

# BACHELOR OF COMPUTER ENGINEERING - A CASE STUDY ON EMPLOYERS' PERCEPTION IN BOTSWANA

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## Abstract

Engineering plays a vital role in a Nation's growth and only a good engineering education can produce good engineers. The true importance of engineering could be measured through its dynamic nature to meet the demands and address the challenges of the constantly changing world. It is imperative to state that Engineering Education in Botswana be designed, developed, delivered and constantly reviewed to produce graduates who can tackle real time challenges and thus contribute towards the Nation's development with a positive societal impact. At Botho University, the degree programme (Bachelor of Engineering in Computer Engineering) was initiated due to enormous demand from the industry for IT specialists and computer engineers. Accordingly, the main objective of the programme was set as producing quality graduates to meet the industry requirements. The curriculum was designed considering IEEE/ACM guidelines matching any benchmark. This paper analyses different factors that influence the demand of Computer Engineering programmes offered in Botswana from the perception of potential employers. The study is performed by using questionnaires collected from various and by conducting interviews with the relevant industry personnel. It is found that the employers feel that these programmes have good demand and the study also highlights the recommendation towards achieving an effective computer engineering programme. The findings present in this paper is anticipated to motivate the curriculum developers in preparing and reviewing engineering programmes that are relevant to Botswana.

## Keywords:

Engineering Education, Curriculum, Industrial Needs, Botswana Education

## 1. INTRODUCTION

Botswana, like some other developing countries, has been continuously investing in young Batswana by providing them full sponsorships to pursue tertiary level education. It is important for Educational Service providers in Botswana to operate within a broad context of tertiary education in the world, African continent and subsequently Botswana. The challenges for Botswana have been and continues to be quality of education; ensuring sustainable tertiary education financing; reducing external placement and costs thereof; policy reforms and rationalisation of institutions; cost-sharing with parents and students; revenue generation by institutions; contributions by the private sector; and levy financing. These challenges have a global imperative and have significant effects on Botswana's local institutions. The last issue is on relevance of programmes to industry needs. The Botswana Qualification Authority [1] Consultancy to forecast and identify a list of priority vocational skills and develop strategies to fast track priority skills development, identified sixteen skills areas as critical to Botswana. In addition, the Human Resource Development Council [2] published 195 Top Occupations in high demand in Botswana. These were defined as those "occupations that are currently experiencing shortages in the labour market

(short term) and occupations that show relatively strong employment growth (long term)" [2]. These occupations are in Health; Public Sector; Agriculture; Information and Communication Technology; Creative Industries; Tourism; Education and Training; Research, Innovation, Science and Technology; Finance and Business Service; Transport and Logistic; Mining, Minerals, Energy and Water Resources; Manufacturing; and Construction. Botho University launched Bachelor of Engineering in Computer Engineering degree programme in the year 2015 to meet the demand for computer engineers in the country. The curriculum was designed based on IEEE/ACM guidelines for Software Engineering [3], with extensive help from the industry and academic advisors from other Universities in Botswana. As per the policy in Botho University to review the programmes every three years, Computer Engineering programme underwent a thorough review process to sample employers' views and opinions regarding the market demand for BEng in Computer Engineering, preferred level at which the programme can be offered, preferred mode of study, skills requirement for the programme, market demand for graduates, sponsorship, possible partnership opportunities and sufficiency of the programme. The main objective of this degree programme is to produce well-qualified computer engineering graduates for the IT industry [5]. In order to achieve this objective, the Faculty has put maximum effort at every stage: design of the programme curriculum, development of the modules and delivery of the modules. The student enrolment numbers for the BEng Computer Engineering programme is shown in Table.1 and Fig.1.

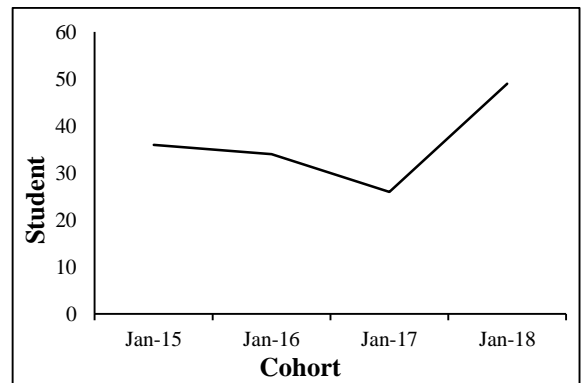


Fig.1. BEng CE Student Enrolment Numbers

Table.1. Student Numbers

Cohort	Student Numbers
Jul-15	36
Jul-16	34
Jul-17	26
Jul-18	49

After enrolment of four cohorts and the first cohort students being registered to pursue Internship module from July 2019, it is high time for critically evaluate the degree programme for its effectiveness. Accordingly, a survey was conducted among the employers to identify the usefulness of the programme in terms of the industrial needs. The results and conclusions arrived from the survey are presented in this paper.

## 2. COMPUTER ENGINEERING EDUCATION IN BOTSWANA

Generally, the discipline of Computer Engineering principles to the design of computers, networks of computers or systems of computers and networked devices. It mostly focuses on the theory and practice of analysis and design of complex digital systems, including general-purpose computers and special-purpose embedded systems [4]. Computer engineering is an academic field which encompasses the broad areas of applied sciences, computer science and engineering it is further defined by Fincher and Finlay [6] as a discipline that embodies the science and technology of design, construction, implementation, and maintenance of software and hardware components of modern computing systems and computer-controlled equipment. BEng in Computer Engineering is one of the newest and fastest growing fields of study in the world and has over the last four decades emerged as a highly lucrative and highly paying degree [7] [8]. According to the Botswana Qualification Authority [1] Computer Engineering skills are in the top skills required in Botswana. Generally, Information and Communication Technology skills are needed in Botswana [1]. Botswana Qualification Authority [1] lists Computer Engineering as the 6<sup>th</sup> critical skill and 5<sup>th</sup> priority area. The report [1] note that BEng in Computer Engineering skill is currently in shortage by a significant margin, and that this skills gap will become even more pronounced as the sectors requiring the skills are expected to expand from 2016. At a global level, the report on 'Employers' Perceptions on the Employability Skills of New Graduates' [9] presents a finding of the detailed study done in order to establish what the key qualities companies are looking for in new graduates.

## 3. RESEARCH METHODOLOGY

The study was undertaken in three sample locations in Botswana namely Gaborone, Francistown and Maun between the months of May and July 2017. This study adapted both phenomenological (qualitative) and positivistic (quantitative) philosophies of data collection - namely desk research, face-to-face interviews and In-depth Interviews (IDIs) among key stakeholders. The aforementioned data triangulation approaches were employed to ensure that each approach's weakness is compensated for by another approach and that the final results of the survey are accurate, reliable and dependable. A total of 22 enumerators were engaged in the data collection process, trained, closely monitored and questionnaire thoroughly validated and re-validated to ensure consistency and accuracy. In total, the enumerators gathered information through questionnaires and by conducting interviews from 50 employers within Botswana. Data was then processed into corresponding pre-structured SPSS database, data scrubbed before analysis commenced. Different approaches were used to analyse qualitative and quantitative data.

Whereas framework analysis technique was used to analyse qualitative data, several other techniques namely data tabulation (frequency distributions, percentage distributions and cross-tabulation data), descriptive data, data disaggregation, moderate and advanced analytical methods were also used. Discourse analysis was carried out on the corpus of verbatim comments to add an additional dimension to the findings, looking at not only what employers said, but also how and why they may have said it. This study adapted both phenomenological (qualitative) and positivistic (quantitative) data collection approaches - namely desk research, face-to-face quantitative research, IDIs among key stakeholders. The data triangulation approaches were employed to ensure that each approach's weakness is compensated for by another approach and that the final results of the survey are accurate, reliable and dependable. Selected employers were sent questionnaires to collect information on the following

- Employment/Internship Acceptance Opportunities
- Demand for BEng in Computer Engineering graduates
- Willingness to sponsor their employees to pursue this programme
- Preferred levels and mode of study at which the Programme can be offered
- Essential Competencies Employers expects from University Graduates seeking Employment
- Sufficiency of the Programme in preparing Graduates for the Job Market
- Employability of Botho University BEng in Computer Engineering graduates in the SADC Region
- Possible Partnership Opportunities
- How to enhance the quality of BEng in Computer Engineering Programme

Since the goal is to produce engineering graduates for the industry, getting feedback from the employers on various aspects of the programme is important.

## 4. ANALYSIS OF THE RESULTS

Employers' analyses comprise of data sampled from 50 firms situated in Gaborone, Francistown and Maun in the following percentages 27(54%), 15(30%) and 8(16%) respectively. Massy [11] in his work states that the degree of employability is key parameter to measure the efficacy of any academic programme. It can further be noted that this study used two significant approaches to gather data and this certainly would have deduced for varied outcome. In most of the cases, the impact is seen to be positive by providing a complete dimension of the existing scenario [12].

### 4.1 EMPLOYER CLASSIFICATION GROUPS & CATEGORIES

For representatively, different employment sectors involved in the study were classified according to Botswana Standard Industrial Classification Criteria (an adopted by United Nations' International Standards Industry Classifications) which revealed that participating firms could be classified into 6 classification groups namely real estate, renting and business activities 41(42%), transport, storage and communication 2(4%), public administration 2(4%), electricity, gas and water supply 2(4%),

construction 1(2%) and financial intermediaries 1(2%). One respondent preferred to remain anonymous hence could not be classified under any category. Firms have been in operation for an average of 7 years. The latest entrant was only 3 months old while the oldest of the firms had accumulated a total of 42 operational years. A few employers 3(6%) were unsure of the length of time they have operated while 2(4%) were none committal and just mentioned that they had been operating for a long time. A total of 15(30%) employers had extended their operation to 8 other regions on the country while the majority operated just a single office 35(70%). Those that had branches operated in Gaborone 14(28%), Francistown 9(18%), Maun 5(10%), Jwaneng 2(4%), Kanye 1(2%), Thamaga 1(2%), Ghanzi 1(2%) and Kasane 1(2%). Two employers in the building and maintenance line of business specified that they operated everywhere in the country.

Three categories of enterprises namely micro, small and medium enterprises were represented in the study in the following percentages 28%, 62% and 10% respectively. Micro enterprises are defined as those that have up to 9 employees, small have between 10-19 employees while mediums enterprises have between 50-250 staff complement.

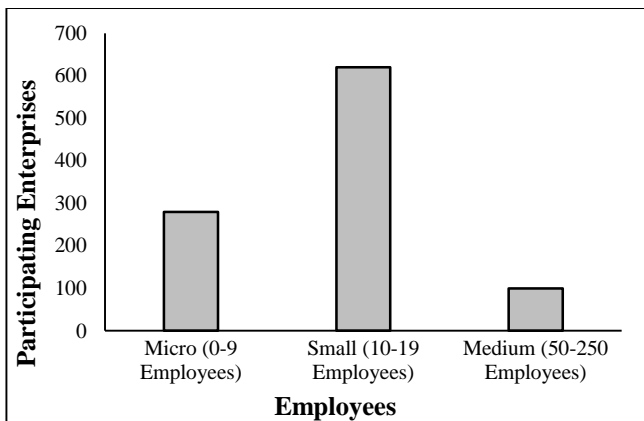


Fig.2. Size of Participating Enterprises (Micro, Small and Medium Enterprises)

**4.1.1 Employment/Internship Acceptance Opportunities:**

A considerable number of employers 41(82%) indicated having employed a total of 145 graduates from local institution of higher learning, and 39(78%) of them expressed the intent to hire 65 graduates in the next two years. Fewer employers 30(60%) indicated having assimilated a total of 80 interns into their establishments in the past, and 39(78%) intend to take in 274 interns in the next two years if the applicants show interest in internship programme, have sufficient knowledge in their area of interest, show commitment, vacancies exist and the company grows with increased workload, to expose students to the industry, business acumen and empower them to develop their ICT knowledge. Employers who were reluctant to take in interns cited inappropriate timing, bias towards qualified and experienced workforce, unavailability of vacancies, lack on seriousness in students taken in for internship programmes.

**4.2 DEMAND FOR COMPUTER ENGINEERING GRADUATES**

The overall demand for BEng in Computer Engineering programme stands at 52.5%. The Fig.3 shows that most

employers perceive the demand for the programme to be average 18(36%) while 16(32%) either felt that there was demand or an insignificant demand for the same 16(32%).

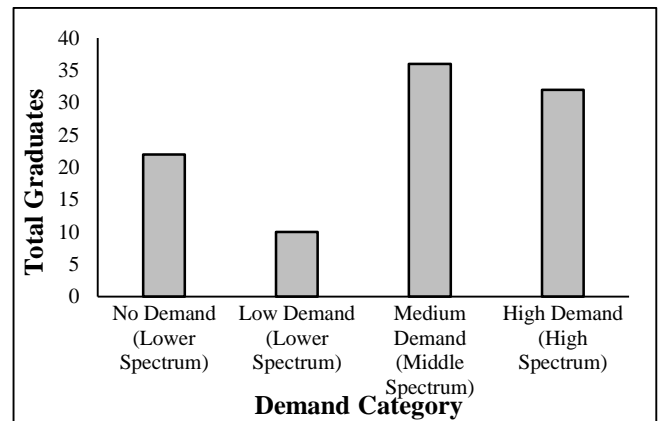


Fig.3. Demand for BEng in Computer Engineering graduates

Given the available opportunities, more than three-quarters of the employers 39(78%) expressed interest in employing BEng in Computer Engineering graduates from Botho University. These employers expounded that they open up their doors to graduates particularly when the local economy and their businesses expand 29(74%) and create employment opportunities for qualified graduates with complimenting skills 10(25%).

Employers who crumpled the chances of employing BEng in Computer Engineering students cited slow growth in the business sector 3(42.9%), the size of their enterprises 2(28.6%), Botho University accreditation concerns 1(14.3%), inexistent vacancies and the relevance of the programme to the local market 6(85.7%). A few employers 4(8%) were unsure of employment chances in their organizations.

**4.3 WILLINGNESS TO SPONSOR**

Sponsorship is one aspect that employers are struggling with and only a handful can set aside finances to upgrade the educational level of their employees and other students. As previously established in this study, hostile business environment that have forced establishments either to downsize, freeze employment, or resulted in stunted growth has a direct bearing on the number of sponsorships employers can extend to candidates.

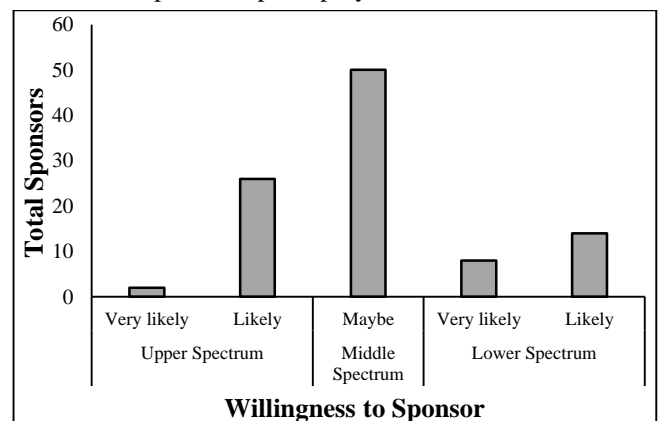


Fig.4. Willingness to Sponsor

From the Fig.4, it is evident that a higher number of employers 14(28%) showed optimism in sponsoring candidates (employees or students) to undertake BEng in Computer Engineering than those who felt there were no sponsorship chances because their companies were financially unstable, lack of company policy to support such an initiative, disinterest in paying for lengthy courses and preference to hire a trainer to impart on more employers rather than sponsoring an individual to school. A half of the employers stated that there were chances that they would consider sponsoring candidates to undertake this programme.

**4.4 PREFERRED LEVELS & MODE OF STUDY AT WHICH THE PROGRAMME CAN BE OFFERED**

There is a call to offer computer engineering programme at various academic levels but the two most preferred levels included PhD 21(42%) and Bachelors 13(26%). A total of 9(18%) preferred the programme to be capped at master level while a minority preferred that the programme be capped at diploma 5(10%) and certificate levels 4(8%). This is depicted in Fig.5(a).

The Fig.5(b) illustrates that of the three options employers preferred, full time campus learning 34(68%) was their most prescribed mode for undertaking BEng in Computer Engineering and this preferences follows the offing in the modules that requires one to fully avail self and concentrate throughout the lectures and practical sessions. A few employers 4(8%) and 12(24%) preferred that the programme be availed through part-time campus learning and distant learning modes respectively.

The reasons employers gave for preferring full time campus learning included maximum concentration on the course content and research 21(61.8%), best mode to undertake a practical course 6(17.6%), offers one an opportunity to interaction with lectures 5(14.7%), access to facilities / resources 3(8.8%), interaction with other students 1(2.9%) and convenience 1(2.9%). Employers preferred Part time campus learning because it offers one an opportunity to work and study at same time 3(75%) as well as enable one to apply what they were learning in the workplace 1(25%).

Those who preferred distant learning cited convenience and the opportunity for one to learn and be exposed to the industry at the same time 7(58.3%), flexibility to study from unrestricted areas 3(25%), intent to learn in a computerized environment 2(16.6%) and the ability to undertake practical and theory at the same time 1(8.3%).

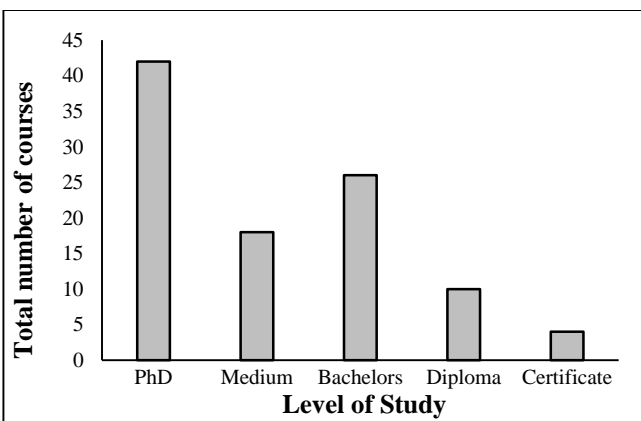


Fig.5(a). Preferred Levels of study

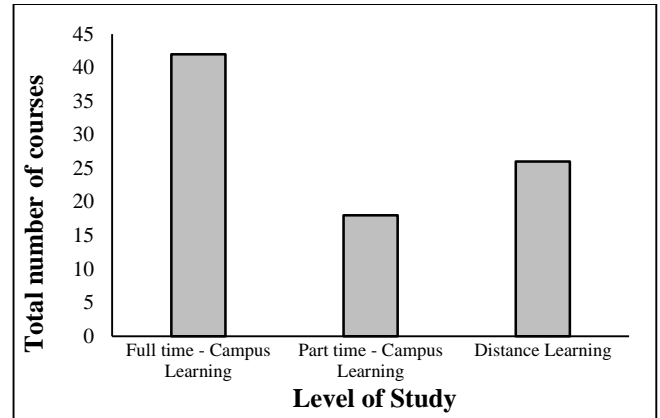


Fig.5(b). Preferred Mode of study

**4.5 ESSENTIAL COMPETENCIES EMPLOYERS EXPECTS FROM UNIVERSITY GRADUATES SEEKING EMPLOYMENT**

Top five essential competencies that employers seek from Computer Engineering graduates include dedication 26(52%); teamwork 22(44%); innovation 18(36%); communication skills 15(30%) and technical skills (networking, hardware, engineering skills) 14(28%). Other competencies are as tabulated in Table.2.

Table.2. Essential Competencies for Employability

Essential Competencies	Employability
Creativity	12(24%)
Smart	11(22%)
Time management	8(16%)
Self-motivated	7(14%)
Integrity	7(14%)
Willing to learn	6(16%)
Business skills	5(10%)
Experience	5(10%)
Professionalism	5(10%)
Problem Solving Skills	5(10%)
Confidence	4(8%)
Practical oriented	4(8%)
Analytical thinking	3(6%)
Passion	3(6%)
Compassionate	1(2%)
Critical Thinking	1(2%)
Good Attitude	1(2%)
Precision	1(2%)
Work under Minimal Supervision	1(2%)
Flexibility	1(2%)
Good problem solver	1(2%)
Multi-tasking	1(2%)
Performance driven	1(2%)
Speedy	1(2%)

#### 4.6 SUFFICIENCY OF THE PROGRAMME IN PREPARING GRADUATES FOR THE JOB MARKET

Asked whether Botho University BEng Computer Engineering programme modules sufficiently prepared students for the job market, 36(72%) employers indicated that indeed the programme does prepare candidates because its content is good and sufficiently covers all the subjects 30(83.3%) which BU has specialization in. They however recommended that the faculty should consistently keep abreast with the trends and development in the industry, be more practical-oriented, remove statistics from the module as it adds no value to the IT programme and consider offering courses with professional certifications such as CISCO, Microsoft Certification, Oracle, Linux, Comptia courses which are essential in the job market. Two employers felt that the programme moderately prepared students for the job market while the remaining few 12(24%) indicated that it does not prepared graduates for the job market given that the modules are not on par with other universities such as UB and BIUST, graduates have theoretical knowledge but no practical experience 4(8%) which is required in the industry, the content does not match requirements 1(2%), the programme lacks advanced certifications which are important to employers 1(2%) and the module lacks hardware electronics or repairing component 1(2%). In order to make the programme more beneficial to the graduates, employers further suggested accreditation of Botho University programmes, improved programme implementation, inclusion of management assistant or human resources, robotics and business management modules for those who may want to venture into entrepreneurship, lengthen internship sessions as the modules do not reflect much of practical work, provide students with course materials and give them an opportunity to specialize at the end of the programme.

#### 4.7 EMPLOYABILITY OF COMPUTER ENGINEERING GRADUATES OUTSIDE BOTSWANA

All employers were invited to scrutinize BEng Computer Engineering programme structure that is being offered at Botho University and determine how the future employment opportunity for these graduates would compare with others of similar qualification in the South African Development Community (SADC) region. Some employers opined that it was sufficient while others felt that the programme would not build a competitive block for the students. Employers who felt that the graduates would compete fairly with others in the region stated that the structure is sound, especially that it was developed by professionals and so matches international standards 13(26%). Another employer 1(2%) felt that the graduates could actually outshine their counterparts in the SADC region. On the other hand, employers who felt the graduates can't compete in the SADC region cited stiff competition from the regional graduates, Botho University students lack leadership skills hence can only be employed at lower levels in the region, the structure is too theoretical, education standard in Botswana are low, modules are not essential for employment, and programmes offered in the region are more technologically advanced. A few respondents were unable to comment given that they hadn't worked with anyone who studied outside Botswana or any SADC foreigner.

#### 4.8 POSSIBLE PARTNERSHIP OPPORTUNITIES

Employers from across the three regions were willing to enter into partnership with Botho University to enrich the development and delivery process of Computer Engineering curriculum that would add value to the students. One area that over a half of them opened to was provision of internship opportunities for faculty students 34(68%) as this is beneficial not only to the students but to these establishments as well. Other important areas that they were available to partner with Botho University in include student visit and exposure 17(34%); mentorship 15(30%); guest lecturer 9(18%); equipment usage; 6(12%); participate in industry reference forum 6(12%); sponsorship 5(10%) moderation 5(10%); and university programme review 3(6%).

#### 4.9 ENHANCE THE QUALITY OF BENG IN COMPUTER ENGINEERING PROGRAMME

Employers recommended that the following would enhance the quality of BEng in Computer Engineering Programme. They include: -

- 3(6%) - Hire highly skilled lectures to deliver the content to students.
- 1(2%) - 1 Accredite your courses and avoid accreditation scandals as students might be demoralized and perform badly on the basis that they are studying for nothing.
- 1(2%) - Increase Botho University campuses across the country.
- 1(2%) - Increase standard of learning and provide sufficient service to the students.
- 1(2%) - Increase the number of laboratories with industrial experience.

#### 5. RECOMMENDATIONS

Botswana only had very few academic institutions offering computer engineering programmes at Bachelor level and this further substantiates that there is a lot of demand. The report therefore presents the findings based on primary and secondary data collected from internal and external stakeholders. They have been reported according to the engagement objectives stipulated above. While majority of employers 36(72%) indicated that the programme sufficiently prepared candidates for the job market because its content was good and covers all the subject's areas 30(83.3%), they also highlighted the few recommendations to ensure that students achieve the set academic endeavours as well as equally get endowed with these competencies.

- Botho University has worked to ensure that the programme is sufficient and market centric. However, it is recommended that the faculty keeps benchmarking against international peer institutions, periodically and consistently consults with the industry stakeholders to maintain programme relevance and sufficiency.
- Given that employers and BIE showed willingness to work in partnership with Botho University in providing internship opportunities, student visits and exposure, mentorship, guest lecture, moderation, university programme review and in industry reference forum participation, it is recommended

that the faculty uses the opportunity to motivate students and revitalize their interest in studies.

- The faculty of Computer Engineering should consistently keep abreast with the trends and development in the industry, be more practical-oriented, remove obsolete modules from the structure as it adds no value to the IT programme and consider offering courses with professional certifications such as CISCO, Microsoft Certification, Oracle, Linux, Comptra courses which are essential in the job market and consider inclusion of robotics and business management modules for those who intend to venture into entrepreneurship.

## 6. CONCLUSIONS

The study was designed to sample respondents' perceptions and opinions regarding Botho University programme demand and sufficiency, skills required for the programme, employment opportunities, preferred mode of study, sponsorship, possible partnership with government, community, industry development priorities and competitor analysis [10]. However, there were few limitations and challenges that were faced while conducting this study. Firstly, the number of relevant industries that could employ computer engineering graduates within Botswana is limited and it was a challenge to find willing employer from that limited number to participate in the study because most of them proved to have tight schedules. Few employers preferred to have fixed appointments prior to conducting the interviews while some requested for questionnaires to be left with them and they took a long time to complete and return them. A good number of employers turned enumerators down saying they were not interested in the study while others said their participation would be meaningless especially that they didn't know anything about the programmes. Scheduling appointments for in-depth interviews also proved to be tedious and difficult as these are high end personnel (CEOs, Chairpersons, Presidents, etc.) who proved difficult to reach. Despite these challenges having 50 participants to contribute in this survey has certainly a meaningful impact. Desk research findings and the employers' (54.5%) overall ratings indicate that there is demand for BEng(Hons) for Computer Engineering programme alluding to the fact that adequate number of industries do not exist in Botswana hence the reason why these engineering graduates would be competing with IT graduates. Programme is linked with the demand of the market and hence Computer Engineering was among programmes sponsored by the Department of Tertiary Education Financing in Botswana. Employers have provided positive feedback to indicate that they are satisfied with the BEng Computer Engineering programme and thus, it can be concluded that there is a demand for BEng in Computer Engineering programme among the employers as it was listed among critical skills area in Botswana.

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