Bridging the Gap: Aligning University Geomatics Programs with Industry Needs and Enhancing Graduates' Employability in Botswana

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Summary

Universities and other tertiary institutions exist primarily to train and produce graduates with requisite skills for various types and places of work. Technologies associated with programs of study have continued to boom unbounded, making it necessary for continued checks and bridging of gaps between tertiary institutions and industry. Considering the forgoing point in the field of Geomatics, a number of technological advances emerges, for instance; Global Positioning Systems (GPS), Geographical Information Systems, Digital Photogrammetry, Satellite Imagery (Remote Sensing), Unmanned Aerial Vehicles and Lidar Points Cloud Technologies. Therefore, it is prudent to study practical applicability of the geomatics knowledge and skills acquired during time of learning at tertiary institution within a geomatics industry. Geomatics education plays a pivotal role in preparing graduates for careers in fields such as surveying, mapping, remote sensing, engineering, mining and geospatial analysis. A study was conducted to help evaluate the practical applicability of geomatics education among geomatics graduates who obtained their qualifications from universities and/or tertiary institutions in Botswana. This study is a pilot approach premised on a hybrid questionnaire consisting of quantitative and qualitative questions. The questionnaire was designed to obtain geomatics graduates feedback on their education, workplace utilization of geomatics knowledge and tools, and suggestions for curriculum improvements. Based on the survey findings and the insights gained, a number of recommendations are advanced for consideration by universities in Botswana to enhance their geomatics programs and better align them with industry.

Key Words

University, Tertiary Institution, Geomatics Graduates, Geomatics Industry, Geospatial Technologies, Gaps

1.0 Introduction

Geomatics education plays a pivotal role in preparing graduates for careers in fields such as surveying, mapping, remote sensing, engineering, mining and geospatial analysis. Graduates of geomatics must continually adapt to influential and disruptive technologies associated with it. A number of technological advances associated with geomatics have continuously emerge in the last three (3) decades. These technologies include; Global Positioning Systems (GPS), Geographical Information Systems; Digital Photogrammetry; Satellite Imagery (Remote Sensing); Unmanned Aerial Vehicles; and Lidar Points Cloud Technologies. These technologies further influence high technological conceptions such as Spatial Data Infrastructure; Digital Cadasters; Three (3) Dimensional City modelling and Digital Twins. The influential frontiers of this technologies, make it prudent to study practical applicability of the geomatics knowledge and skills acquired from tertiary institution within a fluid geomatics industry of any given country. In so doing there has to be a continuing technological bridging of gaps to equip graduates with current knowledge and expertise. This bridging of gaps has been recognized by Young (1992), who back then advocated for intertwined and continual programs development between training institutions and the industry to cater for the ever-changing influential technologies. A similar view was further emphasized by Konecny (2002) in realization of how technology impacts is opening geomatics to several application areas.

In terms of significance of geospatial technology boom and influence, it is considered to be among the three top most influential technologies of our times alongside nanotechnology and biotechnology (Aina, 2009). According Aina (2009) geomatics is a complex field of study with influences propelled by "*computer science, software engineering, airborne and space observation technologies*". The stated sector influences may not necessarily be well covered in a structured tertiary institution program, which in turn have a direct impact on the graduate produced. As opined in Aina, Aleem, Hasan, Alghamdi, Mohamed, (2014) a negative trend relating to tertiary students in geomatics has been recorded in a number of countries and according to these authors initiatives with far reaching impact have to be considered to reverse the trend. Among the initiatives Aina et al (2014) considered impactful in geomatics education, are the following; *(a) revamping the curriculum based on industrial requirements (b) developing a bachelor degree option, and (c) initiating education-industry partnerships to address these challenges*.

In Botswana context, formal geomatics education training has followed an evolutionary process starting in 1989 with erstwhile Diploma in Land Use Studies by the then Botswana Polytechnic. This Diploma was then replaced in 1992 by Diploma in Land Surveying, however, a major shift occurred in 1996 when Botswana Polytechnic was assimilated into University of Botswana as Faculty of Engineering and Technology (Tembo and Manisa, 2002). Under University of Botswana (UB) the Diploma in Land Surveying was further evolved into Diploma in Geomatics in 2002 (Tembo and Manisa, 2002). As time unfolded, the need for a Bachelor of Geomatics program became inevitable and in 2008, the University of Botswana started a fully-fledged four (4) years Bachelor of Geomatics degree program which culminated into the first graduate cohort in 2012. A study was created to review the perceptions of the geomatics graduates regarding geospatial technology gaps in geomatics programs. Kampamba (2023), has conducted a study which can be described to be similar but much wider in approach in that it was investigating employability of the land sector graduates in general. Though this study is recognized, it has to be noted that the need to delve into subject-specific studies is viewed as possessing useful underlying benefits in understanding gaps between university programs and professional practice in industry, hence this study. For the purpose of this paper, this section outlines an introduction to the topic within the frameworks of literature, while the next section dwells on the methodology followed in the investigation and the third section reports on the results obtained. The fourth section is a discussion which evaluate the study method together with results obtained then make recommendations and the fifth section concludes the paper.

2.0 Methodology

The study is a mixed method featuring quantitative and qualitative lines of inquiry. The survey targeted graduates who had completed geomatics and related degrees at universities and/or tertiary institutions in Botswana.

2.1 Research Objectives

This study was designed to address the following generic objectives:

1. **Knowledge and Skills Acquisition Assessment**: To determine the extent to which geomatics graduates acquire knowledge and skills during their university education.
2. **Practical Knowledge and Skills Applicability**: To assess how well the knowledge and skills acquired during university education are being applied in the current professional roles of the graduates, particularly within the geomatics field.

2.2 The Research Questionnaire

The primary data collection method was a structured questionnaire to gather information online relating to graduates' experiences and perceptions regarding their geomatics education and its relevance in their current professional roles. The survey instrument was structured into quantitative and qualitative formats of inquiry.

2.2.1 Quantitative questions

Six questions were used to fulfill the quantitative requirements of this research and they are given below with their specific summaries and descriptions.

- **Demographic Information**: Participants were asked to provide details about their academic qualifications, graduation years, and current employment status in a geomatics-related field.
- **Relevance of Qualification**: graduates were required to rate the overall relevance of their geomatics qualification to their current job role on a scale of 1 to 5 (1 = Not relevant at all, 5 = Highly relevant).

- **Preparation for the Job Market**: graduates were to specify whether they felt their geomatics education adequately prepared them for the job market and professional challenges, with options for "yes" or "no" responses.
- **Program Satisfaction**: participants were asked to rate their satisfaction with the overall quality of the geomatics-related program they had completed on a scale of 1 to 5 (1 = Very Dissatisfied, 5 = Very Satisfied).
- **Career Advancement**: respondents to assess the extent to which their geomatics qualification had contributed to their career advancement, with options ranging from "significantly" to "not at all."

2.2.2 Qualitative questions

To obtain open ended feedback from the informants, the following questions were crafted for them to answer:

- **Utilization of Geomatics Tools**: respondents were queried about their use of specific geomatics software or tools introduced during their studies.
- **Lacking Skills or Topics**: participants were invited to identify essential geomatics skills or topics they believed were lacking in the curriculum and specify improvement areas.
- **Technological Advancements**: graduates were questioned about any techniques or technological advancements in the geomatics field that were not covered during their studies, with space for descriptions.
- **Beneficial Aspects of Curriculum**: graduates were encouraged to identify the aspects of the curriculum they found most beneficial to their career development.
- **Curriculum Improvement Suggestions**: respondents were asked how the curriculum could be improved to align with industry needs and enhance graduates' employability.

2.3 Pilot Study Approach

In order to gauge the study patterns and make a consideration for a more comprehensive study in the future, the objective of a pilot study was adopted as a way of undertaking an outreach to the targeted informants. A pilot study was considered conceivable because of lack of funding and a chance to evaluate the use of online outreach method in data collection among the local tertiary institutions' geomatics graduate community. Following such, an invitation to participate in the survey was distributed through online networks of Botswana Young Surveyors Network and Botswana Institute of Geomatics (BIG). The survey was administered electronically, allowing participants to respond at their convenience. This survey was opened from 21st August to 30th September 2023, with regular reminders being sent out for the targeted geomatics group to respond within the online platforms.

The objective of the pilot study was to advance the questions raised by the researcher and in the same breath obtain feedback, ideas and perspectives from the informant group. A number of persuasive points on the importance of pilot studies are found in van Teijlingen and Hundley (2001). According to van Teijlingen and Hundley (2001), a pilot project has to address two fundamental principles being: as a preparatory study and as a basis of testing research instruments. Therefore, even though the target demographics are presumed to be in excess of 200, the pilot execution was done with an open mind to gauge the respond rates on online platforms and the ability to comprehensively respond to the questionnaire. The reporting of these results is consistent with the conclusions of van Teijlingen and Hundley (2001) that results from pilot studies must be reported and analyzed in their own right. With this in mind the results are reported, analyzed and improvements suggested.

3.0 Results

As mentioned in the method, the online survey was run from 21st August to 30th September. It was closed after observing that; the targeted informants had not been responding for well over two weeks despite the reminders. The resulting survey data was analyzed, and descriptive statistics, including frequencies and percentages, are calculated and presented here. Open-ended responses, such as suggestions for curriculum improvement and descriptions of technological advancements, are qualitatively analyzed to identify common themes and patterns as they will appear in these results. The results of the questionnaire are numbered for clarity and ease of reference.

1. Demographic Information

Among the online networks, there is Botswana Young Surveyors WhatsApp group with over two hundred (200) graduates from Botswana universities and tertiary institutions such as University of Botswana (UB), Botswana International University of Science and Technology (BIUST), Botswana College of Engineering and Technology (BECT) and a number of universities internationally. However, demographic information of the respondents of this pilot study are summarized as follows:

- **Respondents**: 11 of the Alumni responded as shown on Figure 1
- **Qualification:** 9 in Geomatics and 2 in Environmental Science.

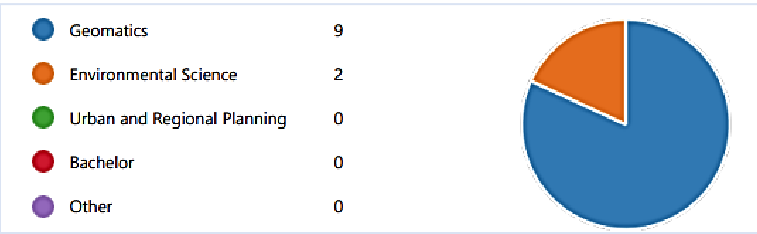

Figure 1: Qualifications

- **Graduation Year**: from Figure 2 below, it could be concluded that most respondents graduated between 2010 and 2022.

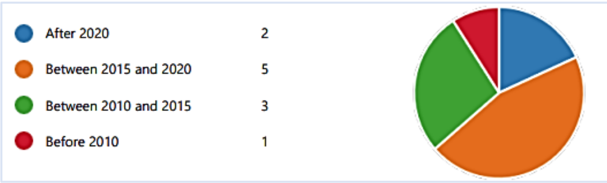

Figure 2: Graduation year ranges

- **Current Employment:** most are in geomatics-related fields.

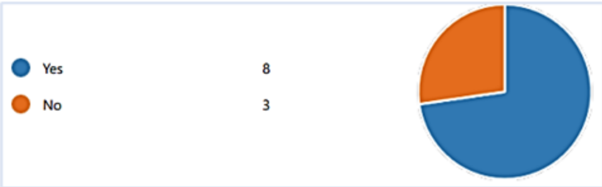

Figure 3: Graduates employability

2. Program Satisfaction

Respondents rated their satisfactions shown in Figure 4 below.

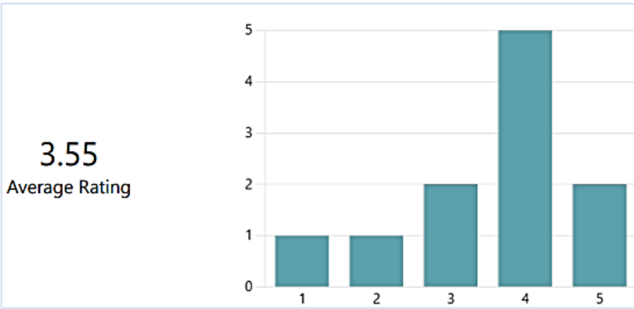

Figure 4: Graduates program satisfaction

In figure 4, the vertical axis represents scales for satisfaction, where 1 represents "Very Dissatisfied" and 5 represents "Very Satisfied." The average rating is 3.55, which can be inferred to say that 64% are expressing some satisfaction with the program they studied.

3. Relevance of Geomatics Qualification

In figure 5, the vertical axis represents scales relevance of studied program, where 1 represents "Lowly Relevant" and 5 represents "Highly Relevant". The results are as follows:

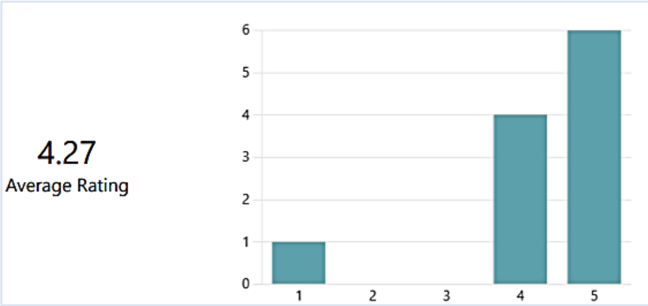

Figure 5: Relevance of Geomatics qualification

Ninety percent (90%) of respondents considered their qualifications relevant or highly relevant (4-5) and only ten percent (10%) of respondents rated the relevance low (1).

4. Preparation for the Job Market

The results are as follows:

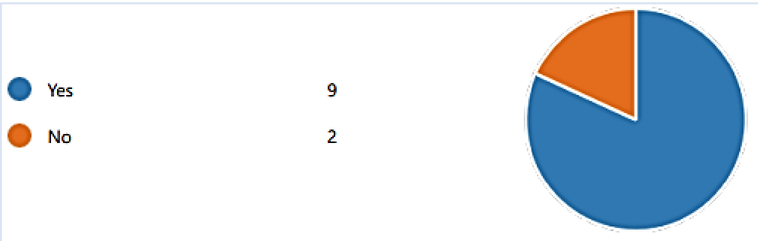

Figure 6: Program preparation for job market

- Figure 6 show that the geomatics program does prepare graduates for the job market. This result can be read together with that of Figure 1 to appreciate the consistency

5. Career Advancement

The responses are as follows:

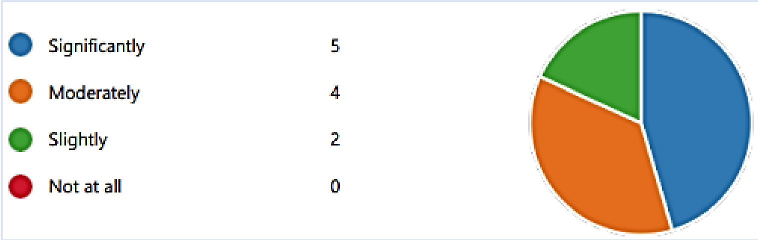

Figure 7: Usefulness of qualification in career advancement

Figure 7 confirms the significance of geomatics training in facilitating career advancement for the geomatics graduates.

6. Utilization of Geomatics Tools

Use of any specific geomatics software or tools introduced during their studies. The responses revealed common software/tools, with the majority mentioning the following:

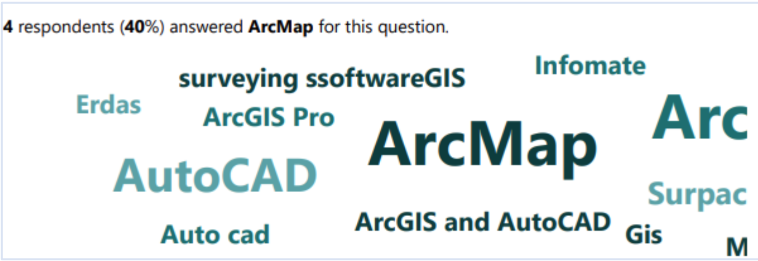

Figure 8: Use of geomatics technologies learned at school in work environment

According to Figure 8, ArcMap/ArcGIS, AutoCAD seem to be the commonly utilized software by the graduates. Indeed, these two (2) software suites are commonly used within universities and industry.

7. Lacking Skills or Topics

The responses yielded the following themes:

Figure 9: Corporate skills perceived as relevant in geomatics training

A number of fundamental skill sets have been identified by the respondents on Figure 9. Some focus on writing skills and ability to run a business while others focused issues to do with policy and corporate governance. Other emphasis focused on machine learning, fieldwork experience and analytical skills.

8. Technological Advancements

Graduates were queried about any techniques or technological advancements in the geomatics field that were not covered during their studies. Several advancements were mentioned, including:

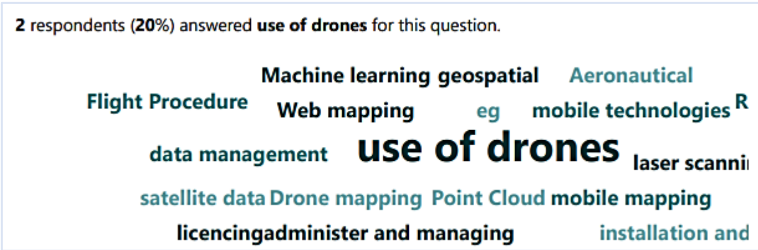

Figure 10: Technological advances viewed as useful for integration in geomatics programs

In Figure 10, the popularity of drones within the respondents is evident. Key technological advancements in geomatics are also listed in this response. Figure 10, should act as a guideline to universities/tertiary institutions in reviewing and re-aligning their programs to embrace technology.

9. Beneficial Aspects of Curriculum

Alumni identified the aspects of the curriculum they found most beneficial to their career development. Commonly mentioned aspects are graphical displayed on Figure 11.

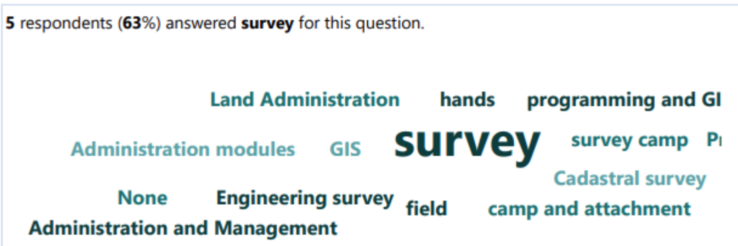

Figure 11: Beneficial aspects of course curriculum

The responses on Figure 11 reveal that most respondents are geomatics graduates.

10. Curriculum Improvement Suggestions

Finally, respondents suggested improving the curriculum to align with industry needs and enhance graduates' employability. Key suggestions included:

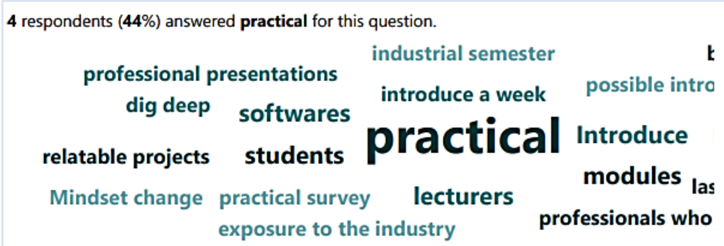

Figure 12: Suggested areas to improve geomatics programs

From Figure 12, graduates have unequivocally emphasized increasing practical exposure to processes and procedures. The practical exposure has been expressed in various forms such as ‘exposure to industry’, ‘industrial semester’, ‘professional presentations’, ‘guest lectures’ and ‘relatable projects. These are pointing towards heavily practice-based qualifications that will reward experience and exposure to the industry and the world of work.

4.0 Discussion

With around two hundred (200) prospective respondents who had an equal chance of responding, only eleven (11) responded as the results shows in Section 3 in Figure 1. Low response could be attributable to a number of issues among them: connectivity, survey incentive, response intuition, timeline and many other reasons that need deeper understanding. Taking 200 as a going population, it can be realized that the response rate was just around 5.5%. A number of scholars have written on these parameters explaining their roles on response rates (Mailu et al., 2021; Cook et al., 2016; Wilson et al., 2010). Mailu et al (2021) utilizing online methods for data gathering achieved a response rate of 11.8% despite having incentives, adequate set timelines and reminders in a population of 345. In their conclusion they alluded to the point that, the impact of these parameters on response rates are conclusively indeterminable and it is difficult to attribute low response to them. In the case of this study, though critical of the response rate, the rest of the results are accepted as indicatory of the need for a more comprehensive survey and are further analyzed to distill important topics required in bridging gaps between university/tertiary education and geomatics industry in Botswana.

Most respondents in this study have expressed a lot of appreciation for university geomatics training, its role in facilitating their employment and shaping their career. On the other hand, the respondents have expressed the desire for more to be done in order to bridge gaps between university training and the industry. To enhance their geomatics programs and better align them with industry needs, the findings highlight and emphasize a number of insights which are summarized as recommendations as the following:

a) **Curriculum Enhancement**: existing programs need to be reviewed and strengthened by introducing modules or courses to address the identified lacking skills and topics such as writing skills, business practices, and emerging technologies like machine learning and LiDAR.
b) **Practical Exposure**: practical exposure for students needs to be increased by incorporating more hands-on experiences, fieldwork opportunities, and real-world projects, helping to bridge the gap between theory and practice. Students generally recommend an extended industrial training (e.g. a full semester course in the industry) that will help them to operationalize and internalize the geomatics theoretical frameworks they get from universities within the industry.
c) **Guest Lectures and Industry Engagement**: geomatics graduates are in favour of industry guest lecturer scenario as it will encourage active engagement with professionals to provide students with insights into the current challenges and trends in the geomatics field. Universities need to start tapping from the industry much more.
d) **Continuous Curriculum Review**: evidence further points towards an establishment of a continuous curriculum review and adaptation mechanism to ensure that geomatics programs remain aligned with industry advancements.
e) **Professional Development**: graduates and current students are encouraged to engage in continuous professional development to stay current with evolving technologies and industry demands. A hybrid of continues professional development courses need to be developed by universities and industry collaboratively to fill the prevailing gaps.
f) **Interdisciplinary Skills**: promotion of development of interdisciplinary skills, including data analysis, communication, and project management among graduates is encouraged as they will prove valuable in various professional settings.
g) **Research and Innovation**: encourage and support research and innovation initiatives within geomatics programs to contribute to advancements in the field. Universities and industry must come together in collaboration to ensure the viability of this.
h) **Collaborations with Professional Networks**: Professional networks such as Botswana Geomatics Institute (BIG) and its mother body International Federation of Surveyors (FIG) are capable of adding significant views, values and help contextualize a number of geomatics concepts for the graduates. BIG is a professional voluntary organization which offers free membership to university students in Botswana. In the case of FIG, it has a Young Surveyors Network (YSN) structure which is open for young graduates from Botswana to join and learn from their peers regionally and globally.

5.0 Conclusion

In conclusion, this survey underscores the importance of geomatics education in preparing graduates for the workforce. While it is evident that geomatics education equips graduates with valuable skills, there is room for improvement and adaptation to ensure that graduates continue to thrive in a dynamic and technology-driven geomatics industry. Graduates feedback has highlighted the need for a stronger emphasis on certain skills such as writing, business practices, and analytical techniques. Geomatics is among areas faced with fast-paced nature of technological advancements which necessitates continuous learning and adaptability. In overall, it is evident that geomatics education significantly impacts graduates' careers, provision of requisite skills and knowledge needed for success in the workforce. To maintain the relevance of geomatics education, university programs must continue to evolve and adapt to industry needs, ensuring that graduates are well-prepared to tackle emerging challenges in the dynamic geospatial field.

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7.0 Authors Biography

1. **Lopang Maphale** 

Lopang is a Registered Professional Land Surveyor in Botswana with Master of Science in Geographical Systems and Doctor of Philosophy in Geomatics. Since completing his first degree in 1994, Lopang has worked as Land Surveyor in Botswana leading to his professional registration as a Land Surveyor in Botswana in 2002. Since 1998, he joined the University of Botswana and has played a vital role in the development of Geomatics training. Lopang was member of a reference group which lead to establishment of Bachelor of Geomatics at the University of Botswana. As an academic, Lopang has played an important role in geomatics research in Botswana which has yielded over 30 articles in conferences and journals. As a professional, he has played a fundamental role in national land registration projects. In terms of professional association, he was instrumental in the establishment Botswana Institute of Geomatics (BIG), and its affiliation to Federation of International Surveyors (FIG). Maphale has served as president of BIG and has been its regular representative at FIG. He has also facilitated continuing professional development (CPD) in the geomatics space through the following courses: AutoCAD, Geographical Information Systems, Land Administration and Records Management and Global Position Systems in Mining and Utilities.

2. **Sibonile Sibanda** 

Sibonile (Sibs) is a trained Land Surveyor with a Master of Science in geo-information. As a geomatics expert she commands over 15 years of experience in planning, executing and managing projects in Remote Sensing, GIS and Surveying. Her remote sensing and GIS experience includes work on infrastructure development, environmental monitoring, and humanitarian projects in the southern region of Africa. Sibonile is currently the Managing Director of Hatfield Consultants Africa (HCA) where they provide solutions for satellite imagery and elevation models in the Southern Africa Region. She has capabilities in geodatabase development, GIS implementation and management, topographic mapping, workflow development and implementation, spatial analytics and web-GIS application deployment.