranked as "Important".
- STD values are between 0.504 – 1.142, this indicates the dispersion of respondents' answers.
- The average mean is **1.68** that ranks as "Extremely Important". Therefore, all factors strongly influence aligning HE output with markets.

From all the above discoveries, we submit that the overall trend or inclination of responses for this question as a whole indicates that all factors strongly influence aligning HE output with markets.

Section Four Results Comparison in the Three Surveys

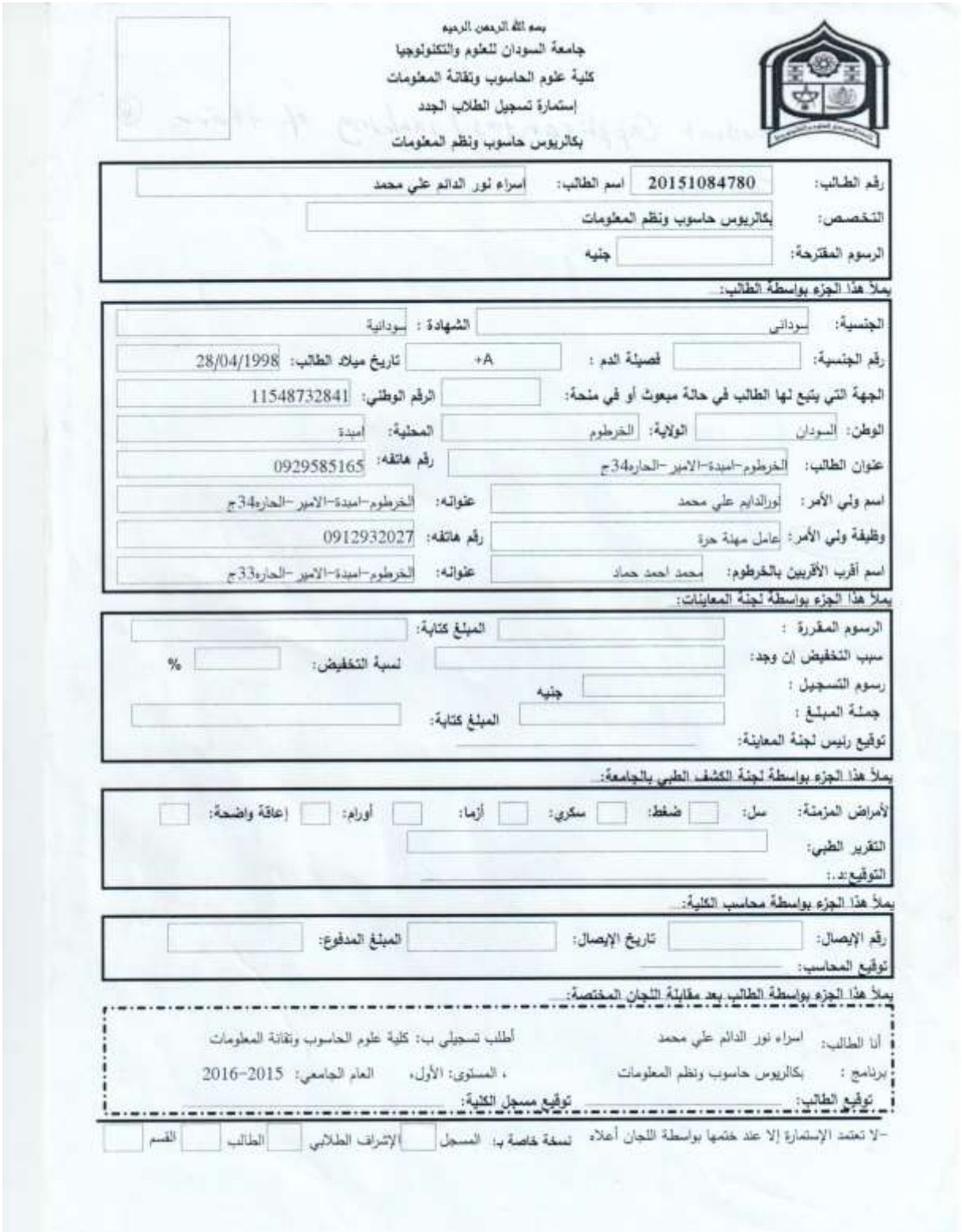
The following table shows a comparison of the results for all the three surveys.

Factor		Students		Graduates		Employers	
		Rank	Class	Rank	Class	Rank	Class
1	Access to Labor & Employment Stats	4	Ext-Imp	1	Ext-Imp	4	Ext-Imp
2	Career Advice @HS & HEIs	2	Ext-Imp	3	Ext-Imp	1	Ext-Imp
3	Correlation bet HE degrees & Occupations	3	Ext-Imp	4	Ext-Imp	3	Ext-Imp
4	Use Tech to Analyze Labor & HE programs	1	Ext-Imp	2	Ext-Imp	2	Ext-Imp
5	Influence of Social Factors	6	Imp	6	Ext-Imp	6	Ext-Imp
6	Two-way Link bet HEIs & Industry	7	Imp	7	Imp	7	Imp
7	Involve Professionals in HE Progs & Planning	5	Imp	5	Imp	5	Imp

From the table above, we notice that all respondents agree that the first four factors 1-4 are top ranked as "Extremely Important" and the bottom three are ranked as "Important". This implies that all seven factors are strong factors in aligning HE output with markets. Both Employers and Students rank factor (4) as top rank and factor (3) as third. At the same time, both Employers and Graduates rank factor (2) fourth. All three groups of respondents agree on the identity and classification of the bottom three factors except only Employers and Graduates rank factor (6) as "Extremely Important".

The top four factors represent features that any respectable BI system or intelligent solution should facilitate; from easy access to admission and employment statistics at one place to a good correlation between HE programs and occupations in the labor market. Even career advice at high schools and HEIs should benefit from utilizing BI intelligent solutions.

Appendix-E SUST Sample Application Form



بسم الله الرحمن الرحيم

جامعة السودان للعلوم والتكنولوجيا

كلية علوم الحاسوب وتقانة المعلومات

إستمارة تسجيل الطلاب الجدد

بكالريوس حاسوب ونظم المعلومات

رقم الطالب: 20151084780 اسم الطالب: اسراء نور الدائم علي محمد

التخصص: بكالريوس حاسوب ونظم المعلومات

الرسوم المقترحة: جنيه

يملأ هذا الجزء بواسطة الطالب:

الجنسية: سوداني الشهادة: سودانية

رقم الجنسية: فصيلة الدم: +A تاريخ ميلاد الطالب: 28/04/1998

الجهة التي يتبع لها الطالب في حالة مبعوث أو في منحة: الرقم الوطني: 11548732841

الوطن: السودان الولاية: الخرطوم المحلية: امبدة

عنوان الطالب: الخرطوم-امبدة-الامير-الحارة34ج رقم هاتفه: 0929585165

اسم ولي الأمر: نورالدايم علي محمد عنوانه: الخرطوم-امبدة-الامير-الحارة34ج

وظيفة ولي الأمر: عامل مهنة حرة رقم هاتفه: 0912932027

اسم أقرب الأقربين بالخرطوم: محمد احمد حماد عنوانه: الخرطوم-امبدة-الامير-الحارة33ج

يملأ هذا الجزء بواسطة لجنة المعاينات:

الرسوم المقررة : المبلغ كتابة:

سبب التخفيض إن وجد: لنسبة التخفيض: %

رسوم التسجيل : جنيه

جملة المبلغ : المبلغ كتابة:

توقيع رئيس لجنة المعاينة:

يملأ هذا الجزء بواسطة لجنة الكشف الطبي بالجامعة:

الأمراض المزمنة: سل: ضغط: سكري: أزما: أورام: إعاقة واضحة:

التقرير الطبي:

التوقيع د.:

يملأ هذا الجزء بواسطة محاسب الكلية:

رقم الإيصال: تاريخ الإيصال: المبلغ المدفوع:

توقيع المحاسب:

يملأ هذا الجزء بواسطة الطالب بعد مقابلة اللجان المختصة:

أنا الطالب: اسراء نور الدائم علي محمد أطلب تسجيلي ب: كلية علوم الحاسوب وتقانة المعلومات

برنامج : بكالريوس حاسوب ونظم المعلومات ، المستوى: الأول العام الجامعي: 2016-2015

توقيع الطالب: توقيع مسجل الكلية:

-لا تعتمد الإستمارة إلا عند ختمها بواسطة اللجان أعلاه نسخة خاصة بـ: المسجل الإشراف الطلابي الطالب القسم

Appendix-F Questionnaires in Arabic

F.1: Students

الرجاء الإجابة على كل أسئلة الاستبيان بوضع علامة ☑ على رقم الإجابة (أو الإجابات) الصحيحة أو ترتيب أرقام الإجابات.

القسم الأول: معلومات أساسية

1	كم كان عمرك	عند قبولك للدراسة الجامعية؟	① 17-16 ② 19-18 ③ 21-20 ④ 23-22 ⑤ 23<
		الآن؟	① 21-20 ② 23-22 ③ 25-24 ④ 27-26 ⑤ 27<
2	كم من السنوات تبقى على تخرجك؟		① 1> ② 2 ③ 3 ④ 4 ⑤ 5
3	هل أنت؟		① ذكر ② أنثى
4	هل تمتلك أو تستعمل؟ (أختر كل الإجابات الصحيحة)		
	① جهاز حاسوب مكتبي ② لابتوب ③ جهاز تاب ④ موبايل ذكي ⑤ موبايل غير ذكي ⑥ تلفاز ⑦ راديو		
5	ما هي مصادرك للأخبار؟ (في السطر الخالي رتب أرقام الإجابات حسب أهميتها لك)		
	① وسائل التواصل الاجتماعي ② التلفاز ③ الراديو ④ الانترنت ⑤ الصحف المطبوعة ⑥ العائلة والأصدقاء ⑦ أخرى		
	رتب أرقام الإجابات هنا ↵		
6	ما هو مجال دراستك؟ (حسب تصنيف وزارة التعليم العالي)		
	① الاقتصادية والاجتماعية ② الانسانية ③ التربوية ④ الزراعية ⑤ الصحية ⑥ العلوم ⑦ الحاسوب ⑧ الهندسية ⑨ أخرى		
7	نوع الجامعة أو الكلية التي تدرس بها؟		① حكومية ② خاصة
8	مكان الجامعة أو الكلية التي تدرس بها؟		① العاصمة ② الولايات
9	ماذا كان دافعك أو سبب اختيارك للبرنامج الدراسي الجامعي الذي تدرس؟ (رتب أرقام الإجابات حسب أهميتها لك)		
	① التوظيف خارج البلاد ② التوظيف داخل البلاد ③ العمل لحسابك الشخصي ④ العائد المادي المجزئ ⑤ درجاتك أدخلتك هذا البرنامج ⑥ إشباع رغبة ذاتية ⑦ تحسين الحالة الاجتماعية ⑧ أخرى		
	رتب أرقام الإجابات هنا ↵		
10	هل مدرستك الثانوية بها مركز للمساعدة على التوظيف أو القبول بالجامعات؟		① نعم ② لا
11	هل قمت (أو تنوي القيام) بعمل تدريب منتظم (internship) أثناء الدراسة أو العمل خلال إجازة الصيف؟		① نعم ② لا
12	هل تعرف أو سمعت عن؟ (أختر كل الإجابات الصحيحة)		
	① الخدمة الإلزامية ② مفوضية الاختيار للخدمة المدنية القومية ③ وزارة العمل ④ مفوضية الإختيار للخدمة المدنية الولائية ⑤ جهاز تشغيل الخريجين ⑥ وكالات التوظيف ⑦ مواقع الكترونية للتوظيف		

القسم الثاني: الوضع الحالي والتوقعات

1	عند تقديمك للقبول الجامعي، ماذا كانت مصادر المعلومات التي ساعدت في تشكيل رأيك حول برامج الدراسة الجامعية والوظائف المستقبلية المحتملة؟ (رتب أرقام الإجابات حسب أهميتها لك)	
	① العائلة والأصدقاء ② مركز مساعدة التوظيف بالمدرسة الثانوية ③ مواقع وزارة التعليم العالي الالكترونية ④ مواقع وزارة العمل ⑤ وسائل التواصل الاجتماعي ⑥ مواقع مؤسسات التعليم العالي ⑦ لا شيء	
	رتب أرقام الإجابات هنا ↵	
2	هل أمدك أي من المصادر أعلاه بمعلومات عن	
	أ. العلاقة بين برامج الدراسية الجامعية والوظائف أو المهن المُحتملة؟	① نعم ② لا ③ لا أعلم
	ب. بيانات توظيف خريجي المؤسسات الجامعية؟	① نعم ② لا ③ لا أعلم
	ج. العلاقة بين المهن والأجور المتوقعة؟	① نعم ② لا ③ لا أعلم
	د. تصنيف برامج مؤسسات التعليم العالي مثلاً حسب نسبة التخرج، التوظيف، الخ؟	① نعم ② لا ③ لا أعلم

	هـ. توقعات لمهن أو وظائف جديدة غير شائعة الآن؟	①نعم ②لا ③لا أعلم
	و. إمكانية العمل خارج البلاد؟	①نعم ②لا ③لا أعلم
3	في أي شكل كانت البيانات التي تلقيتها من هذه المصادر؟ (أختر كل الإجابات الصحيحة)	
	①معلومات شفاهية ②نص مكتوب ③رسوم بيانية وتوضيحية ④جداول وقوائم ⑤أخرى	
4	هل أنت راض عن معلومات برامج الدراسة ومستقبلها المهني المحتمل التي عثرت عليها؟	
	①شديد الرضا ②راض ③إلى حد ما ④غير راض ⑤غير راض بشدة	
5	متى تخطط للبدء بالبحث عن العمل؟	
	①بعد التخرج ②بعد الفراغ من الخدمة الإلزامية ③أثناء السنة الأخيرة ④ أثناء السنة قبل الأخيرة ⑤أخرى	
6	ماذا تتوقع، أثناء بحثك عن عمل، أن تكون مصادر معلومتك عن الوظائف؟ (رتب أرقام الإجابات حسب أهميتها لك)	
	①الأسرة والأصدقاء ②إعلانات الصحف ③إعلانات الكترونية ④بوابات توظيف الكترونية ⑤وكالات توظيف حكومية ⑥وكالات توظيف خاصة ⑦مركز مساعدة التوظيف بالجامعة⑧وسائل التواصل الاجتماعي⑨التلفاز والراديو ⑩أخرى	
	رتب أرقام الإجابات هنا ⮌	
7	بالنظر إلى ما تعرفه الآن، هل مجال دراستك مرتبط بسوق العمل؟	
	①نعم ②لا ③لا أعرف	
8	بالنظر إلى وضعك الراهن وما تعرفه الآن، هل أنت راض عن اختيارك الذي قمت به لمجال دراستك ومسارك الوظيفي أو المهني المُحتمل؟	
	①شديد الرضا ②راض ③إلى حد ما ④غير راض ⑤غير راض بشدة	

القسم الثالث: ذكاء الأعمال (Business Intelligence, BI)

1	يمكن استخدام مستودع البيانات (Data Warehouse) في؟ (أختر كل الإجابات الصحيحة)
	①البيانات التاريخية ②تجميع البيانات ③تحليل البيانات ④التقارير ⑤اكتشاف المعرفة ⑥التخطيط ⑦كل ما سبق
2	"الحلول الذكية" وتقنيات أنظمة ذكاء الأعمال (BI systems) ترصد اتجاهات وميول البيانات باستخدام بيانات تاريخية أو بيانات آنية؟
	①نعم ②لا ③لا أعرف
3	أين تعرفت على أنظمة ذكاء الأعمال (BI systems)؟ (أختر كل الإجابات الصحيحة)
	①أثناء الدراسة الجامعية ②البحث عبر الإنترنت ③وسائل التواصل الاجتماعي ④الأصدقاء ⑤أخرى ⑥لا أعرفها
4	هل تعرف أي مؤسسة تستخدم أنظمة ذكاء الأعمال (BI system) في السودان؟ (أختر كل الإجابات الصحيحة)
	①العسكرية ②البنوك ③مؤسسات التعليم العالي ④وزارة التعليم العالي ⑤أخرى ⑥لا أعرف أي
5	هل توافق على أن نظام معلومات ذكاء الأعمال (BI system) (الذي يُوَضِح العلاقة بين برامج التعليم العالي والمهن والوظائف المُحتملة والأجور المتوقعة) كان من الممكن أن يساعدك عند اختيارك التخصص في المدرسة الثانوية واختيارك مؤسسة وبرنامج التعليم العالي؟
	①أوافق بشدة ②أوافق ③أوافق إلى حد ما ④لا أوافق ⑤لا أوافق بشدة
6	هل توافق على أن نظام معلومات ذكاء الأعمال (BI system) (الذي يُظهِر توجُهات التوظيف لدى خريجي مؤسسات التعليم العالي) قد يساعدك في خياراتك الوظيفية والمهنية؟
	①أوافق بشدة ②أوافق ③أوافق إلى حد ما ④لا أوافق ⑤لا أوافق بشدة
7	هل تؤيد وزارة التعليم العالي ومؤسساتها من جامعات وكليات على استخدام الحلول التقنية لتحليل سوق العمل والتنبؤ، بما في ذلك أنظمة ذكاء الأعمال (BI systems)، للمساعدة في تطوير برامج الدراسة التي تتماشى بشكل أفضل مع الطلب في سوق العمل؟
	①أوافق بشدة ②أوافق ③أوافق إلى حد ما ④لا أوافق ⑤لا أوافق بشدة

القسم الرابع: العوامل المؤثرة

من قائمة العوامل أدناه، المؤثرة على مواءمة برامج الدراسة الجامعية وربطها بالقطاع الإنتاجي وسوق العمل، ضع علامة ☑ في المربع المقابل حسب أهمية العامل المعين برأيك		① مهم جداً	② مهم	③ مهم نوعاً ما	④ غير مهم	⑤ لا علاقة
1	امكانية الوصول إلى اقتصاديات العمل وإحصاءات توظيف الخريجين من خلال مكتب مركزي أو بوابة إلكترونية موحدة					
2	توفر المشورة المهنية في المدارس الثانوية وفي مؤسسات التعليم العالي					
3	العلاقة الواضحة بين "برامج الدراسة الجامعية" و "المهن والوظائف" المُحتملة					
4	استخدام حلول التكنولوجيا الذكية لتحليل سوق العمل والتوقعات للدراسات الجامعية وتوفير النتائج لطلاب المدارس والجامعات					
5	العوامل الاجتماعية مثل أولويات الأسرة والمجتمع لبعض مجالات الدراسة					
6	وجود ارتباط "في الاتجاهين" بين مؤسسات التعليم العالي والمُخَدِمين بسوق العمل (مثلاً، التدريب (internship)، البحوث المشتركة، وما إلى ذلك)					
7	اشراك رجال الأعمال والمهنيين في تخطيط برامج ومناهج التعليم العالي					

F.2: Graduates

الرجاء الإجابة على كل أسئلة الاستبيان بوضع علامة ☑ على رقم الإجابة (أو الإجابات) الصحيحة أو ترتيب أرقام الإجابات.

القسم الأول: معلومات أساسية

1	كم كان عمرك	عند قبولك للدراسة الجامعية؟		①17-16 ②19-18 ③21-20 ④23-22 ⑤23<
		عند تخرجك؟		①21-20 ②23-22 ③25-24 ④27-26 ⑤27<
		الآن؟		①23-21 ②26-24 ③29-27 ④32-30 ⑤32<
2	كم من السنوات مضى على تخرجك؟			①1> ②2 ③3 ④4 ⑤5 ⑥8>5<
3	هل أنت؟			①ذكر ②أنثى
4	هل تمتلك أو تستعمل؟ (أختر كل الإجابات الصحيحة)			
	①جهاز حاسوب مكتبي ②لابتوب ③جهاز تاب ④موبايل ذكي ⑤موبايل غير ذكي ⑥تلفاز ⑦راديو			
5	ما هي مصادرك للأخبار؟ (في السطر الخالي رتب الإجابات حسب أهميتها لك)			
	①وسائل التواصل الاجتماعي ②التلفاز ③الراديو ④ الانترنت ⑤الصحف المطبوعة ⑥العائلة والأصدقاء ⑦أخرى			
	رتب أرقام الإجابات هنا ⮌			
6	ما هو مجال دراستك؟ (حسب تصنيف وزارة التعليم العالي)			
	①الاقتصادية والاجتماعية ②الانسانية ③التربوية ④الزراعية ⑤الصحية ⑥العلوم ⑦الحاسوب ⑧الهندسية ⑨أخرى			
7	نوع الجامعة أو الكلية التي درست بها؟		8	مكان الجامعة أو الكلية التي درست بها؟
	①حكومية ②خاصة			①العاصمة ②الولايات ③خارج البلاد
9	ماذا كان دافعك أو سبب اختيارك للبرنامج الدراسي الجامعي الذي درست؟ (رتب الإجابات حسب أهميتها لك)			
	①التوظيف خارج البلاد ②التوظيف داخل البلاد ③العمل لحسابك الشخصي ④العائد المادي المجزئ ⑤درجاتك أدخلتك هذا البرنامج ⑥إشباع رغبة ذاتية ⑦تحسين الحالة الاجتماعية ⑧أخرى			
	رتب أرقام الإجابات هنا ⮌			
10	هل جامعتك أو كليتك التي تخرجت منها بها مركز للمساعدة على التوظيف أو التخطيط المهني؟			①نعم ②لا
11	أثناء دراستك، هل أخذت تدريب منتظم (internship) أو عملت خلال فترات إجازة الصيف؟			①نعم ②لا
12	ما هي حالتك الوظيفية الحالية؟			
	①لا أعمل الآن ②أعمل بالقطاع الخاص ③أعمل بوظيفة مؤقتة بالقطاع الخاص ④أعمل بالقطاع الحكومي ⑤أعمل بوظيفة مؤقتة بالقطاع الحكومي ⑥أعمل لحسابي الخاص ⑦أعمل بتمويل من جهاز تشغيل الخريجين			

13	هل قمت بتسجيل بياناتك في؟ (أختر كل الإجابات الصحيحة)
	①الخدمة الإلزامية ②مفوضية الاختيار للخدمة المدنية القومية ③وزارة العمل ④مفوضية الاختيار للخدمة المدنية الولائية ⑤جهاز تشغيل الخريجين ⑥وكالة للتوظيف ⑦موقع الكتروني للتوظيف ⑧مركز التوظيف بالجامعة ⑨أخرى

القسم الثاني: الوضع الحالي والتوقعات

1	عند تقديمك للقبول الجامعي، ماذا كانت مصادر المعلومات التي ساعدت في تشكيل رأيك حول برامج الدراسة الجامعية والوظائف المستقبلية المُحتملة؟ (رتب الإجابات حسب أهميتها لك)	
	①العائلة والأصدقاء ②مركز مساعدة التوظيف بالمدرسة الثانوية ③مواقع وزارة التعليم العالي الالكترونية ④مواقع وزارة العمل ⑤وسائل التواصل الاجتماعي ⑥مواقع مؤسسات التعليم العالي ⑦لا شيء	
	رتب أرقام الإجابات هنا ⮌	
2	هل أمدك أي من المصادر أعلاه بـمعلومات عن	
	أ. العلاقة بين برامج الدراسة الجامعية والوظائف أو المهن المُحتملة؟	①نعم ②لا ③لا أعلم
	ب. بيانات توظيف خريجي المؤسسات الجامعية؟	①نعم ②لا ③لا أعلم
	ج. العلاقة بين المهن والأجور المتوقعة؟	①نعم ②لا ③لا أعلم
	د. تصنيف برامج مؤسسات التعليم العالي مثلاً حسب نسبة التخرج، التوظيف، الخ؟	①نعم ②لا ③لا أعلم
	هـ. توقعات لمهن أو وظائف جديدة غير شائعة الآن؟	①نعم ②لا ③لا أعلم
	و. إمكانية العمل خارج البلاد؟	①نعم ②لا ③لا أعلم
3	في أي شكل كانت المعلومات التي تلقيتها من هذه المصادر؟ (أختر كل الإجابات الصحيحة)	
	①معلومات شفاهية ②نص مكتوب ③رسوم بيانية وتوضيحية ④جداول وقوائم ⑤أخرى	
4	هل أنت راض عن معلومات برامج الدراسة ومستقبلها المهني المحتمل التي عثرت عليها؟	
	①شديد الرضا ②راض ③إلى حد ما ④غير راض ⑤غير راض بشدة	
5	أثناء بحثك عن عمل، ماذا كانت مصادر معلومتك عن الوظائف؟ (رتب الإجابات حسب أهميتها لك)	
	①الأسرة والأصدقاء ②إعلانات الصحف ③إعلانات الكترونية ④بوابات توظيف الكترونية ⑤وكالات توظيف حكومية ⑥وكالات توظيف خاصة ⑦مركز مساعدة التوظيف بالجامعة ⑧وسائل التواصل الاجتماعي ⑨التلفاز والراديو ⑩أخرى	
	رتب أرقام الإجابات هنا ⮌	
6	إذا كنت تعمل الآن، كيف حصلت على عملك؟	

	①الأسرة والأصدقاء ②إعلان في الصحف ③إعلان الكتروني ④بوابة توظيف الكترونية ⑤وكالة توظيف حكومية ⑥وكالة توظيف خاصة ⑦مركز مساعدة التوظيف بالجامعة ⑧وسائل التواصل الاجتماعي ⑨التلفاز والراديو ⑩أخرى	
7	أثناء بحثك عن عمل، هل كنت راض عن توافر ومستوى قوائم الوظائف المُعلنة التي وجدتها؟	
	①شديد الرضا ②راض ③إلى حد ما ④غير راض ⑤غير راض بشدة	
8	إذا أنت تعمل، هل عملك في مجال متعلق بدراستك؟	①نعم ②لا
9	بالنظر إلى وضعك الراهن وما تعرفه الآن، هل أنت راض عن الإختيار الوظيفي الذي قمت به (المجال الذي درسته ومسارك الوظيفي أو المهني)؟	
	①شديد الرضا ②راض ③إلى حد ما ④غير راض ⑤غير راض بشدة	

القسم الثالث: ذكاء الأعمال (Business Intelligence, BI)

1	يمكن استخدام مستودع البيانات (Data Warehouse) في؟ (أختر كل الإجابات الصحيحة)	
	①البيانات التاريخية ②تجميع البيانات ③تحليل البيانات ④التقارير ⑤اكتشاف المعرفة ⑥التخطيط ⑦كل ما سبق	
2	"الحلول الذكية" وتقنيات أنظمة ذكاء الأعمال (BI systems) ترصد اتجاهات وميول البيانات باستخدام بيانات تاريخية أو بيانات آنية؟	①نعم ②لا ③لا أعرف
3	أين تعرفت على أنظمة ذكاء الأعمال (BI)؟ (أختر كل الإجابات الصحيحة)	
	①أثناء الدراسة الجامعية ②البحث عبر الإنترنت ③وسائل التواصل الاجتماعي ④الأصدقاء ⑤أخرى ⑥لا أعرفها	
4	هل تعرف أي مؤسسة تستخدم أنظمة ذكاء الأعمال (BI) في السودان؟ (أختر كل الإجابات الصحيحة)	
	①العسكرية ②البنوك ③مؤسسات التعليم العالي ④وزارة التعليم العالي ⑤أخرى ⑥لا أعرف أي	
5	هل توافق على أن نظام معلومات ذكاء الأعمال (BI system) (الذي يُوَضِح العلاقة بين برامج التعليم العالي والمهن والوظائف المحتملة والأجور المتوقعة) كان من الممكن أن يساعدك عند اختيارك التخصص في المدرسة الثانوية واختيارك مؤسسة وبرنامج التعليم العالي؟	
	①أوافق بشدة ②أوافق ③أوافق إلى حد ما ④لا أوافق ⑤لا أوافق بشدة	
6	هل توافق على أن نظام معلومات ذكاء الأعمال (BI system) (الذي يُظهِر تَوجُهات التوظيف لدى خريجي مؤسسات التعليم العالي) قد يساعدك في خياراتك الوظيفية والمهنية؟	
	①أوافق بشدة ②أوافق ③أوافق إلى حد ما ④لا أوافق ⑤لا أوافق بشدة	
7	هل تؤيد وزارة التعليم العالي ومؤسساتها من جامعات وكليات على استخدام الحلول التقنية لتحليل سوق العمل والتنبؤ بما في ذلك أنظمة ذكاء الأعمال (BI systems) للمساعدة في تطوير برامج الدراسة التي تتماشى بشكل أفضل مع الطلب في سوق العمل؟	
	①أوافق بشدة ②أوافق ③أوافق إلى حد ما ④لا أوافق ⑤لا أوافق بشدة	

القسم الرابع: العوامل المؤثرة

من قائمة العوامل أدناه، المؤثرة على مواءمة برامج الدراسة الجامعية وربطها بالقطاع الإنتاجي وسوق العمل، ضع علامة ☑ في المربع المقابل حسب أهمية العامل المعين برأيك		① مهم جداً	② مهم	③ مهم نوعاً ما	④ غير مهم	⑤ لا علاقة
1	امكانية الوصول إلى اقتصاديات العمل وإحصاءات توظيف الخريجين من خلال مكتب مركزي أو بوابة إلكترونية موحدة					
2	توفر المشورة المهنية في المدارس الثانوية وفي مؤسسات التعليم العالي					
3	العلاقة الواضحة بين "برامج الدراسة الجامعية" و "المهن والوظائف" المُحتملة					
4	استخدام حلول التكنولوجيا الذكية لتحليل سوق العمل والتوقعات للدراسات الجامعية وتوفير النتائج لطلاب المدارس والجامعات					
5	العوامل الاجتماعية مثل أولويات الأسرة والمجتمع لبعض مجالات الدراسة					
6	وجود ارتباط "في الاتجاهين" بين مؤسسات التعليم العالي والمُخَدِمين بسوق العمل (مثلاً، التدريب (internship)، البحوث المشتركة، وما إلى ذلك)					
7	اشراك رجال الأعمال والمهنيين في تخطيط برامج ومناهج التعليم العالي					

F.3: Employers

الرجاء الإجابة على كل أسئلة الاستبيان بوضع علامة ☑ على رقم الإجابة (أو الإجابات) الصحيحة أو ترتيب الإجابات.

القسم الأول: معلومات أساسية

1	كم عدد الذين يعملون بمؤسستكم تقريباً؟	① 10> ② 50-11 ③ 100-51 ④ 100<
2	هل تمتلك أو تستعمل مؤسستكم؟ (أختر كل الإجابات الصحيحة)	
	①حاسوب مكتبي ②لابتوب ③شبكة حاسب محلية (LAN) أو لاسلكية (WLAN) ④شبكة حاسب واسعة (WAN) ⑤موقع الكتروني ⑥بوابة الكترونية ⑦بريد الكتروني ⑧ولا أي مما سبق	
3	ما هو عمر مؤسستكم بالسنوات؟	
	① 1> ② 5-2 ③ 10-6 ④ 10<	
4	ما هو تصنيف مؤسستكم؟	
	①مؤسسة حكومية ②شبة حكومية ③عامة ④خاصة ⑤مختلطة ⑥تعاونية ⑦أخرى	
5	هل تُشجع مؤسستكم (بأي طريقة) موظفيها أو عامليها على (أختر كل الإجابات الصحيحة)	
	①المشاركة في مجالس مؤسسات التعليم العالي ②التدريس في مؤسسات التعليم العالي ③الدراسة لدرجات جامعية أو فوق الجامعية ④ولا أي مما سبق	
6	هل تقوم مؤسستكم ب (أختر كل الإجابات الصحيحة)	
	①تقديم دعم لأي برنامج في مؤسسة جامعية ②مشروع مشترك أو برنامج مع مؤسسات جامعية ③تقديم دعم لأي مركز مساعدة توظيف بمؤسسات جامعية ④تنظيم معارض للتوظيف بمؤسسات جامعية ⑤ولا أي مما سبق	
7	رتب التعيينات الجديدة لمداخيل الخدمة (entry-level) بمؤسستكم في السنوات الخمس الماضية حسب المجالات الآتية؟ (في السطر الخالي رتب الإجابات تنازلياً حسب العدد)	
	①الاقتصادية والاجتماعية ②الانسانية ③التربوية ④الزراعية ⑤الصحية ⑥العلوم ⑦الحاسوب ⑧الهندسية ⑨أخرى	
	رتب الإجابات هنا ⮌	
8	هل لدى مؤسستكم برنامج تدريب منتظم (internship) أو توظيف للطلاب خلال الإجازة الصيفية؟	①نعم ②لا
9	هل لدى مؤسستكم برنامج تدريبي متكامل لتعييناتكم الجديدة في مداخيل الخدمة (entry-level)؟	①نعم ②لا

القسم الثاني: الوضع الحالي والتوقعات

1	ما هي مصادر المعلومات التي تستعملها مؤسستكم للتخطيط للتعيينات الجديدة في مداخيل الخدمة (entry-level) مثلاً كتصنيف المؤسسات الجامعية، البرامج والدرجات؟ (رتب الإجابات حسب أهميتها لمؤسستكم)

	①مصادر مؤسستكم الخاصة ②وزارة التعليم العالي ومواقعها الالكترونية ③وزارة العمل ومواقعها ④المؤسسات الجامعية ومواقعها ⑤مراكز التوظيف بالجامعات ⑥وسائل التواصل الاجتماعي ⑦المركز القومي للإحصاء ⑧أخرى		
	رتب أرقام الإجابات هنا ⮌		
2	هل أمدكم أي من المصادر أعلاه بمعلومات عن		
	أ. العلاقة بين برامج الدراسة الجامعية والوظائف أو المهن المُحتملة؟	①نعم ②لا ③لا أعلم	
	ب. بيانات توظيف خريجي المؤسسات الجامعية؟	①نعم ②لا ③لا أعلم	
	ج. العلاقة بين المهن والأجور المتوقعة؟	①نعم ②لا ③لا أعلم	
	د. تصنيف برامج مؤسسات التعليم العالي مثلاً حسب نسبة التخرج، التوظيف، الخ؟	①نعم ②لا ③لا أعلم	
	هـ. توقعات لمهن أو وظائف جديدة غير شائعة الآن؟	①نعم ②لا ③لا أعلم	
3	في أي شكل كانت البيانات التي تلقيتموها من هذه المصادر؟ (أختر كل الإجابات الصحيحة)		
	①معلومات شفاهية ②نص مكتوب ③رسوم بيانية وتوضيحية ④جداول وقوائم ⑤أخرى		
4	هل أنت راض عن معلومات التخطيط المهني أو الوظيفي التي عثرت عليها مؤسستكم؟		
	①شديد الرضا ②راض ③إلى حد ما ④غير راض ⑤غير راض بشدة		
5	ماهي منافذ الأخبار المفضلة لمؤسستكم لإعلان وظائف مداخيل الخدمة؟ (رتب الإجابات حسب أهميتها لمؤسستكم)		
	①داخل المؤسسة ②الموقع الإلكتروني ③الصحف ④بوابات توظيف الكترونية ⑤وكالات توظيف حكومية ⑥وكالات توظيف خاصة ⑦مراكز التوظيف بالجامعات ⑧وسائل التواصل الاجتماعي ⑨التلفاز أو الراديو ⑩أخرى		
	رتب أرقام الإجابات هنا ⮌		
6	رتب منافذ الأخبار أعلاه تنازلياً على أساس الأعداد المستوعبة عن طريقها بمؤسستكم في مداخيل الخدمة (entry-level) في السنوات الخمس الماضية؟ (رتب الإجابات تنازلياً حسب العدد المستوعب عن طريق المنفذ)		
	①داخل المؤسسة ②الموقع الإلكتروني ③الصحف ④بوابات توظيف الكترونية ⑤وكالات توظيف حكومية ⑥وكالات توظيف خاصة ⑦مراكز التوظيف بالجامعات ⑧وسائل التواصل الاجتماعي ⑨التلفاز أو الراديو ⑩أخرى		
	رتب أرقام الإجابات هنا ⮌		
7	ما هي وسائل الإعلام التي تستخدمها مؤسستكم لاطلاع "الموظفين المحتملين" والجمهور بصوره عامه على مجالات عملها وإنجازاتها؟ (رتب الإجابات حسب أهميتها لمؤسستكم)		
	①العاملين بالمؤسسة ②الموقع الإلكتروني للمؤسسة ③الصحف ④مراكز التوظيف بالجامعات ⑤وسائل التواصل الاجتماعي ⑥التلفاز أو الراديو ⑦مهرجانات توظيف ⑧أخرى		
	رتب أرقام الإجابات هنا ⮌		
8	هل أنت راض عن مستوى المعرفة عن مؤسستكم، إنجازاتها وأهدافها من قبل المتقدمين لوظائف مداخيل الخدمة؟		
	①شديد الرضا ②راض ③إلى حد ما ④غير راض ⑤غير راض بشدة		

9	على أي أساس تُرتب أو تُصنف مؤسستكم المتقدمين لوظائف مداخيل الخدمة؟ (رتب الإجابات حسب أهميتها)
	① الجامعة/الكلية التي تخرج منها ②درجة التخرج ③المعرفة بمؤسستكم ④الإحالة (الواسطة) ⑤المقابلة الشخصية ⑥اختبار الكفاءة ⑦إذا أدي تدريب أثناء الدراسة (internship) ⑧إذا كان لديه أوراق علمية منشوره ⑨أخرى
	رتب أرقام الإجابات هنا ⮌

القسم الثالث: ذكاء الأعمال (Business Intelligence, BI)

1	يمكن استخدام مستودع البيانات (Data Warehouse) في؟ (أختر كل الإجابات الصحيحة)
	①البيانات التاريخية ②تجميع البيانات ③تحليل البيانات ④التقارير ⑤اكتشاف المعرفة ⑥التخطيط ⑦كل ما سبق
2	"الحلول الذكية" وأنظمة ذكاء الأعمال (BI systems) ترصد الاتجاهات والميول باستخدام بيانات تاريخية أو بيانات آنية؟
	①نعم ②لا ③لا أعرف
3	هل تستخدم مؤسستكم أي "حلول الذكية" أو تقنية أنظمة ذكاء الأعمال (BI systems)؟
	①نعم ②لا ③لا أعرف
4	أين تعرفت على أنظمة ذكاء الأعمال (BI systems)؟ (أختر كل الإجابات الصحيحة)
	①في العمل ②البحث عبر الإنترنت ③وسائل التواصل الاجتماعي ④الأصدقاء ⑤أخرى ⑥لا أعرفها
5	هل تعرف أي مؤسسة تستخدم أنظمة ذكاء الأعمال (BI system) في السودان؟ (أختر كل الإجابات الصحيحة)
	①العسكرية ②البنوك ③مؤسسات التعليم العالي ④وزارة التعليم العالي ⑤أخرى ⑥لا أعرف أي
6	هل توافق على أن استخدام مؤسستكم لنظام معلومات ذكاء الأعمال (BI system) (الذي يُوَضِح العلاقة بين الخريجين، البرامج، الدرجات، ومؤشرات سوق العمل ويتابع تقدم تعييناتكم في مداخيل الخدمة) كان من الممكن أن يساعد مؤسستكم في توظيف والحفاظ على أفضل المواهب من الخريجين؟
	①أوافق بشدة ②أوافق ③أوافق إلى حد ما ④لا أوافق ⑤لا أوافق بشدة
7	هل تؤيد وزارة التعليم العالي ومؤسساتها من جامعات وكليات على استخدام الحلول التقنية لتحليل سوق العمل والتنبؤ، بما في ذلك أنظمة ذكاء الأعمال (BI system)، للمساعدة في تطوير برامج الدراسة التي تتماشى بشكل أفضل مع الطلب في سوق العمل؟
	①أوافق بشدة ②أوافق ③أوافق إلى حد ما ④لا أوافق ⑤لا أوافق بشدة

القسم الرابع: العوامل المؤثرة

من قائمة العوامل أدناه، المؤثرة على موائمة برامج الدراسة الجامعية وربطها بالقطاع الإنتاجي وسوق العمل، ضع علامة ☑ في المربع المقابل حسب أهمية العامل المعين برأيك	①	②	③	④	⑤
	مهم جداً	مهم	مهم نوعاً ما	غير مهم	لا علاقة

1	امكانية الوصول إلى اقتصاديات العمل وإحصاءات توظيف الخريجين من خلال مكتب مركزي أو بوابة إلكترونية موحدة					
2	توفر المشورة المهنية في المدارس الثانوية وفي مؤسسات التعليم العالي					
3	العلاقة الواضحة بين "برامج الدراسة الجامعية" و "المهن والوظائف" المحتملة					
4	استخدام حلول التكنولوجيا الذكية لتحليل سوق العمل والتوقعات للدراسات الجامعية وتوفير النتائج لطلاب المدارس والجامعات					
5	العوامل الاجتماعية مثل أولويات الأسرة والمجتمع لبعض مجالات الدراسة					
6	وجود ارتباط "في الاتجاهين" بين مؤسسات التعليم العالي والمُخَدِمين بسوق العمل (مثلاً، التدريب (internship)، البحوث المشتركة، وما إلى ذلك)					
7	اشراك رجال الأعمال والمهنيين في تخطيط برامج ومناهج التعليم العالي					

Appendix-G Publication Transcripts

Publication Transcript -1

Bridging Higher Education and Market Dynamics in a Business Intelligence Framework

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Abstract—**The expansion of urbanization and demographic changes defines not only economic demands but makes governments increasingly experience a serious force toward a sustainable development, which causes a need for a qualified and retaining competitive workforce. In view of this trend, governments and businesses start considering technology as vital enabler to solve the rising urbanization issues and improve the living and working environments according to a set of priorities. Simultaneously, competency and skills development are seen as the critical issue for the workforce and the workplaces. Accordingly, the complex interrelationship between strategic management, human capital management, and the overall quality management in an educational as well as enterprise setting move closer to the focus of research.**

This paper discusses an emerging area of research, which explores the utilization of both, advanced technologies in terms of business intelligence and analytic techniques in a multi-component architecture and a sustainable competency-based human capital strategy. The novel approach targets at an alignment of one of the most important higher education outputs, namely the human capital, with market needs and thus, maximizing the benefits of higher education in achieving sustainable economic development.

Keywords—business intelligence; human resources; human capital management; higher education; competency management

I. INTRODUCTION

Urbanization and demographic changes are driving cities and market developments that result in approximately 60% of the world population residing in urban and sub-urban regions [1], [2]. Digital technologies are expected to provide better services for citizens, allow for the effective use of multiple resources and heterogeneous data as well as provide improved or novel sources for education, such as Open learning. Wireless and network technologies, the Internet of Things, cloud computing, decision support systems, business and artificial intelligence, data analysis and mining techniques are only few of the solutions for products and services that are foreseen to make the working and living environments "smarter", and comfortable in the context of transport, climate, food, energy, health, and education [3].

The inherent competition due to this rising development obliges governments and businesses, on the one hand, to seek for innovative ways of doing business, and increase effectiveness and efficiency of work, and productivity. Disappointingly, the uptake of technologies for skills development, talent and competency management, and recruitment has been unacceptably delayed. Many outstanding organizations have provided an extensive research and field testing in this domain. But there is still a need of observing and exploring a wide range of aspects to be able to provide cutting edge human resource programs and systems in the organizations. Unfortunately, strategic management research has commonly not reflected individual competencies that in terms of higher education mainly result as direct output of the higher education programs. Consequently, the identification of highly competent human capital represents a challenging issue of the recruitment process. Furthermore, human resource management is rarely seen as a holistic approach to learning and assessment, talent management, career development, and recruitment [4], [5].

The Human Resource Services Report undoubtedly demonstrates that clear correlations exist between high investment in learning and competitive business results [6]. Applying competencies and talent management builds a basis for outlining the future performance potential and integrating processes into a challenging human resource management [7].

On the other hand, also higher education organizations started to experience the force of the global economy being subject of a strong competition, which is true on the personal level, studying to gain better career opportunities, and on the national level, too, as the following examples demonstrate. Research by Sujitparapitaya, Shirani, and Roldan shows that the higher education services sub-sector is a vital pillar of the US economy [8]. Approximately 8.4% of the US population were enrolled in higher education institutions during the 2008-09 academic year, while in 2000-2001 over half a million foreign students studied in the USA bringing almost $11.04 billion into the U.S. economy [9]. In Sudan, 477,000 students were enrolled in higher education institutions during 2008, and today they are more than half a million [10]. On the positive side, Sudan has been doing well in the World Bank's Key Indicator of higher education gross enrollment ratio as it has been rising steadily (15% in 2012, 17% in 2013). Yet still the country is well below average of the lower-middle-income economies (22.8% in 2012) [11]. However, poor career prospects in rural areas often lead to concentration of employment in the urban areas, illustrating

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the global urbanization development. Senior employees often emigrate in search of better prospects and experience. This 'brain drain' which affects many countries around the world, is reducing the State's ability to set up sustainable economic measures.

Numerous studies have revealed that higher education is vital to countries' prosperity and economic development [12], [13], [14], [15]. A new information and communication technology trend that has been gaining ground in the last years and provides an economical solution to the increased demand for higher education is online and open learning [16], [17].

However, even this remarkable higher education expansion goes hand in hand with the trend for boosting the business performance in organizations, a number of challenges and opportunities exist affecting the individual, organizational as well as societal level. For instance, there is a global disparity between Science, Technology, Engineering and Mathematics (STEM) and medical graduates, on the one hand, and social studies, humanities and education graduates, on the other hand. For example in Sudan, during the 2011-2012 academic year 68% of the Bachelor degree graduates were of the latter group while STEM and medical graduates accounted for 30% [10]. Moreover, there is the overall issue of the disconnection between the business and academic worlds, and the graduates' lack of skills and knowledge required for the professional life [14], [18].

This paper discusses an emerging area of research that addresses the issues above explained by following an approach based on the alignment of learning and competencies, human resource strategy, and market dynamics. This research aims to provide a bridge between higher education and businesses serving the improvement of the graduates' employability as well as the higher education adaptation to market demands as an upcoming strategy.

We argue that business intelligence that is discovered to improve decision making processes can provide the various stakeholders, including higher education policy makers, universities, colleges, labor and employment officials as well as students with deep visibility to analyze performance and hence gear up for dynamic market requirements. The proposed business intelligence framework builds the basis for transferring the value of business intelligence research gained in businesses up-to-date to higher education, especially applying it in a developing country. This framework will facilitate the access to raw data and information and enable building performance models as well as the support of decision making processes in terms of more timely, informed, high-quality decisions, planning and efficiency advancement.

The remainder of this paper is organized as follows. Section 2 describes the background for this research concentrating on the interaction between business intelligence technologies and organizational management to provide better clarification of these important aspects of the targeted research. Section 3 explores the new opportunities that business intelligence offers for the alignment between higher education and market by detailing the design of the proposed framework, whilst Section 4 provides a summary of the paper and the future direction of the research.

II. Background

Globalization, the information and communication technologies evolution, and the fact that businesses and higher education undergo strategic transformation toward using innovative technologies in complex decision making, for example students' retention and quality control environments [19], [20], [21], make different data sources leading to constantly growing big datasets ready for further analysis, transforming the data to useful information and gaining insights and trends for future strategic forecast. Favorably, the businesses, affecting the processes of the graduates' employability as well as the higher education institutions, have huge data and information available. This fact triggers the need to gather more data and information, and process them to make highly accurate and timely decisions based on current and historical data.

Business intelligence is considered a relatively new but very promising area in information systems [22]. According to Hancock and Toren, business intelligence is "a set of concepts, methods, and technologies for turning separated data in an organization into useful information in order to improve business performance" [23]. It covers many tools and technologies that can be used to support better or optimum business decision, such as online analytical processing, analytics, data warehousing, data mining, process mining, complex event processing, business performance management, benchmarking, text mining, predictive analytics, prescriptive analytics, and reporting. Business intelligence systems may also involve decision support systems. Fig. 1 illustrates the main components of a business intelligence systems referring to gathering data from multiple sources and in various formats, storing data in a data warehouse, analysing the data and providing access to data by visualizing the results. It demonstrates the fact that business intelligence by its components refers to computer systems, and thus, it can serve as a business enabler like other information technology systems.

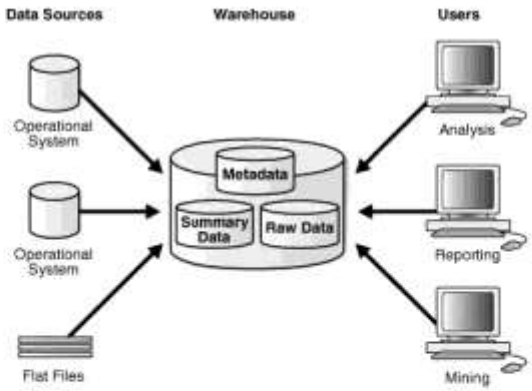

Figure 1. Business intelligence components [24].

The main added value of applying business intelligence consists in providing the tools for transforming raw data into smart information and knowledge. Thus, business intelligence represents a technical approach or method to generate knowledge from high quality operational data (the manipulated transactions data or cleansing data). Moreover, the business intelligence approach offers the opportunity for combining the various technologies and tools according to a set of user requirements to maintain the consistent efficiency and effectiveness of the business processes. Typically knowledge can be obtained for example about customer needs, customer decision-making processes, the competition, and general economic, technological, and cultural trends [25]. This knowledge enables organizations executives and managers to plan strategic, tactical, and operational work, and take a decision with an increased rate of accuracy.

Against this background, business intelligence regards the strategic management by enabling organizations to manage and refine business information with the objective of making more effective business decisions in various business scopes [26]. In an organization's structure, it is absolutely necessary to timely manage significant amounts of relevant data to enhance data, information, and knowledge processing, facilitating this way the swift decision making with the certainty of the data source that is analyzed with reference to the organizational goals [27].

Over the last years, many studies have been undertaken that have explored various business intelligence utilizations in academia, ranging from predicting students' performance in the UK [28], to admission [29] and administration [8] in the USA, to higher education management in South Africa [19], in Malaysia [30], and student retention in Bulgaria [31], the value of big data in higher education [32], data mining in higher education [33], and finally the status of business intelligence in higher education [34].

However, economic advances realized in businesses as a result of using business intelligence technologies still significantly outperform the expectation for effective data analysis in higher education. Up to now, little attention was given to aligning the higher education output, namely the human capital, with the market demand. Being the main focus of this research, this target evolves to a dynamic element of the omnipresent War for Talent following identical main organizational challenges to ensure the right employees with the right qualifications at the right time. According to Klett [4], [5], these challenges concern:

- At the strategic level: the identification of gaps in the organizational human capital strategy and methods.
- At the tactical level: the identification of the employee's talents and skills gaps as well as the concrete development of the employee's skills.
- At the operational level: the shift from managing data and information to managing people, attitudes and knowledge in terms of human capital and talent, which particularly calls for a proper alignment of learning ability, assessment and performance technologies, and quality management to suitably setup development plans whereas employees follow feasible career paths.

Fig. 2 illustrates the main building blocks of a performance management framework in an organization that reflect competency management, learning, assessment and quality aspects as well as the interrelationship between the organizational goals, the personal and organizational development according to strategic, tactical and operational organizational level, as above explained.

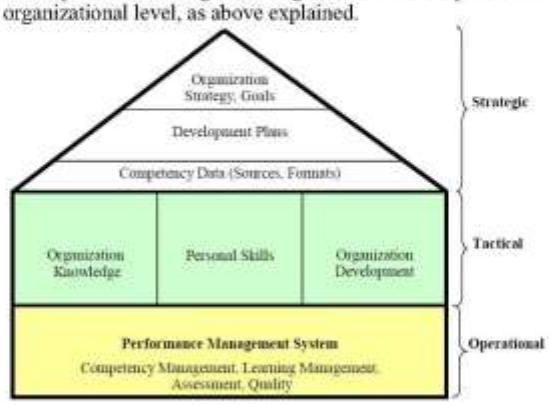

Figure 2. Business performance management components [4].

Referring to the required organization evolution in products and services that imposes significant challenges to educational and corporate decision makers as well as policy makers, in the next section we introduce a framework that builds on the holistic approach for the business related human resource management explained (see Fig. 2), elevating it to a market-driven education-to-businesses human capital management.

III. Proposed Solution

Generally, talent management, career development, recruitment, and learning and assessment toward competency development are viewed as fragmented parts, and possible issues are resolved in an isolated manner. The integration of those parts into a holistic approach toward market-driven human capital management can trigger beneficial effects in the means of organizational as well as individual performance, and organizational as well as individual competitive advantage by multiplying the effects of the single parts.

The proposed novel framework is designed to help higher education organizations resolve many issues attributable to demographic changes, employability of graduates, rapid technological advances and restricted funding sources by better linking those organizations to businesses based on intelligent solutions for concurrent discovery and analysis of data referring to market demands and market orientation. Furthermore, it will support the educational sector in many developing countries like Sudan that still face a lack of administrative and business information, have huge amount of manually managed data, as well as poor or inaccurate labor and employment statistics to plan processes by establishing the basis for an effective education-to-businesses connectivity.

Competitive performance in today's organization requires an adequate consideration of the acquisition, recognition and use of competencies within the organizations. Exploiting the potential of the human capital and boosting its value to the organization involves a systematic process to determine the competencies that are fundamental to achieve enhanced job performance (organizational factor), and conversely, the knowledge, skills, attitudes and behaviors compulsory for a person to carry out a particular job in an outstanding manner (individual factor). Building on a technology-based competency management that enables planning, classifying, mapping and implementation of specific personnel measures to achieve the professional development of the workforce, organizational goals can be better set up, measured and adjusted according to statistical and market data. This way, human resources management is strictly related to the organizational strategic objectives. Seen in light of the strategic management point of view, the technology challenge refers to the identification of the performance models for the human resources development strategy to continuously maximize the competitive advantage based on the organization's unique culture, capabilities and business goals [4], [5].

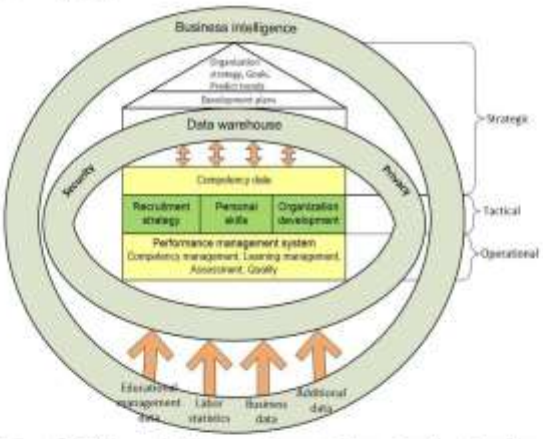

Figure 3. Business intelligence framework for education-to-business linkage.

Fig. 3 illustrates the main components of the proposed business intelligence framework by incorporating all the important operational blocks of the business related human resource management explained in the previous section, and the technologies behind, adding value due to the integration of the competency-based performance data and input data from higher education management, businesses, labor statistics and additional sources, such as market trends, trade associations, standards bodies, sponsoring organizations, migration (internal as well as external) statistics, etc., in a data warehouse. This organization of data in the data warehouse facilitates the growing business and social requirement for capturing, storing, exchanging, and managing competencies coming from various sources and having different formats. Once stored, data analysis techniques, such as data mining, machine learning, social analytics, etc., can be applied to acquire knowledge from this information.

At the same time, the use of business intelligence to resolve business challenges not only points toward benefits, but also problems to overcome, like any other technology based approach. Committing to talent management, assessment, recruiting and learning, and thus, tracking, identifying, storing, processing and analyzing competencies and skills data, can introduce a variety of business advantages such as transparency about the expectations of the employees and managers, development of a common language in the case of distributed and global organizations, in order to effectively communicate among multiple locations as well as implementation of consistent development standards across the enterprise [4], [5]. Nevertheless, this comprehensive data warehouse approach faces also complex privacy and security issues as well as consideration of cost factors and compliance with law and regulations and specific requirements, based on learners', administrative and business data, as illustrated in Fig. 3 on the level of the data warehouse storage but interfacing with all the applications in the business intelligence framework.

The identification of gaps and the required development of skills enable organizations to suitably work out development plans whereas employees follow achievable career paths [4]. Accordingly, the business intelligence framework builds on an alignment between learning ability, competencies and performance that by analyzing the data from the various internal and external sources as illustrated in Fig. 3, allows for long term development goals for both, the organizations and the employees.

The multifaceted aspect of quality of the business related human resource management evolves to a challenge that requires now intensive solutions for the effectiveness of higher education consistent with its market relevance. Thus, it is necessary to identify the factors affecting higher education systems, such as rising costs of educational services, changing technology patterns, growing expectations and entitlements of students, parents, employers, and society, large-scale inefficiencies in the job market, pressure to increase employability of graduates, growing diversity as well half-value period of knowledge, changes in the approach to learning and educational management as well as rapid development of educational technologies, and growing importance of information and communication technologies in this sector, and explore relevant data.

Consequently, the proposed application of information technology in a real time framework facilitates the access to data and information and enables the support of decision making processes and multidimensional data analysis establishing the basis for computerized advancement of the higher education sector by means of improved and informed decisions. Against this background, the business intelligence framework provides a "channel" by which higher education and businesses can set up, modify, fine tune and adapt organizational goals to be most advantageously adjusted to the prevailing economic development while maintaining

quality based on the extracted smart knowledge from accurate, actual and historical data in real-time. In addition, extracting the right information at the right time will significantly allow for reaching efficiency and effectiveness, including cost reduction, in the processes of linking higher education and businesses, and valuably enhance the organization's capability for strategic analysis toward the achievement of organizational goals, and simultaneously, user satisfaction. Last but not least, higher education institutions whether on private or public level gain the opportunity to effectively, and moreover, jointly explore the amount of data and information that is available daily from various sources in higher education institutions and businesses increasing the graduates' employment opportunities. Putting a focus on the privacy and security of personal information expedite the stakeholders to enforce their policy and improve the information service as well as minimize the lack of trust.

IV. Summary and Future Work

There is consensus among researchers that more cooperation and integration between businesses and higher education institutions is needed, as businesses are not satisfied with the graduates' levels of "real-world" experience and higher education institutions are struggling to keep pace with the ever changing market demands. This was evident in both, top world economies and developing countries. In addition, there is an agreement on the strong linkage between higher education and economic prosperity as studies have shown.

This paper has discussed existing issues and significant opportunities around an emerging strategy toward an effective linkage between higher education and businesses. By transferring the value of business intelligence research recently gained in businesses to higher education, this research creates an opportunity for higher education to keep up with innovation and serve as an economic driver.

The proposed business intelligence framework enables higher education and businesses to collect, share and deal with big amounts of data, analyze performance and apply intelligent solutions to match dynamic market requirements. It facilitates higher education to timely discover and predict market demands as an upcoming strategy toward improving the graduates' employability and shaping educational goals. Simultaneously, the proposed framework will help organizations drive economic developments by analyzing and applying competencies to human resource management systems, considering human capital as a key source of innovation and competitive improvement and applying a market-driven human capital management. Thus, talent, learning and competencies evolve to essential business aspects of organizational goals.

Moreover, the framework will aid in resolving the growing urbanization issues and improving the living and working environments in a longer term. Future work aims to evolve the proposed business intelligence framework into a fully functional system that will be setup and evaluated within a Sudanese education environment. The perception of using information and communication technologies as a strategic mechanism is widespread in developed as well as developing countries, whereas developing countries are struggling to adopt the best practices in terms of technology and business processes.

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Investigating the Success of Business Intelligence in Aligning Higher Education and Labor Market

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Abstract — The global expansion of Higher Education (HE) and socioeconomic changes exert tremendous pressures on HE and its alignment with labor market. Education-to-employment is a complex process that involves many activities and stakeholders, including HE Institutions (HEIs), policymakers, employers -public and private- as well as students among many others. This paper investigates the value and advantage of adopting Business Intelligence (BI) technologies to enhance decision-making throughout the process. It utilizes a mixed model research approach to develop a basic BI implementation model while exploring the main factors affecting its adoption, and empirically investigating stakeholders' perception and expectation of its effectiveness. Content analysis techniques and exploratory interviews were used in identifying main characteristic factors affecting adoption and their associated variables. The underlining study is based on a survey instrument administered to three key stakeholder groups, namely, students, graduates, and employers in Sudan. The data analysis clearly supports the research hypothesis that utilizing BI yields reliable information, knowledge-based decisions, improved process, and thus better HE alignment with labor market.

Keywords — *Business intelligence; higher education; career planning; decision-support, technology adoption.*

I. INTRODUCTION

Numerous studies have concluded that HE is of utmost significance to societies, economies and is a strong impetus for change and development [1], [2]. It is well established that it provides various avenues to enhance the effectiveness and efficiency of the workforce, by staying connected with the global knowledge economy and boosting productivity [3]. Globalization, urbanization and demographic changes are driving labor market developments that result in elevated global unemployment [4], [5]. While expanding HE is vital, aligning it with the labor market [6], [7], is not a simple endeavor as will be shown in the paper.

The education-to-employment process encompasses every step of the successful transformation of students into contributing members of the workforce. It is engaged in all activities during the students' developmental phases, starting with selecting academic majors in High School (HS), to choosing HE programs, applying for HE admission, and culminating with joining the labor force after graduation. There are several decision points throughout the process, that involve, and are influenced by, various factors and stakeholders. Examples of these decision-support factors include the availability of HE and employment information, its reliability, and social and environmental influences. The stakeholders include HE policy makers, universities, colleges, labor and employment officials, employers, recruiters and employment agencies both public and private, as well as students and graduates.

Evidently, all institutions, businesses and agencies involved in the education-to-employment process, separately, collect huge amounts of data and information for their own usage. One of the main challenges of this process is to consolidate and organize all relevant data in such a way that makes it available for further stakeholders' analysis and their mutual benefit. Hence, transforming dispersed data into actionable information, resulting in accurate and timely decisions, while empowering insight into trends for future strategic forecast.

Innovations in the information and communication technologies have enabled businesses as well as HE to better respond to their growing challenges and achieve their objectives. For example, adopting technologies such as decision-support and BI systems to improve their complex decision-making and strategic transformation. BI covers many tools and technologies that support organizational knowledge management and optimum business decisions [8]. For instance, online analytical processing, data warehousing, data mining, business performance management, benchmarking, and predictive analytics. One of the most crucial assets that BI brings to decision-making, is its presentation of complex information to planners, such as, dashboards and visualization. Research [9], stated that each BI systems component represents tasks used to exploit information in order to perform five actions in decision-making. These actions are

acquiring, searching, gathering, analyzing and delivery of information.

Many research articles were published in recent years on the various BI applications in HE, ranging from predicting students' performance [10], to admission [11], administration and quality control [12], and HE management [13]. Similarly, several studies exist on BI applications and utilization in business and industry [14], and yet there is meager research on its adoption and application in enhancing the education-to-employment process.

This research hypothesizes that applying BI technologies in the education-to-employment process yields reliable information, knowledge-based decisions, improved process, and therefore better HE alignment with labor market.

To evaluate the benefit of adopting BI in the education-to-employment process, first, an identification and examination of the factors affecting its adoption must be carried out. Followed by an investigation of stakeholders' perception since their attitude affects the success or failure of the implementation. Consequently, the following research questions arise: Why should the education-to-employment process adopt BI? What factors or characteristics are crucial in BI adoption, in general, and in the education-to-employment process in particular? How do stakeholders perceive the adoption of BI? and the effect of the aforementioned factors? These are the main research questions.

This study addresses the above research questions by conducting content analysis [15], and exploratory interviews with key personnel at various stages of the education-to-employment process, to develop a BI implementation model and identify the main characteristic factors affecting its adoption. Moreover, a qualitative field study is conducted to explore the benefit, significance, and influence of the identified factors. Thus, examining why and how the education-to-employment process would adopt and apply BI via key stakeholders believes, attitudes and activities.

Three large-scale qualitative surveys of major stakeholder groups, namely, employers, recent graduates and students in Sudan, were conducted. The surveys explore how stakeholders perceive the activities of the existing education-to-employment process, its information sources, and their level of interaction with the process. Furthermore, they investigate the environment readiness, and stakeholders' reception to and expectations from the use of intelligent technologies.

The paper is organized in five sections beginning with this introduction. The following section presents recent relevant research on BI application in HE and human resource management that serves as background for this study. The next section outlines the research methodology that is organized in two phases. First, it explores the development of a basic BI implementation model taking advantage of the components of the education-to-employment process and identifying its characteristic factors. Second, it describes the steps taken to create a survey instrument, collect data, and the approach to its analysis. Originating from data, the subsequent section is the Analysis section that covers a detailed investigation and presentation of the results in light of the most significant surveys' aspects. Finally, the last section provides a summary of the paper and addresses the future direction of the research.

II. BACKGROUND

It is clear from the previous discussion about the education-to-employment process, that aligning HE with labor market is not merely a matter of examining quantitative factors, such as admission statistics, graduation rates, and employment statistics. But also, the study of qualitative aspects is equally important as well. This includes investigating stakeholders' attitude, expectation and perception toward various specific activities and features of the education-to-employment process, along with socioeconomic factors.

Recent research [16], has proposed a BI framework that builds on the holistic approach of the business-related human resource management. It assists organizations including HEIs, and businesses as well as individuals, such as students, and graduates to effectively manage the education-to-employment challenges outlined in the introduction. The above research has shown that the framework provides the various stakeholders, with deep insights to analyze performance, and hence, prepare for responding to dynamic market requirements.

Fig. 1. BI framework for education-to-business linkage [16]

Fig. 1 illustrates the main components of this framework at the level of the Data Warehouse (DW) storage and the technologies behind. It exposes the complex interrelationship between the organizational and individual strategic, tactical and operational goals, development, and performance. In addition, the framework adds value due to the integration of

competency-based performance data and input data from HE management, labor statistics, businesses, and additional sources into a DW. Once data from these various sources is integrated in the DW, analysis techniques can be applied to acquire knowledge from the data. Issues of privacy and security are considered on both, the level of the DW as well applications' interfaces in compliance with laws and regulations

Data analysis enables the design of strategic goals, trends prediction, and supports planning processes for the different stakeholders. Both at the organizational (HEIs, governing bodies and businesses) and individual levels (students, graduates). The availability and exploration of such information can introduce a variety of business advantages, such as transparency, informed decisions and improved communication across organizations. On one hand, HEIs and planners, gain the opportunity to effectively, and jointly explore the data available from various sources, whereas businesses gain improved entry level recruitment. On the other hand, HS and HE students and graduates are empowered to make better informed choices for their career paths in terms of HE programs and career planning, leading to improved graduates' employment opportunities.

To gain greater understanding of the components of the education-to-employment process and the factors affecting a successful BI adoption, the next section explores the creation of a basic BI implementation model founded on the abovementioned framework, and identifies and examines the effect of a comprehensive set of variables on its adoption based on a large-scale empirical study in Sudan.

III. METHODOLOGY

This section describes the methodology used to realize the research objectives by answering the research questions outlined in the introduction. It is organized into two phases; the initial phase, develops a basic BI implementation model in the education-to-employment process based on the framework presented in the previous section. Additionally, it discovers the manifold factors involved in its successful adoption. While the second phase creates an efficient survey instrument vital for investigating its effectiveness. This investigation is done by exploring key stakeholders' perception, satisfaction and expectation of the process' activities, information, and outcomes plus their assessment of the identified factors. The second phase also lays out the survey goals and the approach to its data analysis. Toward this aim, a mixed model research approach [17], that involves collecting, analyzing and interpreting data by using both, quantitative and qualitative methods was utilized.

In the first phase, content analysis procedures are used while performing an extensive review of documentation sources, statistical data, and an exhaustive study of all the relevant activities and procedures involved in the education-to-employment process internationally and specifically in Sudan. The aim is to identify potential stakeholders, data, its sources, and their interaction to create a basic BI implementation model. As discussed earlier, many of the identified stakeholders collect their own data, and dependent on information and communication technologies in doing their business. In fact, in Sudan, admission to all HEIs [18] and selection for civil service employment [19], are fully centralized and automated across the country. Therefore, both activities provide a wealth of digital information and are core pillars for the implementation and success of BI in the education-to-employment process.

Fig. 2. Education-to-employment BI implementation model

Fig. 2. illustrates the resulting unique BI implementation model in the education-to-employment process. The model is based on the framework illustrated in Fig. 1, a full review of the process and literature and the exploratory field study.

The following is an explanation of the nine data sources and the data they contribute to the DW in the center of Fig. 2, starting with number 1, the Ministry of HE and Scientific Research (MHESR) and moving in a clockwise direction. MHESR provides information on HE institutions, types, programs, categorization, intake, etc. While numbers 2 and 3 are HEIs and the Federal Ministry of Education (FME). Together they provide data related to HEIs and HS education correspondingly. Their data include, HE and HS students, applicants, and graduate's information, such as biographic, enrollment, graduation rates, etc. Number 4, the Directorate of Admission and Certificates Verification and Accreditation (DACVA) [18], is a department within the MHESR. It delivers critical core information on HE admission by program, acceptance, ratios of applicants to acceptance, etc. Whereas number 5, is the Ministry of Labor and Administrative Reform (MLAR) that provides stateside job listing and recruitment. It also supplies the national lists of jobs

and qualification structures, that are vital input into the DW as it creates the necessary correlation between, HE degrees and employment occupations.

Continuing with numbers 6, Employers, and 7, similar to MLAR for the public sector, they both supply the DW with employment information inside and out of the country respectively. Number 7, is the Secretariat of Sudanese Working Abroad (SSWA). Their information includes employment requirements, jobs listing, recruitments, and categorization based on education and skill levels, etc. Proceeding to number 8, the Central Bureau of Statistics (CBS), that feeds the DW with information about employment rates per economic sector, and employment and job growth rates, etc. Last in the figure is number 9, the National Civil Service Recruitment Commission (NCSRC) [19], that contributes information about public sector jobs listing, hiring and categorization, etc.

All data sources, attributes, data types, and other characteristics are systematically documented in a preliminary data dictionary together with an updated list of the identified stakeholders. Exploratory interviews at various stages are used to corroborate findings. In accordance with the mixed research approach adopted, the above identified information and feedback are reprocessed as input to further refine the model. This BI model in conjunction with the valuable information acquired are used as essential building blocks for the imminent successful implementation of the BI solution.

Having produced the BI implementation model, the focus now switches to identifying the crucial factors affecting its successful adoption and their associated variables. For this purpose, and under the guidance of the model, and the data dictionary, analytical research and content analysis procedures are carried out. These procedures aim to recognize, document and categorize key characteristic factors affecting both (i) the application and adoption of BI technologies [20], [21], [22], in the education-to-employment process in particular, and (ii) the alignment of HE with labor demand in general [6], [7], [23]. As a result of these activities, two lists of characteristic factors emerge, and they are: (a) non-technical factors: these include, perception and attitude aspects, organizational and process-related issues, in addition to social influences and barriers; (b) technical factors: these address infrastructure, technology readiness, data quality, and the presentation of information.

An in-depth discussion of these factors will follow as they will be used as the basis for the survey design.

The second phase of the research focuses on the qualitative field study, including the development of the survey instrument, its administration to key stakeholders, collecting data, and outlining the analysis approach. The following are the details of the research processes of the field study:

A. Target Group

Three core stakeholder groups that affect and are affected by the education-to-employment process were selected as target group of the survey. They play a pivotal role in the process itself and in the success or failure of the BI solution. Specifically, the three groups are: (i) students: these are HE students in their final year or the one before, (ii) graduates: these are limited to recent graduates who have graduated in the last five years, and (iii) employers: these are organizations both public and private that employ HE graduates.

B. Sample

Participation in the survey target group was solicited according to the stratified random sampling method. The objective was to enhance the representativeness of the study by broadening participation by HE programs, geographic location, and private and public HEIs. Furthermore, to verify the reliability of the sample and credibility of the sampling methodology, during data analysis, variables were mapped against well-established facts and or reference information. For instance, comparisons between the results of gender breakdown, graduates' employment rate, HEIs' type and location were carried out against published HE data and national labor statistics.

C. Survey Design and Goals

The survey utilizes many formats of questions to better solicit information, including multiple and singular-answer, and rank-answer type questions. Additionally, the target groups' level of agreement is captured using Likert-type scales ranging from "Strongly Agree" to "Strongly Disagree". The initial survey instrument was tested and pretested several times and feedback collected to avoid possible ambiguity and improve completeness, readability, and the logical sequencing of questions. Modifications included reformatting, consolidating questions, translating the surveys to the Arabic language and revalidating the translation in terms of meaningfulness. The survey was then piloted in four states including the capital Khartoum, both in private and public HEIs, and businesses.

In line with the research methodology, the goals of the survey are twofold: (1) to examine the effect of the characteristic factors on the BI adoption in the education-to-employment process, while providing an opportunity to iteratively improve the underlining model; (2) to deduce conclusions on a successful BI adoption practice by comparing the existing process against expectations of the target group.

D. Survey Instrument

The identification of the characteristic factors conducted during the previous phase of the research, resulted in more than a hundred survey variables being created. For clarity and to facilitate the impending

analysis, these factors are categorized into the following four interrelated groups:

1) ***Environmental Readiness:*** This group of factors deals with the identification and assessment of the various information sources and stakeholders of the education-to-employment process. Data is collected about the target groups' biographic information, their decision-support and general informative sources, their use of technology both, individually and institutionally.

The objective of the inquiry is threefold; first, is to examine if stakeholders, data, and infrastructure are prepared for the BI implementation or not. Second, establish that the survey sample is reliable and representative of the overall population. Third, explore important interdependences to identify potential statistically significant relationships by mapping variables in this group against other variables. Examples are, the correlation between respondents' age and their use of technology, or the institutions' geographic location and their utilization of intelligent solutions, etc.

2) ***Satisfaction:*** This groups refers to the target group's satisfaction with the existing process, the information it produces, and their evaluation of data-relevant characteristics. Data is collected from: first, from the target groups' perception of the various education-to-employment activities and features, for instance, career advice, job listing sources, employment agencies, etc. Second, their level of satisfaction with the information received reflected by its characteristics, such as, availability, quality, reliability, integrity, accessibility, presentation and visualization.

The objective of this group is to discover if respondents' assessment indicates a need for improvement in the current process, in which activities? in what direction? and to what extent?

3) Technology Use: This group of factors addresses both the perception and expectation of the target group toward utilizing technology, specifically in the education-to-employment process. It expands on the first group's assessment of the general technology use by focusing on intelligent technologies and BI in particular. Data is collected about: first, the target groups' readiness and inclination towards the use of technology and massive data in HE decision-making. Second, data about their level of willingness to embrace intelligent technologies for the purpose of aligning HE with labor market demand, and ultimately improving the education-to-employment process.

The objective is to explore if and how the target groups' assessment renders the growing importance of information and communication technologies in supporting the decision-making process. In particular, BI technologies with their well-documented benefits of data consolidation, analytical tools, and decision-making support.

4) ***Awareness:*** This group concerns the evaluation of major characteristic features that have the potential to seriously affect the adoption of BI technology. Data is collected about the target groups' knowledge and ranking of seven essential preselected influencing features. These features represent technological risks and social barriers to the impact of BI application and adoption. The BI implementation model in Fig. 2 and the in-depth education-to-employment process review have necessitated the presence of these indispensable features.

This inquiry's objective is to examine respondents' insight into how they prioritize these distinctive features and its reflection on a successful BI adoption.

After laying out the methodological steps of the research approach, the next section presents and discusses a selection of significant survey results from each of the four groups of factors. The purpose is to effectively expose the interrelationship between seminal factors and the underlining variables in support of improving the current education-to-employment process.

IV. ANALYSIS

Data from the three surveys was decoded and entered into IBM's SPSS for Windows [24]. Results were cross-tabulated to examine the interdependence between variables. Tests for statistical significance were used to confirm that observed survey results reflect the characteristics of the population. Statistical analysis was performed using Chi-square for test of association. Frequency tables' bar charts, line graphs, and pie-charts were performed as descriptive statistics. A p-value of less than 0.05 was considered significant in all statistical analysis.

A. Abbreviations

The following are abbreviations used in statistical results' tables and figures in this section:

Info: Information, Imp: Important, Ext: Extremely, and progs: programs.

B. Results and Discussion

Statistical analysis results belonging to each of the four characteristic factors groups are discussed in detail, and their impact on the survey goals and study objective is outlined.

The first group of factors focuses on gauging environmental readiness as well as corroborating results against reference values or well-established facts. For this purpose, the surveys inquire about technology prevalence among the target group.

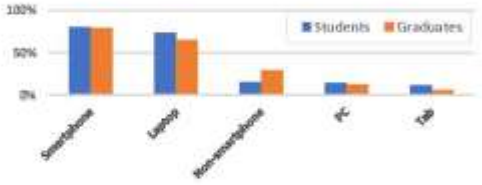

Fig. 3. Technology prevalence

Fig.3 shows the students' and graduates' ranking of their top five used technology and communication devices. Results indicate that they both are technology savvy with "Smartphone" (80.5% students, 79.1% graduates) topping the list, followed by "Laptop" (73.8% students, 65% graduates). The use of technology is widespread among employers as well, since their survey results show that almost all responding employers rely on computers, software applications and networks for their core business. As pointed out in the previous section, infrastructure and technology readiness is a crucial factor for a successful BI adoption, and the aforementioned results clearly confirm the first survey goal.

Continuing with environmental readiness, the survey results demonstrated that 58% of the responding employers are private, consistent with the Sudanese labor force survey [25], that found 53% of the workforce are employed by private or family owned businesses. Also, the gender distribution for both responding students and graduates indicates that females are slightly more than males, in line with the overall HE enrollment and output data published by the MHESR [26]. Similarly, respondents' breakdown by public or private HEI is reflective of the population, with 59.7% of responding graduates and 64.3% of students coming from public institutions [26]. These findings clearly establish the relevance and accuracy of the survey results as they are substantiated by well-established reference information from labor and HE sources, and subsequently, assure the overall quality and reliability of the survey outcome.

Fig. 4. Career-planning information sources

In regard to the second group of characteristic factors, namely satisfaction levels with career-planning information and its sources. Students and graduates were asked to rank the sources that provided them decision-support information when applying for HE and when choosing their HS major. The query was about specific information on HE programs, ranking, etc., and possible career paths, in terms of quality and reliability. As seen in Fig. 4, both groups unanimously ranked "Family & Friends" as their top source, and by a big margin from the rest. In fact, results indicate that 52% of students and 67% of graduates selected only one source of career-planning information that is "Family & Friends".

Fig. 4 also indicates that the web portals of HEIs, and the ministries of HE and labor are all ranked pretty low as possible sources of information. In another follow-up inquiry, about the presentation of the received career-planning information, both students and graduates indicated "verbal" format. Other information formats, such as, statistical reports, ranking tables, and charts were completely insignificant. The complete, investigation of career-planning and decision-support information has found that they are scant, and not readily visible, and when available, they are subjective, unreliable and poorly presented. Therefore, it is not surprising that the survey finds out that the target group is consistently dissatisfied with such information availability and quality.

The results discussed above highlight the need for a system that offers precise, accurate, and non-subjective information with common availability in an easy-to-use and understand format, and consequently, they strongly support the second survey goal.

TABLE I. GRADUATES' INFORMATION AVAILABILITY STATISTICS

Career-planning data attributes	Mean μ	STD	p-value	Trend
(1) Degrees to occupations correlation	1.53	.658	.000	Y
(2) Graduates' employment statistics	1.92	.607	.000	N
(3) Salary reference information	1.70	.627	.000	N
(4) HE programs' ranking	1.75	.674	.000	N
(5) Trend in occupations	1.85	.691	.000	N
(6) Overseas employment statistics	1.43	.637	.000	Y
Average	1.70			N

Staying with the second group of characteristic factors, satisfaction, respondents were asked if the decision-support data they received included any of the six attributes named in Table I above. The table displays the descriptive statistical analysis of graduates' results. As discussed in the previous section, these attributes are required inputs for the BI implementation model in Fig. 2. A three-point Likert scale with ("1-Yes", "2-No", "3-U{Unsure}") captured feedback. As shown in the table, statistical hypothesis testing was used to calculate, the Mean (μ), Standard Deviation (STD), Chi-square (not shown), and p-value. The target group's level of satisfaction with the existing education-to-employment process is gauged by examining their assessment of the availability and reliability of the above attributes.

It is clear in Table I, that all p-values are less than the assumption significance level of 0.05, indicating

statistical significance. Thus, the observed difference is unlikely to be due to chance, and if we were to repeat the survey with different samples there is a 95% chance, we will get similar results. The table also shows responses' inclination or Trend column that depends on the mean score on the Likert scale, i.e., the closer to 1 the stronger the agreement. Only two of the six mean values, namely (1) and (6) in the table, demonstrate that respondents *strongly* believe they have received reliable information. The rest indicate that "No" information was received or they are "Unsure". This implies that the decision-support information received lacks integrity, is vague and indecisive. In addition, the combined mean (1.70) itself, is pre-determined as "N" on the scale or no information, further confirming this outcome, and in turn rendering the target groups' career-planning sources (majority reply on "Family & Friends" as shown previously) unreliable. These are significant conclusions, and they emphasize the need for transforming the existing education-to-employment process, and hence, establish the second survey goal. While the findings discussed above belong to graduates, comparable results were received in the students' survey as well.

Remaining with the same enquiry about the quality of decision-support information, a similar conclusion was received when querying employers. As they were asked about entry-level recruitment-planning information and its sources. Specifically referring to information about HEIs and their programs, ranking, quality, graduation and employment ratios, etc. The survey found that a clear majority (81%) of employers mostly rely on their organizations' own internal knowledge to plan for and recruit entry-level candidates. Another noteworthy finding is that, about 50% of employers indicated that their top criteria in ranking entry-level candidates, is again their own internal ranking of the HEIs the candidates graduated from. Whereas other factors such aptitude tests, interviews, and referrals are much less significant.

All of the results discussed above, reveal that in the absence of published, reliable, and objective ranking of HEIs and their programs, employers as well as students and graduates are often compelled to rely on subjective or non-substantiated information and sources. Correspondingly, these conclusions validate the second survey goal, and further demonstrate that HEIs, the MHESR, and governing bodies must highly prioritize publishing and disseminating complete, unbiased, actual, and quality information. Since this information not only impacts, HE admission, but also influences employment and hiring too.

Proceeding to the third group of characteristic factors that examines the target group's attitude and receptiveness towards the use of technology. Employers were asked whether they believe that BI technologies can assist the MHESR and HEIs to better plan, and manage the alignment of HE programs with the labor market demand.

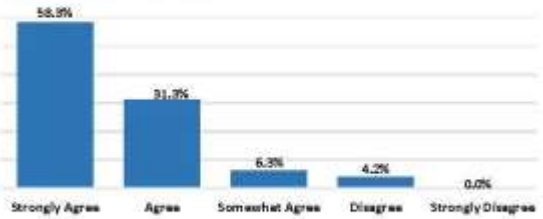

Fig. 5. Employers' result: BI assists in aligning HE with labor market

The histogram in Fig. 2 illustrates the employers' survey results. With "Strongly Agree" at 58.3%, and "Agree" at 31.3%, these results demonstrate that the overwhelming majority of respondents (31.3%+58.3%=89.6%) agree that BI technologies do assist in improving the education-to-employment process. It is also clear that, simultaneously, disagreement is low at 4.2% whereas "Strongly Disagree" is zero, and the rest of the responses are neutral. This result reflects the employers' strong trust in the advantages of BI solutions.

Comparable results were obtained when both, students and graduates, were asked a similar question about the utilization of intelligent technologies to aid HS students and graduates in selecting their desired HE program and career path. This result with the former employer's outcome and discussion clearly indicate that the majority of respondents have a high degree of confidence in the benefits of BI adoption, and therefore, validate the first survey goal.

TABLE II. GRADUATES' FEATURES ASSESSMENT STATISTICS

Influencing features	Mean	STD	p-value	Trend
1) Access to labor & employment statistics	1.47	.725	.000	Ext-Imp
2) Availability of career advice at HS & HEIs	1.60	.872	.000	Ext-Imp
3) Correlation between HE degrees & occupations	1.52	.833	.000	Ext-Imp
4) Use of technology to analyze labor & HE progs	1.55	.872	.000	Ext-Imp
5) Influence of social factors	2.33	1.198	.000	Imp
6) Bidirectional link between HEIs & industry	1.67	.912	.000	Ext-Imp
7) Experts involvement in HE planning	2.17	1.265	.000	Imp
Average	1.76			Ext-Imp

The last group of characteristic factors that reflect awareness, investigates the target group's assessment of the impact of the seven influencing features listed in Table II. A five-point Likert scale was used to capture each feature's significance on the successful BI application and adoption.

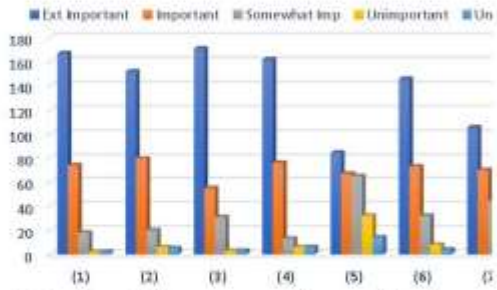

Fig. 6. Graduates' features assessment frequency distribution

Fig. 6 demonstrates that features (3), (1) and (4), in this order, show the highest "Ext Important" ranking. These features correspond to system inputs to the BI model outlined in Fig. 2. The three represent essential system requirements, and accordingly this result further authenticates the BI solution adoption.

Table II additionally shows that the average mean value is 1.76, that corresponds to "Ext-Imp" on the Likert scale. Hence, overall all the features strongly influence the success of the BI adoption, and thus, validate the first survey goal.

TABLE III. FEATURES' RANK AND CLASSIFICATION COMPARISON

Feature	Students		Graduates		Employers	
	Rank	*Class*	*Rank*	*Class*	*Rank*	*Class*
(1)	4	Ext-Imp	1	Ext-Imp	4	Ext-Imp
(2)	2	Ext-Imp	4	Ext-Imp	1	Ext-Imp
(3)	3	Ext-Imp	3	Ext-Imp	3	Ext-Imp
(4)	1	Ext-Imp	2	Ext-Imp	2	Ext-Imp
(5)	6	Imp	6	Ext-Imp	6	Ext-Imp
(6)	7	Imp	7	Imp	7	Imp
(7)	5	Imp	5	Imp	5	Imp

Table III presents a comparison of results from the three target group members for the same features. It establishes that the target group's ranking of all features is only confined between "Ext-Imp" and "Imp". Moreover, feature (4), namely "Use of technology to analyze labor market and HE programs", was ranked top by students and employers, and second by graduates and consequently supports the first survey goal.

The comprehensive analysis of the complete survey results has exposed the inconsistencies and deficiencies of the current education-to-employment process while simultaneously highlighting the many advantages of BI adoption. Therefore, the research goals are notably supported and substantiated by the results.

V. SUMMARY AND FUTURE WORK

This paper has investigated the adoption of BI technologies to enhance decision-making in the education-to-employment process and the alignment of HE with labor market. It has created a basic BI implementation model, identified essential factors for its adoption, and empirically examined stakeholders' attitudes and expectations toward its value and advantage. A survey instrument was used that had three major stakeholders as target group, namely, students, recent graduates, and employers.

This large-scale empirical study has concluded that there is substantial stakeholders' support for the use of technology and the adoption of BI throughout the education-to-employment process. This support is consistent and is contrasted with their dissatisfaction with the current process in all the examined activities, ranging from HE admission and career planning to recruitment and talent retention. Furthermore, the research demonstrated, that major prerequisites for BI implementation are already available and fit-for-purpose. Examples are, the readiness of core DW digital input data from the automated nationwide HE admission and civil service recruitment schemes, and simultaneously, the keen technology-savvy main process stakeholders.

Based on the analysis of the survey results, this research has substantiated the research hypothesis that adopting BI technologies in the education-to-employment process yields consistent information, efficient decisions, improved stakeholders' satisfaction, and ultimately better alignment of HE programs and outputs with labor market dynamics.

Consistent with the mixed model research approach applied, the identification of the essential characteristic factors for the successful BI adoption is among the main outcomes of this study. Moreover, the study has also showed that in the absence of reliable, and objective information, decisions are often based on non-substantiated information and unreliable sources, which in turn lead to dissatisfaction with the whole process.

The study has laid out the foundation for improving the education-to-employment process while providing insight to HE planners, businesses and HEIs to better realize the value of BI, the possible obstacles, and the existing leverage in its adoption. It has also provided a base for further BI research and extending empirical studies to various geographic contexts with the aim of amending the statistical analysis, and refining the DW concepts as well as BI components.

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