SECTION A:	QUALIFICATION DETAILS																	
QUALIFICATION DEVELOPER (S)	BOTHO UNIVERSITY																	
TITLE	Master of Science in Computer Vision														NCQF LEVEL	9		
FIELD	Information and Communication Technology		SUB-FIELD		Media Technology										CREDIT VALUE	240		
New Qualification		✓	Review of Existing Qualification															
SUB-FRAMEWORK	General Education	✓	TVET			Higher Education	√											
QUALIFICATION TYPE	Certificate	I		II		III		IV		V		Diploma		Bachelor				
	Bachelor Honours			Post Graduate Certificate			Post Graduate Diploma											
	Masters	√		Doctorate/ PhD														

RATIONALE AND PURPOSE OF THE QUALIFICATION

RATIONALE:

Computer vision is the field of computer science that focuses on replicating parts of the complexity of the human vision system and enabling computers to identify and process objects in images and videos in the same way that humans do. The need for developing this qualification emerged from a labour market survey indicating the scarcity of available professionals able to design, develop and evaluate new and existing solutions relevant to the fourth industrial revolution (HRDC 2019). The Human Resource Development Council Top 20 Occupation report (2019), highlights machine learning specialists, data analysts and scientists, big data specialists as one of the occupations facing shortages in the labour market.

The proposed qualification, Master of Science in Computer Vision (CV) will address this shortage in Botswana. This qualification will enable students to apply computer vision techniques to solve various real-world problems and develop skills for research in the field of machine learning, data analysis and image processing. The qualification will provide learners with the knowledge and skills related to machine learning techniques to process images, extract features and classify descriptors obtained from images, amongst others.

The MSc in Computer Vision qualification is intended to provide the country with graduates who have a specialized theoretical knowledge and well-developed research and practical skills in a scientific field and can therefore serve the community in a variety of important ways, in both the public and private sectors.

Development of the human capital is essential in achieving the VISION 2036 pillars mainly Pillar1: Sustainable Economic Development and Pillar 2: Human and Social Development. These two pillars emphasize transformation of Botswana economy to a knowledge-based economy producing a globally competitive human resource. They represent key strategies for driving economic growth and diversification. This qualification, MSc in Computer Vision contributes towards Vision 2036's realization by equipping prospective graduates with the necessary skills and competencies for sustainable economic growth.

The NDP 11 goal states the need to provide an adequate supply of qualified, productive and competitive human resources policy frameworks. It is to this effect that the MSc in Computer Vision qualification is being developed: to achieve the vision by equipping the learners with the knowledge, skills and competencies in line with the creation of a knowledge-based economy in Botswana.

Prioritization of occupations in demand is also informed by national priorities as outlined in the VISION 2036, National Development Plan-11 and long- term strategies of the different sectors of the economy. The MSc in Computer Vision qualification was therefore developed to contribute and compare human capital development and to fulfill the demand gap as per HRDC 2019 report. It is against this background that this qualification has been developed to address the urgent need for adequately trained manpower to manage the area of Computer Vision in various sectors of the economy (HRDC 2019, Vision 2036, National Development Plan 11)**.** This qualification helps to build the human capital in the areas of data analysts and scientists, machine learning specialists, digital transformation specialists, innovation professionals, robotics specialists and engineers, user experience and human mission interaction designers as listed in HRDC 2019 priority list table 1 future jobs

page no 1. According to the below link work is in progress related to Computer vision and AI surveillance in Africa. https://www.africaportal.org/publications/work-progress-computer-vision-and-ai-surveillance-africa/

In addition, a market survey was conducted to establish whether the qualification was viable. The study was undertaken in three sample locations in Botswana namely Gaborone, Francistown, and Maun. This study adapted both phenomenological (qualitative) and positivistic (quantitative) philosophies of data collection - namely desk research, telephonic interviews, face-to-face interviews, and In-depth Interviews (IDIs) among key stakeholders.

The responses from the survey were positive indicating that the qualification was contemporary, needed and sustainable for the sector. The report presents the findings based on primary and secondary data collected from internal and external stakeholders. The responses from the survey (employers (51.1%), alumni (91.7%), current students (60.9%) and prospective (66.0%) students) were positive and the qualification was needed by stakeholders hence it is sustainable.

PURPOSE:

The purpose of this qualification is to produce graduates with knowledge, skills, and competence to:

- Demonstrate advanced proficiency in the area of computer vision, image processing, virtual reality and medical imaging.
- Design and implement new algorithms which possess the ability to capture, understand, and interpret the visual information contained within images and video data, and translate this data.
- Implement innovative image processing methods and learn various techniques.
- Conduct innovative research in computer vision opening new opportunities for how dynamic scenes can be analyzed and video footage can be represented, edited, and seamlessly augmented with new content.

ENTRY REQUIREMENTS (including access and inclusion)
Entry into this qualification is through any one of the following requirements: ● The minimum admission requirement is a bachelor's degree Honors in Computer Science and its equivalent OR Post -Graduate Diploma in Computer Science and its equivalent. ● Applicants that do not meet the above criteria but possess relevant industry experience will be considered through recognition of prior learning (RPL).

SECTION B	***QUALIFICATION SPECIFICATION***
GRADUATE PROFILE (LEARNING OUTCOMES)	***ASSESSMENT CRITERIA***
1. Critically examine solutions to computer vision problems	1.1 Ascertain suitable procedures to examine computer vision problems 1.2 Examine problems and prepare computer vision solutions 1.3 Initiate creative solutions to problems *1.4* Construct suitable documentation of solutions.
2. Critically analyze and evaluate image processing techniques to propose solutions to problems in computer vision.	2.1 Determine the most appropriate media production techniques to support VR design and development. 2.2 Evaluate and compare state of the art image processing and machine learning approaches in context of various application domains, mainly computer vision. 2.3 Use different approaches to both biometric and non-biometric approaches to verification and identification of humans for security and forensic applications. *2.4* Validate a range of machine learning approaches, their evaluation and model selection. *2.5* Grasp the principles of state-of-the-art deep neural networks.
3. Design and develop innovative computer vision applications and image processing solutions	3.1 Apply computer vision algorithms for digital image enhancement, 3.2 Construct image compression and texture-based image segmentation.

	3.3 Communicate new ideas and solutions within the field of image processing and computer vision. *3.4* Create computer vision models using advanced image processing techniques.
4. Demonstrate innovative skills and strategies to advance knowledge in the area of computer vision and its applications.	4.1 Identify and assess the main research methods used in computer vision. 4.2 Select appropriate research method(s) for a computer vision project 4.3 Undertake a literature search and critical analysis of literature 4.4 Engage in independent critical thinking, rational inquiry, and self-directed learning.
5. Work independently as well as in a team and critically evaluate individual as well as other's work.	5.1 Demonstrate negotiation and leadership skills. 5.2 Coordinate and execute tasks independently and within groups. 5.3 Evaluate outcome and report results in a professional manner. 5.4 Use personal and soft skills to communicate effectively in a range of situations.

SECTION C	***QUALIFICATION STRUCTURE***				
COMPONENT	***TITLE***	***Credits Per Relevant NCQF Level***			***Total Credits***
		Level [7]	***Level [8]***	***Level [9]***	
FUNDAMENTAL COMPONENT *Subjects/ Courses/ Modules/Units*	--	--	--	--	--
	--	--	--	--	--
	--	--	--	--	--
	Digital Image Processing	--	--	9	20

CORE COMPONENT *Subjects/Courses/ Modules/Units*	Computer Graphics and Virtual Reality	--	--	9	20
	Image Acquisition and Reconstruction	--	--	9	20
	ICT Project Management	--	--	9	20
	Deep Learning in Computer Vision	--	--	9	20
	Computer Vision: Foundations and Applications	--	--	9	20
	Research Project 1: Proposal Writing	--	--	9	20
	Research Project 2: Dissertation	--	--	9	60
ELECTIVE/ OPTIONAL COMPONENT *Subjects/Courses/ Modules/Units*	*-- --*	*--*	*--*	*--*	*--*
	Advanced Image Processing	--	--	9	20
	Visual Learning and Reconstruction	--	--	9	20
	Biometrics	--	--	9	20
	Machine Learning	--	--	9	20

SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL	
TOTAL CREDITS PER NCQF LEVEL	
NCQF Level	***Credit Value***
9	***240***
TOTAL CREDITS	***240***

Rules of Combination:

(Please Indicate combinations for the different constituent components of the qualification)

- This qualification has 240 credits and takes at least two years to complete.
- The credit combination for this qualification is from 200 core components (8 modules), which are compulsory and 40 (2 Modules) is from elective components.

ASSESSMENT ARRANGEMENTS

This qualification is assessed and moderated as follows:

Formative assessment: 50%

Summative assessment: 50%

Assessment Types:

- Practical test
- Class assignments
- Informal class tests
- Formal modular tests
- Project

Summative assessment:

Integrated assessment, focusing on the achievement of the exit-level outcomes, will be done by means of a written examination (of at least 2 - 3 hours) at the end of every module (per module).

Project: Learners need to complete a dissertation and submit at the end of the qualification.

Pass requirements:

A learner passes a module if he/she obtains a final mark of 50% or more in the module. The final mark is constituted of the formative assessments (50%) and the summative assessment (50%). A learner qualifies for the MSc in Computer Vision on NCQF level 9 when he/she passed all required modules individually. The final mark for the qualification is calculated by averaging the marks obtained in the various modules. The student should complete 240 credits to complete the qualification.

MODERATION ARRANGEMENTS

Pre-assessment Moderation:

This moderation is carried before assessment tasks are given to students. All submitted sets of question papers &marking keys are shared with the moderators. Each assessment pack should be moderated by two Moderators where possible. The question paper moderation report should be filled in for each question paper. Moderator report will be shared with question paper setter so that moderator feedback will be taken into account when finalizing the question paper.

Post-assessment moderation or moderation of marking:

Moderation of completed assessment tasks is categorized as post-assessment moderation. It is carried out after assessment tasks have been marked. The set of answer scripts and marking keys are shared with the moderators. At least 10% of the answer scripts in a module should be moderated during post assessment moderation. The moderators and assessors are well trained and have registered with BQA. The internal and external moderation will be done in-line with the Moderation policy of the Institution.

RECOGNITION OF PRIOR LEARNING

Candidates may apply the recognition of prior learning whether such learning has been gained through formal study, through workplace learning, or through any other formal or informal means, any candidate applying for recognition of Prior learning (RPL) or credit Accumulation and Transfer (CAT) will be expected to provide evidence of such learning that much be relevant, sufficient, valid, verifiable and authentic. Provision of RPL for award of the qualification will be in line with the National RPL policy.

CREDIT ACCUMULATION AND TRANSFER

A clear framework through which students can accumulate learning credits and transfer such credits toward appropriate qualifications helps to validate and recognize learning gained through formal and informal means, provides flexibility to students, and allows students to progress relatively seamlessly through their lifelong learning journey. Credit transfer Will be applied in line with National Credit Accumulation and Transfer (CAT) Policy.

PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)

Learning Pathway:

Vertical:

A Master of Science in Computer Vision graduate can continue to pursue a Doctoral degree in Computer Vision or Image processing.

Horizontal:

A Master of Science in Computer Vision graduate can do the following qualifications:

- MSc in Robotics
- MSc in Machine Learning
- MSc in Computer Science
- MSc in Computer Graphics and Imaging

Employment Pathway:

The Master of Science in Computer Vision is targeted at those wishing to become.

- Computer Vision Firmware Specialist
- Machine Vision Specialist
- Machine Learning Specialist
- Robotics Specialist

- Diagnostic Computer Vision Leader.
- Camera Firmware Specialist - Post Processing.
- GPU Image Processing Framework Software Specialist.
- Image Processing Algorithm Developer.
- Algorithms Specialist - AI/ML & Image Processing.
- Data Analysts & Scientists.
- Big Data specialist.
- New technology specialist.
- Robotics and Innovation Professionals

A graduate with a master's qualification can contribute strategically to academic and research industry development and thus become empowered and self-reliant.

QUALIFICATION AWARD AND CERTIFICATION

The learner will be awarded '**Master of Science in Computer Vision'** after attaining 240 credit value as specified in the rules of combination and credit distribution.

- To successfully complete the qualification the learner must complete all the 240 credits and should have successfully defended the proposal and final dissertation (Viva Voce).
- The credit combination for this qualification is 200 credits from core components and 40 credits from elective components

This qualification does not have exit awards. Therefore, if the candidate does not meet the prescribed minimum standards of the qualification, the leaner will exit with a transcript.

REGIONAL AND INTERNATIONAL COMPARABILITY

This Qualification was compared with various universities running similar qualifications. The following universities and their qualifications were taken for the comparisons:

Local: This qualification is not offered locally.

Regional: This qualification is not offered regionally.

International:

- MSc Image Processing and Computer Vision – University of Bordeaux. France.
- MSc in networks and Image Innovation and Engineering – University Paris 13
- MSc in Computer Vision – Carnegie Mellon University, The Robotics Institute Pittsburgh, USA)

M.Sc Image Processing and Computer Vision – University of Bordeaux. France.

Similarities:

The University of Bordeaux and this qualification has similar modules as core and optional, such as Advanced Image Processing, Project Management, and Biometrics. The project module is critical in all project activities; thus, it is provided as core module to help managers to handle project work effectively.

Differences:

The credit system for University of Bordeaux differs from this qualification. This qualification has optional modules carries 20 credits plus dissertation being at 60 credits. The assessments' process of University of Bordeaux is not discussed in detail whereas this qualification has assessment in the form of conducting in-core Assessment and written exam. The University of Bordeaux offers more programming and theory-based module, but this qualification gives more on practical with research-based modules.

Master's in networks and Image Innovation and Engineering– University Paris 13.

Similarities:

The University Paris 13 offers their qualification in 4 semesters, which include modules as Digital Image Processing, network security, Computer graphics and virtual reality and Advanced image processing which is similar to this qualification. Both qualifications consider dissertation as core module, where all students must partake to complete their master qualification. Assessment is by coursework, including written assignments and examination. Applicants must have done an undergraduate degree only in a related field. Students are required to do research methodology module before they undertake their research project. This qualification and University Paris 13 have dissertation as common which is offered in semester 4.

Differences:

The University Paris 13 offers the core curriculum, with 60 ECTS credits of optional classes and is divided into 2 semesters of 30 ECTS credits each, they organized in a "core curriculum-track specialization-internship" sequence 1st semester: core curriculum (24 ECTS credits) then optional classes (4) ECTS credits) then track specialization classes (6 ECTS credits) and in 2nd semester: 4 to 6 months internship where as in this qualification optional modules carries 20 credits plus dissertation being at 60 credits.

MS Computer Vision – Carnegie Mellon University, The Robotics Institute Pittsburgh, USA)

Similarities:

Though with Carnegie Mellon University some module like this qualification has given as optional i.e) elective, and not core, show the significance for one to learn of these to be able to manage their environments. Computer Vision Essentials and Visual Learning and Recognition are the modules that suits to this qualification.

Differences:

The credit system for Carnegie Mellon University is unlike this qualification credit system, where the dissertation work assigned consists of 24 units and other modules as 12 units. This qualification has a dissertation in semester 4 while in Carnegie Mellon University there is no dissertation, it has only seminar and elective courses / modules. The credit system is also processed in terms of units, in total the student has to acquire 144 units to complete the course, but in this qualification the student has to attain 240 credits.

This qualification concentrates on computer vision and its applications while robotics course compliments the Carnegie Mellon University. The Carnegie Mellon University is geared towards more robotics course with less exposure to Image while this qualification provides more modules for technical expertise. The proposed qualification is geared towards real life challenges found in the IT field as well as designed towards meeting the new technology trends.

REVIEW PERIOD

5 Years