SECTION A:	***QUALIFICATION DETAILS***																	
QUALIFICATION DEVELOPER (S)	University of Botswana																	
TITLE	Master of Medicine in Radiology															***NCQF LEVEL***		09
STRANDS (where applicable)	*Not applicable* *1.* *2.* *3.* *4.*																	
FIELD	Health Sciences and Social Services			***SUB-FIELD***			Health Sciences									***CREDIT VALUE***		652
New Qualification						√	*Legacy 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

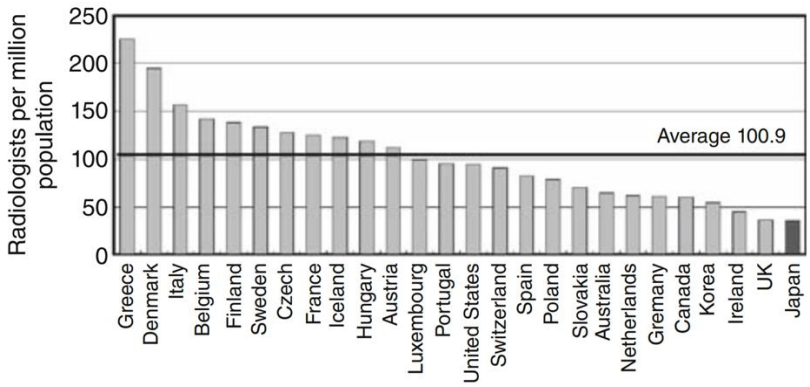
RATIONALE:

The Masters of Medicine (MMed) Radiology qualification is to meet the growing health needs of Botswana. The MMed Radiology qualification is directly in-line with the national development agenda in Botswana. In the Ministry of Health (MoH) Integrated Health Service Plan of 2010-2020, it is stated that "A shortage of trained and qualified staff remains one of the major bottlenecks towards availability of quality healthcare in Botswana". In this Service Plan, radiologists are among the specialists required in Botswana for the new service delivery model. Radiologists

contribute to the Essential Health Service Package, especially in the diagnosis and monitoring of communicable diseases such as tuberculosis, respiratory infections and complications of HIV, and non-communicable diseases and conditions such as trauma, complications of hypertension and cardiovascular diseases, cancers, respiratory diseases, and chronic obstructive pulmonary diseases. Radiologists are also listed as special medical practitioners required to support the health of Batswana in the near future (from 2020 to 2028), according to the Priority Skills and Employment Trends published by the Human Resource Development Council of Botswana.

There is a critical shortage of radiologists in Botswana. There are currently approximately 14 radiologists working in Botswana or 5.9 radiologists/million population (14 radiologists/2,389,888 population of Botswana). None of these are Batswana. Even in the private medical system, hospitals are struggling to recruit and maintain radiologic expertise. As a comparison, the UK has the lowest number of radiologists among high-income countries at 40 radiologists/million population (See Table below). But even with this ratio of radiologists per million population, a new UK workforce report shows that this level of staffing represents a severe shortage of radiologists and poses a serious threat to the UK National Health Service, with patients facing long, anxious and inevitable waits for diagnoses and surgery (Royal College of Radiologists census report 28 April, 2021).

Radiologist per Million Population in High Income Countries



*****Source: Nakjima Y, Yamada K, Imamura K, Kodayashi K. Radiat Med (2008) 26:455–465

Likewise, the shortage of radiologists in Botswana has a severe impact on healthcare in the country. In the public sector, only a few percent of X-ray exams are interpreted by a radiologist (personal communication, Mrs Masego Tabengwa, former Chief Radiographer, Princess Marina Hospital). In Princess Marina Hospital (PMH), this is currently resulting in the delayed diagnosis and misdiagnosis of diseases (personal observation, Wallace Miller, Head of Department, Radiology at UB). There is currently a 3-6 month waiting period to acquire a non-urgent computed tomography (CT) examination and, in some cases, these studies are never interpreted by a radiologist (e.g. some studies performed in Mahalapye and Maun). When radiological services are not available in the public

sector, patients are often referred to the private hospitals, at the expense of the government. In addition, until recently, there has been no provision for interventional radiology (IR) services in-country and currently there is only one practicing IR subspecialist at Sidilega Hospital. There is also very limited Nuclear Medicine offered in some private hospitals (e.g. Bokamoso Hospital has thyroid scans and nuclear renograms).

A clinical history and physical provide only limited capacity to diagnose underlying diseases. In modern health care, most disease diagnosis is accomplished through a combination of clinical history, physical exam, laboratory evaluations and **imaging studies.** Imaging studies expand the range of diagnostic possibilities. Medical imaging and interpretation are essential for a precise evaluation of major trauma, the detection, diagnosis and monitoring of cancer, the diagnosis and evaluation of cardiovascular diseases, of deep tissue infections (including tuberculosis), of surgical complications, of autoimmune diseases and of a gamut of chronic degenerative diseases of nearly all the organs of the body. To expand beyond the basic care currently delivered in Botswana, medical imaging and interpretation are essential for the diagnosis and monitoring of many clinical conditions that can be treated to avoid progression of disease, and thereby improve morbidity and mortality of Batswana. During the height of the COVID pandemic in Botswana, patients were cared for in Sir Ketumile Masire Teaching Hospital (SKMTH), a hospital that is only just opening for the treatment of non-Covid disease, but that has sophisticated imaging equipment. The UB Head of Radiology identified the following undiagnosed, pulmonary diseases by thoracic CT in patients who were being evaluated for COVID pneumonia: tracheobronchomegaly, connective tissue disease related interstitial lung disease, widespread bronchiectasis and sarcoidosis. These are examples of undiagnosed diseases that were only brought to light because of the COVID crisis and the use of imaging examinations and expert radiologic interpretation in a hospital that is not yet in general use.

It seems reasonable that Botswana should strive eventually to approach the current ratio of radiologists to population as in the UK. Even though this ratio appears to be inadequate for a high-level income country, it could be acceptable for a middle-income country that is expanding their health care services. This would mean approximately 100 radiologists in total are required to provide adequate healthcare in Botswana once the health care system is fully mature. If Botswana were to train 3 radiology residents per year, it would take 30 years to train this number of radiologists, so it is imperative to begin training as soon as possible.

The WHO has shown that to retain specialty expertise, that expertise must be trained in close proximity to the area of need. Therefore, establishment of a training program in Botswana is necessary to retain Radiologist expertise in country. To meet the national goals and improve access to care, there is a need to train and retain highly qualified specialists in Radiology to staff the public hospitals in the country.

PURPOSE: (itemise exit level outcomes)

The MMed in Radiology aims to produce graduates who will provide a high standard of diagnostic services in the country and beyond, while at the same time creating the next generation of medical educators in Radiology. The purpose of the qualification aims to produce graduates with highly specialised knowledge, skills, and competencies to:

- Interpret and communicate radiological findings
- Perform and manage the service of radiology
- Conduct clinical research and audits in radiology practice
- Provide care within a multi-disciplinary team with other providers in the healthcare system
- Work and teach in care teams, including medical students, radiographers and radiologists in training, and engage in lifelong learning.

The MMed Radiology qualification will train specialists who can participate in the improvement of the health systems globally.

MINIMUM ENTRY REQUIREMENTS (including access and inclusion)

The minimum entry requirements to MMed Radiology shall be:

- Applicants must hold a Bachelor degree in Medicine (MBBS or equivalent) from a recognized University (NCQF level 8) and have completed a recognized supervised one-year internship programme and at least one year of clinical practice after internship.
- They must also be registered or registrable with the Botswana Health Professions Council (BHPC).
- Passage of Part I of the Fellowship of the College of Diagnostic Radiologists South Africa Boards or equivalent is strongly preferred.

Recognition of prior learning (RPL) will be allowed for entry into the qualification as per the institution's policies in-line with National RPL policy.

SECTION B	***QUALIFICATION SPECIFICATION***
GRADUATE PROFILE (LEARNING OUTCOMES)	***ASSESSMENT CRITERIA***
1.0 Interpret and communicate radiological findings	1.1 Detect disease using all forms of imaging 1.2 Accurately report findings (orally/written) 1.3 Identify a reasonable working diagnosis or differential diagnosis
2.0 Perform the service of radiology	2.1 Decide on appropriate radiologic investigations 2.2 Perform radiologic procedures competently and safely 2.3 Recognise risks and complications of radiologic investigations and procedures and take appropriate action 2.4 Care for patients, including educate and counsel them on the risks and benefits of radiologic procedures 2.5 Practice radiologic protection and equipment safety methods 2.7 Maintain adequate radiologic records 2.7 Effectively communicate with health care professionals (orally/written) 2.8 Guide patient care with respect and dignity at all times
3.0 Manage a Clinical Imaging Service	3.1 Identify key elements of a clinical imaging service 3.2 Manage the resources to sustain a clinical imaging service 3.3 Manage radiology-specific inventory 3.4 Determine type of radiologic equipment required and manage them through their life cycle 3.5 Determine and implement performance measures that contribute to the efficient, effective, and economic use of resources 3.6 Acquire a general competency in service delivery management
4.0 Acquire and critically evaluate new medical/radiological Information	4.1 Utilise electronic and traditional information 4.2 Engage in continued professional development

	4.3 Critically appraise the quality, relevance and utility of new information 4.4 Appropriately apply new information in interpretation of imaging exams
5.0 Engage in research and personal professional development	5.1 Produce a fully evaluated dissertation 5.2 Manage and produce a Critical Performance Portfolio 5.3 Engage in personal and career development (leadership development and relevant learning opportunities)
6.0 Advise on health promotion and disease prevention	6.1 Educate and advise patients on health promotion and disease prevention 6.2 Implement health promotion/disease prevention strategies as related to medical imaging 6.3 Tender advice about appropriateness of imaging studies, especially radiologic screening and the hazards of under-, mal-, over- use of imaging evaluations
7.0 Play an active role in training other health care professionals	7.1 Participate in academic teaching activities 7.2 Participate in academic meetings 7.3 Provide relevant in-service training to radiation and related practitioners. 7.4 Provide advice to health practitioners on appropriate imaging methods to maximise the potential for accurate diagnosis
8.0 Function as an effective team member with other health workers	8.1 Treat all health care workers with respect 8.2 Recognize the roles of other health care workers and consult appropriately 8.3 Provide leadership when called upon to do so or when the situation demands it

SECTION C	***QUALIFICATION STRUCTURE***				
COMPONENT	***TITLE***	***Credits Per Relevant NCQF Level***			***Total Credits***
		Level [9]	***Level [ ]***	***Level [ ]***	
FUNDAMENTAL COMPONENT *Subjects/ Courses/ Modules/Units*	Communication, Ethics and Professionalism	***4***			***4***
	Introduction to the Medical Literature	***4***			***4***
	Principles and Techniques of Medical Education	***4***			***4***
	Introduction to Clinical Research	***4***			***4***
	Public Health Principles and International Health	***4***			***4***
	Introduction to Healthcare Management	***4***			***4***
CORE COMPONENT *Subjects/Courses/ Modules/Units*	Introduction to Radiology I	***68***			***68***
	Introduction to Radiology II	***68***			***68***
	Intermediate Radiology I	***68***			***68***
	Intermediate Radiology II	***68***			***68***
	Advanced -Intermediate Radiology I	***68***			***68***
	Advanced-Intermediate Radiology II	***68***			***68***

	Advanced Radiology I	***68***			***68***
	Advanced Radiology II	***80***			***80***
	Dissertation I	***12***			***12***
	Dissertation II	***12***			***12***
	Dissertation III	***12***			***12***
	Dissertation IV	***12***			***12***
	Presentation of Dissertation I	***12***			***12***
	Presentation of Dissertation II	***12***			***12***

STRANDS/ SPECIALIZATION	*Subjects/ Courses/ Modules/Units*	***Credits Per Relevant NCQF Level***			***Total Credits***
		Level [ ]	***Level [ ]***	***Level [ ]***	
Not applicable					
1.					
2.					

SUMMARY OF CREDIT DISTRIBUTION FOR EACH COMPONENT PER NCQF LEVEL	
TOTAL CREDITS PER NCQF LEVEL	
NCQF Level	***Credit Value***
9	***652***
TOTAL CREDITS	***652***

Rules of Combination:

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

All the above courses must be passed, and an original research thesis submitted to obtain the MMed Radiology qualification. Fundamental (Level 9) courses = 24 credits and Core (Level 9) course = 628 credits for a total of 652 credits.

ASSESSMENT ARRANGEMENTS
Assessment will be comprised of 40% formative assessment (assessment of performance and competencies and logbook) and 60% summative assessment (examinations and final dissertation).
MODERATION ARRANGEMENTS
There will be internal and external moderation as a quality assurance measure, in line with the institution's policy. Internal moderation will be performed by the institution's radiology faculty. The final fourth year examination will be moderated by appropriately qualified and experienced internal and external moderators. Internal moderators must be registered as a specialist in Radiology by the BHPC and accredited by the BQA. External moderators must be registrable with the BHPC.
RECOGNITION OF PRIOR LEARNING
Recognition of Prior Learning (RPL) will be applicable for consideration for award in this qualification and will be in line with institutional and National policies.
CREDIT ACCUMULATION AND TRANSFER
Credit accumulation and transfer will be applicable for award of this qualification on a case-by-case assessment and be in line with institutional and National policies.
PROGRESSION PATHWAYS (LEARNING AND EMPLOYMENT)
Horizontal Pathways Graduates may choose to pursue sub-specialty fellowship training in the following: • Postgraduate Diploma in Interventional Radiology • Master of Science in Interventional Radiology • Master of Philosophy in Interventional Radiology • Postgraduate Diploma in Paediatric Radiology **Vertical Pathways** Graduates may seek doctoral training including: Doctor of Philosophy in Diagnostic Radiology

Doctor of Medicine in Diagnostic Radiology

Doctor of Medicine in Health Sciences: Medical Imaging and Radiation Sciences

Employment Pathways

Graduates who have completed their training can register with the BHPC or equivalent health authority (dependent on regulations) to practice independently as a Radiology Specialist and are able to practise according to regional and international standards. Employment possibilities following registration may include:

- Specialist Radiologist in public or private practice
- Lecturer, Senior Lecturer, Assistant Programme Director, Associate Professor or Professor in a Faculty of Medicine
- Medical Specialist, Consultant or Superintendent in a hospital/health clinic
- Medical Board Member or Registrar
- Medical Insurance Health Risk Manager or Principal Officer
- Medical Director in a drug or medical device company.

QUALIFICATION AWARD AND CERTIFICATION

Candidates have to earn a minimum of 652 credits and satisfy all rules of combinations to be awarded Master of Medicine in Radiology. MMed Radiology certification will be granted according to the institution's certification policies.

SUMMARY OF REGIONAL AND INTERNATIONAL COMPARABILITY

There are no formal international benchmarks or standards for an MMed in radiology. This MMed in Radiology programme has been designed to meet the standards of the College of Radiologists (COR) of the Colleges of Medicine of South Africa (CMSA) and is also comparable to other international standards for content and duration of training of an MMed in Radiology. The programme is designed to be four years in duration. This is within the range of programme duration in South Africa, East Africa, the USA and Europe, which are three to five years full-time training in length. Four years is sufficient time for all competencies to be learned but also keep training costs to a minimum. Training in this programme with be by imaging modality (e.g. plain films, CT etc). The curriculum content can be taught either by modality (as in the University of Cape Town and Stellenbosch) or by body system (as in Pretoria and University of Pennsylvania) but the net result after four years of apprenticeship is the same, with similar material covered by either method. Programmes vary slightly in the amount of time spent on some modalities (e.g. more ultrasound and less nuclear medicine is taught in this MMed programme compared to Stellenbosch), but the length of time spent in each modality has been targeted in this programme to the needs of radiologists practicing in Botswana after training. For example, ultrasound is used very frequently in Botswana and nuclear medicine is currently not or little offered in the

country and will likely be performed by nuclear medicine specialists in the future. Nevertheless, all modalities are sufficiently covered in this programme to pass the exit examination of the COR of the CMSA. The learning outcomes and expected exit competencies are directly in line with the standards of South Africa and similar to other high quality international Radiology programmes. The programme has been reviewed and provisionally approved by an Evaluation Subcommittee of the COR of the CMSA. Full accreditation by the CMSA can be applied for after the programme has been running for two years.

REVIEW PERIOD

The program will be reviewed 5 years after initiation according to the institution's programme review policy and NCQF policy.