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An initial SWOT study of the Medical Physics profession in Malta: The Perspective of Medical Physicists

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To Abel Makkonen Tesfaye

For fuelling my motivation with his sonically versatile studio albums

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An initial SWOT study of the Medical Physics profession in Malta: The Perspective of Medical Physicists

Abstract

Background: In Malta, medical physics is a relatively new profession and thus far, there has not yet been a systematic situational analysis to determine how the profession is currently progressing. A SWOT study of the medical physics profession in Malta was therefore deemed necessary such that a strategic plan may be developed.
Objectives: (a) To develop a vision statement for the profession in Malta. (b) To analyse the current state of the profession in Malta by establishing internal strengths and weaknesses of the profession, and external opportunities and threats with respect to the desired vision statement as perceived by the medical physicists themselves. (c) To develop an initial set of strategic objectives for the medical physics profession in Malta.
Research Methodology: A mixed-method research approach was used in this study, the philosophical perspective was pragmatic, the research strategies were a qualitative survey of relevant documents for the vision statement and a mostly quantitative survey of the opinions of Maltese medical physicists to identify the SWOT themes. The data collection techniques were document analysis for the vision statement and a semi-structured online anonymous questionnaire for the SWOT themes, the data collection tool for the SWOT was a specially designed thematic template, the data analysis technique was SWOT analysis with the use of Microsoft Excel for numerical data.
Results: A vision statement was proposed and the SWOTs of the medical physics profession in Malta as perceived by the local medical physicists with respect to the vision statement were identified.
Conclusions and Recommendations: The medical physics profession in Malta has many strengths and opportunities. However, there are also some weaknesses and threats. Strategic objectives for the profession were proposed. It is suggested that further research be conducted to clarify the SWOTs further by including in-depth interviews with both medical physicists and other stakeholders.

Keywords: Medical physics profession, medical physicists, SWOT analysis, vision statement.

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List of Definitions

competence means having the capacity to effectively use information and/or methodological skill sets in work or study contexts and for the advancement of one's career and self. The European Qualifications Framework (EQF) defines competence with reference to autonomy and responsibility (EQF, 2008).

laser safety expert means a person, also known as Laser Safety Adviser in some countries, who is certified to provide advice with regards to the safe utilisation of lasers as per Directive 2006/25/EC of the European Parliament and of the Council of 5 April 2006 on the minimum health and safety requirements regarding the exposure of workers to risks arising from physical agents (artificial optical radiation) (19th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC) (OJ L 114, 27.4.2006, p. 38) (2006/25/EC, 2006).

magnetic resonance safety expert means a person that is capable to offer expert guidance on the engineering, analytical, and managerial elements of the secure clinical utilisation of magnetic resonance devices (Hand et al., 2012).

medical physics expert means an individual or, if provided for in national legislation, a group of individuals, having the knowledge, training, and experience to act or give advice on matters relating to radiation physics applied to medical exposure, whose competence in this respect is recognised by the competent authority (2013/59/EURATOM, 2013).

physical agents means a group of sources of energy. Examples of physical agents include noise, vibration, electromagnetic radiation, electricity, and extremes of temperature (OSHwiki, 2022).

radiation protection expert means an individual or, if provided for in the national legislation, a group of individuals having the knowledge, training and experience needed to give radiation protection advice in order to ensure the effective protection of individuals, and whose competence in this respect is recognised by the competent authority (2013/59/EURATOM, 2013).

SWOT analysis means a framework that determines the internal strengths and external opportunities a profession may use to achieve its goals, as well as seeking to reduce any internal weaknesses and protect against external threats (Lewis and Littler, 1997).

List of Acronyms

AI Artifical Intelligence.

CPCM Council of Professions Complementary to Medicine.

CQMP Clinically Qualified Medical Physicist.

D&IR Diagnostic and Interventional Radiology.

DRL Diagnostic Reference Level.

EFOMP European Federation of Organisations for Medical Physics.

ENEN+ European Nuclear Education Network.

EQF European Qualifications Framework.

ESMPE European School for Medical Physics Experts.

EUTEMPE European Network for Training and Education of Medical Physics Experts.

fMRI Functional Magnetic Resonance Imaging.

FREC Faculty Research Ethics Committee.

GDP Gross Domestic Product.

IAEA International Atomic Energy Agency.

ICT Information and Communication Technology.

IPEM Institute of Physics and Engineering in Medicine.

ISCO International Standard Classification of Occupations.

LINAC Linear Particle Accelerator.

LN Legal Notice.

LSE Laser Safety Expert.

MAMP Malta Association of Medical Physics.

MP Medical Physics. Medical Physicist. .

MPE Medical Physics Expert.

MPP Medical Physics Professional (i.e., Medical Physicists and Medical Physics Experts).

MR Magnetic Resonance.

MRI Magnetic Resonance Imaging.

MRSE Magnetic Resonance Safety Expert.

MRSO Magnetic Resonance Safety Officer.

NM Nuclear Medicine.

PEST Political, Economic, Social-Psychological, Technological, and Scientific.

PET Positron Emission Tomography.

QA Quality Assurance.

QC Quality Control.

RO Radiation Oncology.

RP Radiation Protection.

RPC Commission for the Protection against Ionising and Non-Ionising Radiation.

RPE Radiation Protection Expert.

RT Radiotherapy.

SL Subsidiary Legislation.

SMP Specialist Medical Physicist.

SWOT Strengths, Weaknesses, Opportunities, Threats.

TB Tuberculosis.

UREC University Research Ethics Committee.

US Ultrasound.

Chapter 1

Introduction to the study

1.1 Introduction

This chapter outlines the problem statement of this study and why it was chosen. The background and context of the problem are discussed along with the objectives, scope, and the research design. This is followed by a brief discussion of the ethical considerations and relevance of the study. The chapter ends with an overview of the dissertation.

1.2 Problem Statement

As the Medical Physics (MP) profession in Malta is still in its initial stages, there has not yet been a systematic situational analysis to determine how the profession is currently progressing. A Strengths, Weaknesses, Opportunities, Threats (SWOT) study of the MP profession in Malta is therefore crucial in order to increase strengths, take advantage of opportunities, overcome current weaknesses, and counter threats, such that a strategy plan for the profession in Malta may be developed.

1.3 Background and Context

In Malta, MP is a relatively new profession. Discussions on the profession's development and recognition began in 2007 with a partnership between a professor at the University of Malta and the three existing clinical Medical Physicists (MPs). At the time, clinical MPs were employed by the Ministry for Health under the title of 'scientific officers' because the profession was relatively unknown and was not legally recognised. Additional MP trainees were employed in 2012, when the Ministry of Health acknowledged the relevance of the profession. A grant from the European Social Fund was won due to a strong partnership between the Ministry of Health and the University of Malta's MP Department (Caruana and Grech, 2016). According to the Council of Professions Complementary to Medicine (CPCM) (2014), MP was classified as a regulated profession under the said council by a legal notice issued by the Maltese government in 2014. The national Commission for the Protection against Ionising and Non-Ionising Radiation (RPC) (2021) recognises and certifies Medical Physics Experts (MPEs) in Malta. Malta currently has a total of 20 clinically qualified MPs who at present work within the specialties of Radiation Oncology (RO), Diagnostic and Interventional Radiology (D&IR), and Nuclear Medicine (NM) (Caruana and Grech, 2016, CPCM, 2014). The Malta Association of Medical Physics (MAMP) holds meetings and seminars as part of its national activities, with members presenting clinical issues, research studies and accomplishments (MAMP, 2019). MAMP encourages members to participate in the activities of the Association and the European Federation of Organisations for Medical Physics (EFOMP). Legal Notice (LN) 397 of (2012) and LN 288 of (2019) established the M.Sc. in Medical Physics and B.Sc.(Hons) in Physics, Medical Physics and Radiation Protection respectively in Malta. The latter was set up to ensure a steady number of applicants to the Masters and hence new entrants to the profession (given the low number of physics and engineering graduates) and that Masters graduates are well prepared for entry to their MP traineeship since a one year M.Sc. in Medical Physics was simply not enough to acquire the necessary knowledge and skills given the rapid expansion of medical device technology and use of physical agents in medicine.

1.4 Objectives of the Study

The objectives of the study were the following:

a) To develop a vision statement for the MP profession in Malta.

b) To analyse the current state of the profession by establishing internal strengths and weaknesses of the profession, and external opportunities and threats with respect to the desired vision statement and as perceived by the MPs themselves.

c) To develop an initial set of strategic objectives for the MP profession in Malta.

1.5 Scope of the Study

The study was delimited to the perspective of the local registered clinical Medical Physics Professional (i.e., Medical Physicists and Medical Physics Experts) (MPP).

1.6 Research Design

The research design provides a methodological framework for the conduct of the research study and for data collection and analysis whilst also providing a conceptual framework to interpret and acknowledge the research (Clark et al., 2021). A research design consists of a research approach (quantitative, qualitative or mixed), philosophical perspective, and research methodology (research strategy, data collection technique, data collection tool and analysis).

a) Research Approach: A mixed-method research approach was adopted for this study. Qualitative document analysis was used to develop the vision statement whilst a mostly quantitative survey was used to discover SWOT issues as seen from the perspective of the clinical MPs.

b) Philosophical Perspective: A pragmatic philosophical perspective was utilised since a real-life setting is being studied (Dou, 2021).

c) Research Methodology: The methodologies for each objective are given below:

    i) Objective 1: An initial vision statement was developed via a document analysis of EFOMP policy statements and international literature with regard to the MP profession.

    ii) Objective 2: An online semi-structured anonymous questionnaire was used to collect SWOT themes from the perspective of the local MPs.

    iii) Objective 3: The SWOT analysis results were used to create an initial list of strategic objectives via standard SWOT strategic planning techniques.

1.7 Ethical Considerations

An information letter, consent form and link to an anonymous online semi-structured questionnaire was delivered to all local clinical MPPs via the Secretary of the MAMP acting as intermediary to the research study. Participation in the study was entirely voluntary and the participants were advised that filling in and submitting the questionnaire implied consent. Furthermore, the participants were also advised that the data collected could not be traced back to them. In fact, they were informed that, the researcher, would not be able to identify from whom the information came from nor whether any particular MP participated in the study or otherwise. This study has been approved by the University Research Ethics Committee (UREC) of the University of Malta.

1.8 Relevance of the Study

The relevance of the study for the various stakeholders is as follows:

For patients: A committed team of MPPs who understand the vision of how the profession can evolve guarantees that the profession's members have the capacity to grow and develop, and hence provide patients with effective, secure, and efficient services.

For the MP profession and professional practice: The MPPs involved would be able to acquire a future vision for the profession and a research-based list of strategic objectives to attain the vision and hence enhance the state of the profession in Malta.

1.9 Conclusion

This chapter presented an introduction to the study. Chapter two provides a critical review of the literature. Chapter three describes the research methodology whilst chapter four presents the results together with their analysis and discussion. Chapter five summarises the main conclusions of the study, proposes recommendations arising from the study and suggests directions for future research.

Chapter 2

Literature Review

2.1 Introduction

This chapter presents a review of the literature about the MP profession focusing in particular on relevant EU directives and guidelines, documents of international and European organisations such as the International Atomic Energy Agency (IAEA), and EFOMP, and also Maltese legislation. In addition, this chapter presents a critical review of the literature regarding strategic planning and the utilisation of the SWOT methodology in healthcare.

2.2 Medical Physics in Healthcare

The history of MP may be attributed to have started with Sanctorius, who made use of a measuring technique in physics, which was weighing, and applied it to medicine as a method of health monitoring in the early seventeenth century. The name 'Medical Physics' (or, more precisely, Physique médicale) was first used in 1778 by Félix Vicq d'Azir who was the general secretary of the Société Royale de Médecine. According to Vicq d'Azir medical training should include MP as well as other basic sciences. 'La Médecine eclairée par les sciences physiques' was a brief-lived newspaper that Comte de Fourcroy founded in 1791. He puts forth his own viewpoint in the preface to the first issue stating that the study of medicine always begins with the study of physics and without having studied physics, one cannot become a physician (Duck, 2014). The 1814 updated version of Nysten's medical lexicon eventually contained a definition of MP. This definition is noteworthy for being thorough and concise: "Physics applied to the knowledge of the human body, to its preservation and to the cure of its illnesses."

In 1824, the first physics textbook for medical students was published by Pelletan (Pelletan, 1824). Carlos Matteucci was a physics professor who published a book in 1844 with the aim of having an adequate combination of physics principles and its new medical applications (Matteucci, 1844). An addendum on medical physics for 'Müller-Pouillet's Lehrbuch der Physik' was published in 1850s by a physiologist Adolf Fick. Fick later on published 'Die medizinische Physik' in 1855. A book with the title 'A Text-Book of Medical Physics for the use of Students and Practitioners of Medicine' was published as the first MP book in English by John Christopher Draper (Draper, 1885).

After a century of sporadic advancements in therapeutic medical treatment, physics applied to medicine saw a significant relaunch during the last ten years of the nineteenth century. The discovery of radioactivity by Henri Becquerel in 1896, Röntgen's discovery of X-rays in 1895, and Marie Curie's subsequent discovery of radium are what gave rise to medical imaging and radiotherapy. The Nobel Prize winning Danish physician Niels Finsen was a pioneer in the use of infrared and ultraviolet light for medicinal purposes. He developed the "red room" method of treating smallpox lesions in 1893, and in 1895 he demonstrated that UV therapy could be used to cure the deforming type of Tuberculosis (TB) known as lupus vulgaris. Thus, phototherapy came into effect. The birth of Ultrasound (US) may be traced back to the discovery of piezoelectricity by Jacques and Pierre Curie in 1881 (Duck, 2010, 2014). Heinrich Hertz's discovery of radio waves in 1888 led to Arséne d'Arsonval, in 1895, to develop the first therapeutic high-frequency heat treatment device (Duck, 2014). MPs now contribute significantly to the majority of healthcare fields.

2.3 Employment Status and Specialties of Medical Physicists

MPs work in hospitals or as consultants to hospitals, the administrative sector, industry, or academia (Evans et al., 2016). Regardless of where the MP works, all MPs apply their physics expertise to the solution of problems in healthcare, and they do so in various but complementary contexts.

The academic and industrial sectors are home to the first category of MP. Teaching to MP students and other medical and healthcare professions and/or doing research that is directly or indirectly related to healthcare are the primary responsibilities of academic MPs. MPs carry out research in a wide range of fields connected to the use of physics in healthcare. This sort of work is far wider in scope than that of a hospital based MP and includes not just the use of medical devices but also the study of the effects of physical agents on human health, physiological modelling, computer applications in medicine, and the development of novel imaging tools and technologies (Evans et al., 2016).

The primary responsibility of hospital based MP is to use their physics expertise to ensure the optimised, ethical, efficient, safe and scientific use of medical devices as well as development of new clinical services (Christofides et al., 2016). Regarding medical devices, several EU directives have been promulgated.

MPs employed in hospitals are frequently found in departments such as D&IR, RO, NM, and Radiation Protection (RP) that use equipment based on x-rays or radioactive sources and these are traditionally the four principal areas of specialty for MPs. Ionising radiations, in the healthcare industry, are commonly referred to as the photons or particles associated with having adequate energy to ionise molecules in the body if their energy is absorbed by tissues. MPs also offer services in bioengineering, medical electronics, Information and Communication Technology (ICT), physiological measurements, audiology, clinical applications of non-ionising radiation (e.g., lasers, ultraviolet light, and microwaves), and Magnetic Resonance (MR) and US imaging (Evans et al., 2016).

A person who is qualified to practise independently and is eligible to register as a healthcare professional with the title 'Medical Physicist' in one or more of the aforementioned specialties is referred to as a Clinically Qualified Medical Physicist (CQMP). A CQMP will then progress to become a Specialist Medical Physicist (SMP) by accumulating more advanced clinical experience and completing specialist training in their specialty area (Christofides et al., 2016). EU Directive 2013/59/EURATOM (2013) uses the title 'Medical Physics Expert' in lieu of 'Specialist Medical Physicist'.

2.4 Competences and Responsibilities of Medical Physics Professionals

The following subsection presents the competences and responsibilities of a MPP as specified by EU Directive 2013/59/EURATOM (2013), the 'European guidelines on MPE' project (EU Commission, 2014), European and international organisations such as EFOMP (EFOMP, 1984), (Hand et al., 2012), (Caruana et al., 2014), (Evans et al., 2016), (Christofides et al., 2016), (Caruana et al., 2018), (Busoni et al., 2021) and IAEA (IAEA, 2013), and Maltese Subsidiary Legislation (SL) (S.L.585.01, 2018).

2.4.1 Responsibilities of the Medical Physics Profession as specified by EU Directive 2013/59/Euratom

According to the EU Directive 2013/59/EURATOM (2013), to guarantee the proper safety of patients undergoing medical radiodiagnostic and radiotherapeutic treatments, a high level of competence and a clear description of roles and tasks among all specialists participating in medical exposure are essential. This is applicable to MPs and other equivalent experts involved in medical radiological procedures. In the case of MPEs this is provided in Article 57(1b) and Article 83(2) of the Directive as shown in Appendix A.

2.4.2 Competences of a Medical Physics Professional as specified by the 'European Guidelines on Medical Physics Expert' project (RP174)

The EU guidance on medical physics expert (EU Commission, 2014) is intended to improve the implementation of provisions related to the MPE in the Directive and to facilitate harmonisation of the role and education and training of MPs among the member states with the goal of enhancing cross-border mobility. The core competences for the key activities of an MPE as specified by EU guidelines on MPE project are the following:

a) Scientific problem solving service: Identifying instances of less than ideal performance while using radiological instruments and verifying that suggested adjustments have improved performance of the device.

b) Dosimetry Measurements (and other physical agents as appropriate): Evaluation, calibration, and upkeep of dosimetry-related instrumentation; independent verification of dose-related quantities supplied by devices (including software devices).

c) Patient Safety / Risk Management: Monitoring of radiological devices and analysis of clinical protocols involving dosage audit and assessment of incidents that include inadvertent medical exposures.

d) Occupational & Public Safety / Risk Management (when there is an impact on medical exposure or own safety): Balancing occupational risk and patient requirements in the correlation of medical and occupational exposures.

e) Clinical Medical Device Management: Offer technical assistance and partake in the specification, selection, acceptance testing, Quality Assurance (QA), commissioning, installation design, and decommissioning of medical radiological devices.

f) Clinical Involvement: Performing routine radiation protection and Quality Control (QC) measures for the benefit of the patient. Making use of phantoms to make the necessary testing and calibration on the modalities before the device may be used on patients.

g) Development of Service Quality and Cost-Effectiveness: Implementation of new MP services, and clinical protocols whilst providing appropriate consideration to financial concerns.

h) Expert Consultancy: Providing professional guidance to the general public in clinics that might not have MP knowledge.

i) Education of Healthcare Professionals (including MP trainees): A MPP should also be involved in the training of MP students and the clinical training programmes.

j) Health Technology Assessment: Assuming control over the physics portion of health technology evaluations pertaining to medical radiological equipment and applications of radioactive sources.

k) Innovation: Creating new or changing already existing equipment (including software) and using procedures to better handle clinical issues that have not yet been solved.

Appendix B presents a detailed list of competences that an MPE is expected to possess for each activity.

2.4.3 Responsibilities of the Medical Physics Profession as specified by the European Federation of Organisations for Medical Physics (EFOMP)

Maintaining a high level of service in the hospital is the clinical MPs primary duty (EFOMP, 1984). There are two distinct functions of an MPP according to the EFOMP. One function is the one that MPs can perform their clinical roles through their scientific expertise in the field of MP. A second function is that they exercise managerial roles at a high level when they serve as administrators for the MP service (Evans et al., 2016). In close collaboration with other healthcare professionals, MPs are in charge of the standardisation and calibration of medical equipment as well as the precision and safety of physical procedures used in clinical applications. The creation of new procedures, physical methods, and equipment is one of their other duties, along with research, clinical oversight of the use of medical devices, health technology assessment, and service development. They also have a duty to educate and teach future MPs as well as technical employees in the MP department. This obligation extends to physicians, nurses, medical technical assistants, and more. In their managerial role, often the head of the MP department, will be accountable to central administration and be in charge of financial control as well as general hospital and/or a local region organisation (Evans et al., 2016). Caruana et al. (2014) provides the updates necessary to describe the key activities of a MPP following the publication of (EU Commission, 2014). Caruana et al. (2018) elaborates on the role and competences of a MPP as per EU Directive 2013/59/EURATOM (2013) and by the European guidelines on the MPE project (EU Commission, 2014).

EU Directive 2013/59/EURATOM (2013) is concerned with the role of the MPE in ionising radiation only. EFOMP has always pushed for a defined role for MPPs also in non-ionising radiations. For example, the Magnetic Resonance Safety Officer (MRSO) and the Magnetic Resonance Safety Expert (MRSE) are two professionals that EFOMP advises for managing safety inside MR units (Hand et al., 2012). Occupational group 2111 of the International Standard Classification of Occupations (ISCO) describes MPs as the preferred profession for the position of magnetic resonance safety expert when it states that physicists have the duty of "ensuring the safe and effective delivery of radiation (ionising and non-ionising) to patients to achieve a diagnostic or therapeutic result as prescribed by a medical practitioner" (Hand et al., 2012, International Labour Organisation, 2012).

Specialised Magnetic Resonance Imaging (MRI) techniques have grown significantly over the past few years, including spectroscopy, diffusion and perfusion weighted imaging, Functional Magnetic Resonance Imaging (fMRI), and synthetic MRI. Many of these techniques are being combined with Artifical Intelligence (AI) which is becoming more prevalent in these fields. Moreover, there has been an emergence and development of novel MRI settings (Positron Emission Tomography (PET)/MRI, Linear Particle Accelerator (LINAC)/MRI, interventional MRI), as well as the approval for the clinical use of extremely high field MRI systems (7 T), with the associated new safety areas concern (Busoni et al., 2021).

EFOMP in its Malaga Declaration (2007) insists that the role of radiation protection of workers and the general public (today known as the radiation protection expert) should be always assigned to MPPs. The Malaga declaration is at present being updated to create an updated vision of the role of MPPs. This updated vision includes a role for MPPs in all medical devices and physical agents used in medicine and including patient, workers, and the general public (Caruana C.J., personal communication, August 7, 2022).

2.4.4 Responsibilities of the Medical Physics Profession as specified by the International Atomic Energy Agency (IAEA)

The duty of the CQMP in clinical practice is to collect and analyse clinical physics data for the diagnosis or treatment of diseases, as well as to optimise or guide other health care professionals to optimise the use of radiation to guarantee the quality and safety of therapeutic or diagnostic procedures (IAEA, 2013). According to IAEA (2013) the responsibilities for a MP are the following:

a) Calibration and verification of measurement instruments: Regular calibration of the instruments utilised.

b) Technical supervision of equipment operation and maintenance: Setting up acceptance and commissioning processes for therapeutic, and diagnostic equipment. Working closely with service engineers.

c) Records and documentation: Demonstrating adherence to the equipment and process guidelines.

d) Clinical computing and networking: Ensure systems are operational by testing network integration and data transmission.

e) Research and development: Assessing new technology and looking at the adoption of new practises while supporting the clinical staff's preparation for their use.

f) Education and training: Providing medical practitioners, nurses, MP trainees, and students, with lectures and training in MP.

IAEA issued the core tasks of a CQMP specific to the specialties of Radiotherapy (RT), D&IR, NM, and RP (IAEA, 2013). The IAEA does not distinguish between MP and MPE. A CQMP is equivalent to the MPE. It also does not distinguish between MPE and Radiation Protection Expert (RPE) in healthcare. For the IAEA, RP is part of the duties of the MP.

Appendices C and D present a detailed list of competences that a MPP is expected to possess for each corresponding specialty according to the IAEA.

2.4.5 Responsibilities of the Medical Physics profession as specified by Maltese legislation

The fundamental legislation for radiation protection in Malta the Basic Safety Standards for Ionising Radiation Regulations, 2018 are stipulated in LN 210 (L.N.210, 2018). This LN provides the general responsibilities of an MPE under regulation 107. As of 2020, LN 210 was amended by LN 184 (L.N.184, 2020) and the latest regulation is the SL 585.01 (S.L.585.01, 2018). It can be stated that there is a general agreement when comparing the duties of an MPE as stipulated in the Maltese legislation and in the EU Directive 2013/59/EURATOM (2013) Article 82. Regulation 107 of the SL can be found in Appendix E.

MPs in Malta specialise in one of three areas: RO, NM, and D&IR (Caruana and Grech, 2016). According to the Ministry for Health in Malta (Duties DIR, 2022), a MPE in D&IR shall provide guidance about medical radiological tools and make a contribution to the following:

a) Dosimetry: Using appropriate equipment to analyse the dosage to be given to the patients during treatment.

b) Radiation protection programme: Participating in the department such as contributing to equipment selection in the programme.

c) Safety Culture: Dedicated to question any negligence and improve own knowledge in terms of safety. To maintain ongoing efficiency and optimum usage of medical radiological devices, such as overseeing routine patients.

d) Diagnostic Reference Levels (DRLs) and Dose Audits: Assuming responsibility of the dosage distributed to an individual. Dose audits of various medical modalities are also to be carried out.

e) Optimisation: Optimising procedures prior to their use on patients by utilising phantoms and simulations first.

f) Quality Assurance Programme: Offer technical guidance and take part in specification, selection, and acceptance testing, commissioning, installation design and decommissioning of medical radiological devices.

g) Accidental or unintended medical exposures: The MPE is responsible for any incidents due to unintended medical exposures. The MPE must also report, where needed, any incidents to the local authorities responsible for such matters.

h) Education and training: The MPE must contribute to the education of MP students and the clinical training of MP trainees and other staff in relevant departments related to D&IR.

Similar documents describe the duties of a MPP within RO and NM.

2.5 The Medical Physics Profession in Malta – A Brief History

Insight to the development of the MP profession in Malta has already been provided in Chapter 1, Section 1.3. In addition, most Maltese CQMPs obtained their clinical training in the UK (Caruana et al., 2021). This has been advantageous for the profession because they were taught by some of the leading European MPs. The Maltese coordinator of the project insisted with the UK MPs that they utilise the IAEA training manuals (IAEA, 2009), (IAEA, 2010), (IAEA, 2011) in all three specialty areas: RO, D&IR, and NM. The MP profession in Malta is now developing its own training programme locally, which will again be in accordance with the IAEA standards (Caruana et al., 2021).

2.6 Importance of Vision Statements for a profession

Vision statements are important because they can assist any entity (e.g., profession, organisation, individual) to define long-term direction and objectives that must be achieved. According to (Bart, 2001), the vision statement describes the desired future state of the entity within the ambit of its mission statement. A vision statement should be able to contribute to the organisation's or profession's identity (Cardona and Rey, 2006). The social impact that a vision statement leaves to the various stakeholders should also be considered (Collis and Rukstad, 2008). These definitions can be reduced to three core elements that a vision statement should embody: a fundamental ideology, a vision for the future, and acknowledgement of service to stakeholders. A description and purpose of a profession's ideals is contained in the vision statement's fundamental ideology. The profession's envisioned future is a description of the services it can provide in the future and a specification of how the profession benefits its stakeholders, including patients, other healthcare professionals as well as community and society.

MPPs have historically been associated with ionising radiation based medical devices. The role of MPPs must evolve along with the medical device technologies and the utilisation of physical agents aside from ionising radiation. For instance, non-ionising radiation based imaging and therapeutic technologies need MPPs attention as well because they are already well-established. The MPP frequently receives requests for help in other fields such as sophisticated physiological monitoring, AI, and nanotechnology because the variety of medical radiological tools as well as physical agents employed in hospitals nowadays transcend the utilisation of both ionising and non-ionising radiation. EFOMPs competent committee is currently updating its vision, possibly as an update to the Malaga Declaration, for the MP profession in the direction of medical devices and physical agents (Caruana C.J., personal communication, August 7, 2022).

2.7 Importance of Strategic Planning for the development of the profession

In order to determine a profession's strategies, it is necessary to identify the needs of society, environmental factors, organisational capabilities, and any internal weaknesses of the profession and external threats. The strategy of any profession is a list of objectives to help it achieve its vision and the means to achieve those objectives. Lacking strategic planning, a profession may degrade due to constantly responding to external pressures (Lawlor, 2010). According to Perera and Peiró (2012) all kinds of professions, including those in healthcare, may be guided by strategic planning, which is a perfectly legitimate and practical technique. According to Caruana (2020) "strategic planning is a systematic process for developing and achieving a desired future vision."

It is strongly advised that the processes in creating a strategic plan be carried out in collaboration with the profession's members as this will guarantee that everyone is aware of what is occurring and why certain actions were taken in a particular way. Additionally, it provides a forum for the members of the profession to engage in the creation and execution of the vision. This would help prevent unpleasant emotions in the future, when the strategic plan is being implemented (Caruana, 2020). Perera and Peiró (2012) outlined five characteristics that when combined, suggest the need for strategic planning. These are:

a) Clientele who are more aware and demanding.

b) Increasing numbers of competent and professional rivals.

c) Limited organisational resources.

d) The client is given more attention than the service.

e) Size and intricacy of the organisation.

Further insight can be obtained in Appendix F.

Each of the above mentioned factors place a profession in a situation where their internal and external circumstances as well as those of their clients are always changing. It should be emphasised that there is no single strategic planning model for all professions. Each profession's distinct qualities must be considered whilst designing the formal strategic planning framework (Steiner, 2010).

2.8 Use of SWOT Analysis for the development of strategic plans

SWOT analysis is one of several methods that may be applied to the strategic planning process of an entity whether organisation or profession (Phadermrod et al., 2019). SWOT analysis' primary benefit is its simplicity, which has led to its continuous usage in different organisations and top businesses (Ghazinoory et al., 2011). The majority of strategy development frameworks being utilised are currently based on a SWOT technique model. Caruana (2020) outlined a list of processes for creating a strategic plan by utilising the SWOT methodology. This list can be accessed in Appendix G.

Caruana (2020) outlined all the aspects of SWOT which are summarised hereunder:

a) Strength (S): The profession's strengths are those attributes that will enable it to accomplish the vision. To prevent the strength from becoming a threat the profession needs to maintain the quality of its strengths. The core competences are very significant strengths that are seen as a strong advantage when compared to other competing professions.

b) Weakness (W): Weaknesses of the profession will hinder it from fulfilling the vision. The critical weaknesses are of great significance. Contrary to core competences, which guarantee a profession survives, critical weaknesses are a disadvantage that, if not addressed, can hinder it severly.

c) Opportunity (O): They are advantageous issues arising from the surrounding environment that may be used to accomplish the vision. The profession will be able to advance and expand if the key opportunities, that is those opportunities with the greatest benefit value, are identified.

d) Threat (T): These are the drawbacks from the surrounding environment that, if not addressed, would prevent the vision from being accomplished. Existential threats, are threats whose effects might entirely disrupt the vision of the profession. They must be quickly recognised and eradicated.

SWOT analysis offers a way to pinpoint the factors that obstruct or improve the achievement of the intended vision. Such issues must be identified before the strategic plan can be developed.

2.9 SWOT Analysis and its use in Healthcare

Incorporating a SWOT analysis in the health sector is unquestionably a useful tool for medical staff, and its applications range from improving patient care, increased effectiveness in equipment use, and higher standards in hospital administration. Given its many benefits, SWOT analysis has a bright future in healthcare (Turankar et al., 2014). SWOT analysis is also very beneficial in healthcare as it assures that there are imperative advancements in the medical field (Gandolf, 2021).

SWOT analysis was employed by Caruana et al. (2010) for producing a strategic plan for the role of biomedical physicists in Europe for the education of professionals in healthcare. A qualitative analysis of biomedical physics curricula offered to professionals in healthcare throughout Europe recognised the internal strengths and weaknesses. A review of the literature in the fields of healthcare professional education, and higher education led to the identification of external opportunities and threats, which were then categorised according to the traditional Political, Economic, Social-Psychological, Technological, and Scientific (PEST) categories.

Aslan et al. (2014) made use of the SWOT analysis to study Turkey's developing healthcare system. The authors address the demands of an expanding population, Turkey requires an increase in healthcare staff. To lessen the burden of hospitalisation on public hospitals, which are mostly focused on chronic illnesses, nursing homes can be utilised. To raise the proportion of healthcare spending in Turkey's Gross Domestic Product (GDP), a more open and unbiased performance management system emphasising patient and employee satisfaction must be created.

Terzic-Supic et al. (2015) employed SWOT analysis such that a list strategic objectives could be obtained for the utilisation of hospital management. The authors believed that programs for formal and informal training are increasingly in demand, particularly for healthcare staff in executive roles. This was described as a necessity for hospitals in an environment that is very competitive.

Von Kodolitsch et al. (2015) used SWOT to develop specific medicinal plans for individuals with aortic illness. The authors began by defining the therapy's objective and listing all evidence-based treatment choices. In a subsequent stage, they evaluated each therapy option's advantages and disadvantages using a SW matrix. The authors employed the SWOT matrix to create a customised medical plan by matching "SW" with "OT" in the final stage, where they evaluated opportunities and threats specific to the particular patient.

Figueira et al. (2016) conducted a SWOT analysis of the current MP profession in Portugal with the purpose of identifying potential measures that may be performed to improve the state of the profession. Based on the response of 83 Portuguese MPs, the most common strength was the dedication of the MPs towards the profession. A weakness mentioned was the lack of professional recognition. The growing need of new installations was seen as an opportunity and one main threat mentioned was the pressure from other professionals such as radiographers that are performing some MPs tasks. The authors concluded that it was beneficial to use SWOT in assisting the MPs in creating a strategic action plan to enhance the existing state of affairs.

Topor et al. (2018) made use of SWOT in interprofessional healthcare education at academic medical centres. A workshop consisting of a webinar and an in-person presentation was conducted and the main objective of this workshop was to educate participants on how to create interprofessional learning activities using SWOT analysis. The session was well-received by the participants, who felt that it achieved the intended learning goals.

Through the use of a SWOT analysis Andersson et al. (2021) concluded that AI will alter the MP profession by increasing opportunities linked to the use of AI in healthcare. The survey amassed a 40% response rate of which 90% believed that AI might alter how MP is practised, and 81% believe that AI does not pose a risk to the MP profession. The majority of respondents supported using AI in educational programmes. The author's understanding is that occupational readiness for AI was usually poor among the participants and was a weakness that needed to be addressed with some urgency.

Vella et al. (2022) used SWOT to analyse the constancy testing programme in a major hospital in Malta for medical imaging devices. The study showed that the present constancy testing programme has several advantages due to the team having analytical expertise, but also some disadvantages, mostly due to the profession in Malta being so new. Several opportunities for the programme to be enhanced were identified such as there being a rise in the utilisation of diagnostic medical imaging devices which is beneficial for the MPPs. Nevertheless, there are some threats such as possible loss of MPPs who conduct these tests.

2.10 Conclusion

The literature related to the study was critically reviewed in this chapter. The research methodology that was employed in the study will be described and discussed in the next chapter.

Chapter 3

Research Methodology

3.1 Introduction

The project's methodology is described in this chapter. The methodology used needs to be designed in a way that addresses the objectives of the study. A methodology is made up of a research approach, philosophical perspective, research strategy, data collection technique/procedure/tool, and a data analysis technique. A mixed-method research approach was used in this study, the philosophical perspective was pragmatic, the research strategies were a qualitative survey of relevant documents for the vision statement and a mostly quantitative survey of the opinions of Maltese MPs to identify the SWOT themes, the data collection techniques were document analysis for the vision statement and a semi-structured online questionnaire for the SWOT themes, the data collection tool for the SWOT was a specially designed thematic template, the data analysis technique was SWOT analysis.

3.2 Research Approach

A mixed-method research approach was adopted for this study. A mixed-method study is one that uses both qualitative and quantitative methods of data collection and analysis. This kind of research helps a researcher to qualitatively comprehend complex issues as well as to utilise statistical analysis when necessary (Creswell, 1999). According to Rossman and Wilson (1994) this approach is particularly useful because it has the potential to better understand the issues through different lenses and obtain eclectic data that better respond to the perspectives and opinions of the stakeholders relevant to the study. In this study, a qualitative document analysis of relevant documents (legislative and documents from international and professional organisations) was used to formulate the vision statement that would guide the strategic planning whilst a mostly quantitative survey was utilised to generate comprehensive SWOT thematic data from CQMPs in Malta. In this way the data collected would better reflect the actual state of the profession with respect to the vision statement.

3.3 Philosophical Perspective

One of the most prevalent philosophical schools of thought in research today is pragmatism, which was employed in this study. Pragmatism allows for a free choice to use any methodology and research analyses such as to ensure that the study's research objectives are achieved (Legg and Hookway, 2008).

3.4 Research Strategies

A research strategy is a comprehensive plan for carrying out a research study that enables the methodical and timely execution of research to yield high-quality findings and thorough reporting. The research strategies for formulating the vision statement and identifying SWOT themes are described in Subsections 3.4.1 and 3.4.2 below.

3.4.1 Research strategy for developing the vision statement for the Medical Physics profession in Malta

Since we live in a globalised world and since Malta is part of Europe the creation of the vision statement was carried out via a document analysis of relevant EU (and associated national) legislation and the international and European literature about the MP profession.

3.4.2 Research Strategy for the identification of SWOT themes

The research strategy for the identification of the SWOT themes was a mostly quantitative survey among MP professionals in Malta. The aim of the survey was to capture the SWOT themes. The formulation of the queries in the questionnaire was guided by the vision statement. The questionnaire was designed to identify what strengths the profession has with respect to the vision statement, to identify if there were any weaknesses that would hinder the achievement of the vision, any opportunities available to MPs to help them achieve the vision and any threats that would stop them from achieving the vision.

3.5 Data Collection Techniques/Procedures/Tools

The data collection techniques/procedures/tools for the vision statement and the SWOT themes are identified in Subsections 3.5.1 and 3.5.2 respectively.

3.5.1 Data Collection Techniques/Procedure/Tool for the vision statement

The data collection techniques used for the vision statement was document analysis. Document analysis was performed on documents from European (EU Commission, 2014) and/or International organisations that seek to represent or assist MP societies such as EFOMP (EFOMP, 1984), (Hand et al., 2012), (Caruana et al., 2014), (Evans et al., 2016), (Christofides et al., 2016), (Caruana et al., 2018), (Busoni et al., 2021) and IAEA (IAEA, 2013) as well as legal instruments provided by the EU such as the Directive 2013/59/EURATOM (2013). Moreover, local SL (S.L.585.01, 2018) was also analysed.

3.5.2 Data Collection Techniques/Procedure/Tool for identifying the SWOT themes

The primary data collection technique used for identifying the SWOT themes was an online anonymous semi-structured questionnaire. The Google Forms software was used to collect the data. The questionnaire was made available to all CQMPs in Malta and the survey was filled on a voluntary basis. The semi-structured questionnaire with the MPPs aided in presenting viewpoints that were required to assess the current situation of the MP profession in Malta with respect to the suggested vision statement.

Data was collected following ethical clearance from the Faculty Research Ethics Committee (FREC). The questionnaire was placed online so that prospective participants would be able to complete the questionnaire at their own convenience. An online survey was also seen as beneficial when compared to an interview since the data would not have to be transcribed manually which enabled the time that would have been taken to transcribe the surveys, to be used more effectively. It was decided that the questionnaire would be anonymous so that participants would be free to express their opinions without fear of repercussion. A questionnaire is considered anonymous if it does not seek personal information, such as their name or email address. As a result, it is impossible to discern any variables in the replies that may be connected to a respondent. Some advantages and disadvantages of anonymous questionnaires are listed in Table 3.1.

Establishing the main objectives would be the first stage in developing a questionnaire. What is it that you want to learn? What are the particular research questions? Five criteria were outlined by Fowler Jr and Fowler (1995) as a roadmap for creating effective questions. These five points were used to guide the formulation of the questions. These five criteria can be found in Appendix H.

The online semi-structured questionnaire, took around one hour for the participant to complete and mainly consisted of close-ended questions with an attached Likert scale of the form: 'Strongly Agree', 'Agree', 'Not Sure', 'Disagree', 'Strongly Disagree' whilst other questions required simple 'yes' or 'no' replies. However, a few open-ended questions were also used when it was deemed that more insight needed to be gathered on certain queries. The questionnaire consisted of six sections. Section one consisted of some general questions with the aim of identifying any accreditations the participant might possess whilst introducing them to the roles and responsibilities identified in the proposed vision statement. Section two and three sought to identify further possible internal strengths and weaknesses of the MP profession in Malta respectively with respect to the proposed vision statement whilst sections four and five sought to identify external environmental opportunities and threats of the MP profession in Malta respectively. Finally, section six contained some concluding questions. The full questionnaire can be found in Appendix I.

TABLE 3.1: Benefits and limitations of anonymous questionnaires.

Benefits	**Limitations**
Participants are more inclined to respond honestly and in more details on certain matters.	Unable to conduct any follow ups.
Higher participation rate.	Specific issues cannot be referenced to the respondent to see if the situation has been rectified.
Instantaneous recording of participant responses into a database.	People talk more easily than they write.
Less pressure is exerted on the participants to give an immediate response.	

3.6 Data Analysis Techniques

The data analysis techniques used to analyse the vision statement and the SWOT themes are presented in Subsections 3.6.1 and 3.6.2 respectively.

3.6.1 Method of analysis for the vision statement

The EU, EFOMP, IAEA, and LN documents were analysed by searching for the following words within the documents: vision, future, role, competences, responsibilities, duties, key activities. A vision statement was then formulated which encompassed the future mission for MPs as envisaged by EFOMP.

3.6.2 Method of analysis for the SWOT themes

The main aim of the design of the questionnaire was to encourage SWOT topics to be identified. Table 3.2 presents the thematic template that was used to analyse the data and explicitly showing the SWOT categories.

Numerical data analysis was performed by using Microsoft Excel. The quantitative data from the questionnaire were analysed using descriptive statistics. To analyse such data the mean score was obtained. Averaging was used to analyse questions that have an ordinal categorical (Likert) scale (e.g., strongly agree, agree, not sure, disagree, strongly disagree). A level of agreement score was achieved by assigning values $+2.0$ = 'Strongly Agree', $+1.0$ = 'Agree', 0.0 = 'Not Sure', -1.0 = 'Disagree', -2.0 = 'Strongly Disagree' to the Likert scale and computing the average. A value between $+0.5$ and $+2.0$ indicated agreement with the statement with a value above $+1.0$ indicating strong agreement. Corresponding negative values indicated disagreement and strong disagreement whilst

TABLE 3.2: Design of the SWOT template.

Internal Factors	
Strengths	**Weaknesses**
External Factors	
Opportunities	**Threats**

a value in the range $-0.5 < Mean < +0.5$ indicated a more neutral, indecisive or ambiguous stance.

3.7 Piloting the Questionnaire

This research study was aiming at obtaining responses from all CQMPs in Malta, which accounts to a maximum of 20 possible participants. To avoid further loss of participants due to the fact that any participant taking part in a pilot study would have had to be excluded from the main study, the questionnaire was not tested for content validity and reliability on the participants but by intensively consulting the principal supervisor and co-supervisor. The principal supervisor is a world authority on the use of strategic planning in MP, and the co-supervisor is the president of the MAMP. Both analysed the questionnaire several times, each time improving the content and simplifying the structure and language to increase clarity. As a double check, a short evaluation of the questionnaire was also added as a supplement to the main questionnaire. The evaluation sheet and a summary of the responses are shown in Appendix J.

3.8 Ethical Considerations

The research study was approved by the FREC of Health Sciences of the University of Malta. Since the questionnaire was totally anonymous the research proposal did not present any potential issues in the domain of research ethics and/or data protection, therefore data collection was authorised by FREC. FREC approval can be found in Appendix K.

3.9 Limitations of the Research Methodology

The main limitation in such questionnaires is usually the low response rate. This will be discussed at a later stage of the dissertation.

3.10 Conclusion

The study's methodology was discussed in this chapter. Chapter 4 presents the results obtained as well as a thorough discussion of the data.

Chapter 4

Results and Discussion

4.1 Introduction

This chapter provides the proposed vision statement for the MP profession in Malta. Data obtained from the semi-structured questionnaire is documented and discussed. This includes internal strengths and weaknesses and external opportunities and threats of the profession with respect to the vision statement from the perspective of the local MPs. This chapter ends by proposing a list of strategic objectives for achieving the proposed vision.

4.2 Vision Statement for the Medical Physics profession in Malta

Given the present work being done by the EFOMP Professional Matters committee (EFOMP, n.d) regarding the future role of MPs, it was decided to adopt the version of the vision statement as being suggested by the EFOMP professional matters committee at the time that the questionnaire was being finalised. The proposed vision statement being proposed at the time was:

"The Medical Physics profession will be recognised by all healthcare stakeholders as contributing to maintaining and improving the quality, safety and cost-effectiveness of healthcare services through patient-oriented activities requiring expert action, involvement or advice regarding the specification, selection, acceptance testing, commissioning, quality assurance, decommissioning and optimized clinical use of present and future

medical devices and regarding patient risks from all associated physical agents including protection from such physical agents, installation design and surveillance, and the prevention of unintended or accidental exposures to physical agents; all activities will be based on current best evidence or own scientific research when the available evidence is not sufficient. The scope includes risks to volunteers in biomedical research and carers and comforters. Medical Physics Professionals will also take on at the expert level the added function of the protection of workers and the general public from physical agents (such as Radiation Protection Expert, Magnetic Resonance Safety Expert and Laser Safety Expert)." (Caruana C. J., personal communication, March 22, 2022).

4.3 Questionnaire Section 1: General Questions

Questions 1.1 to 1.3 provided some background information about the participants. The questionnaire garnered a total of eight responses out of the 20 clinical MPs in Malta resulting in a response rate of 40%, which is a normal response rate to such questionnaires. The areas of specialty of the MPs which took part in the survey were as follows: three from RO, three from D&IR, and two from NM. There were therefore a similar number of responses from all three specialty areas. The sample was therefore considered as sufficiently representative of the Maltese MP profession.

In Q1.4, the MPs were asked if they were certified as MPEs by the RPC, where eight (100%) replied as yes whilst none (0%) replied as no. Having such a high percentage of MPs certified as MPEs is a strength for the profession.

Questions 1.5 to 1.7 queried the participants regarding the following sections of the vision statement "*Medical Physics Professionals will also take on at the expert level the added function of the protection of workers and the general public from physical agents (such as Radiation Protection Expert, Magnetic Resonance Safety Expert and Laser Safety Expert).*" In Q1.5, the MPs were asked if they are certified also as RPEs by the RPC, where six (75%) replied as yes whilst two (25%) replied as no. This is also considered a strength since the majority are recognised also as RPEs. The two respondents that replied no in Q1.5 were from RO, but in fact it is common knowledge that there are many RPEs in RO. Q1.6 and Q1.7 asked if the participants were certified as MRSE and Laser Safety Expert (LSE) respectively by any accredited organisation to which all (100%) replied no for both questions. With regard to the vision statement this can be seen as a weakness since none of the MPs in Malta are recognised as a MRSE nor as a laser safety expert. This is indeed a pity as courses for certification in these areas are easily available (the Institute of Physics and Engineering in Medicine (IPEM), UK holds such course regularly). MPs should be encouraged by MAMP to attend such courses.

Questions 1.8 to 1.16 queried the participants with regard to the following section of the vision statement "*the specification, selection, acceptance testing, commissioning, quality assurance, decommissioning and optimized clinical use of present and future medical devices and regarding patient risks from all associated physical agents including protection from such physical agents, installation design and surveillance, and the prevention of unintended or accidental exposures to physical agents*" with respect to the following device categories: ionising radiation based medical devices, non-ionising radiation based medical devices, all medical devices, and no medical devices. The tables generated for each question show the observed frequencies for each Device Category by Specialty Area of the respondents.

In Q1.8, participants were asked for which categories of medical devices are MPs in Malta involved with respect to specification and procurement. The results are shown in Table 4.1. Out of the eight participants, seven (87.5%) answered that MPs in Malta are involved in the specification and procurement of ionising radiation based medical devices and five out of eight (62.5%) answered non-ionising radiation based medical devices. This means that MPs are quite strong in the specification and procurement of theses two specific categories of devices. However, only two out of eight (25%) answered that MPs are involved in the specification and procurement of all medical devices which is a weakness with respect to the vision statement. Overall, the perception is therefore that MPs in Malta are involved in the specification and procurement of ionising and non-ionising radiation based medical devices but very little outside these two traditional categories. Hence with respect to the vision statement which states that MPs should endeavour to involve themselves in all medical devices the position of the profession is still weak. This is expected since the profession is a very young profession in Malta. However, the profession should endeavour to expand its scope of practice to beyond radiation-based devices as recommended by the vision statement. In its meeting of August 2022 in Dublin the EFOMP Council approved a new Work Group to make proposals regarding the involvement of MPs in Physiological Measurement (Caruana C.J., personal communication, 5 September, 2022). MPs are already involved in this specialty in several countries in Europe (notable Finland and the UK). In addition, MPs are also involved in Audiology in Germany, Holland and Austria (Caruana et al.,

TABLE 4.1: Crosstab for Specialty Area and Device Category of Q1.8.

			Device Category		
			Ionising radiation based medical devices	Non-Ionising radiation based medical devices	All medical devices
Specialty Area	Radiation Oncology	Count	2	1	2
	Diagnostic and Interventional Radiology	Count	3	3	0
	Nuclear Medicine	Count	2	1	0
		Total	7	5	2

2014). The MAMP should work with the University of Malta to introduce such areas in the curriculum. The author of this thesis has been advised that the University will be introducing Physiological Measurement in a revised MSc Medical Physics curriculum for October 2023 (Caruana C.J., personal communication, 5 September, 2022).

There are higher percentages of MPs from D&IR (100%) than MPs from RO and NM (33.3% and 50% respectively) who perceive that MPs are involved in the specification and procurement of non-ionising radiation based medical devices. This is probably because the MPs in D&IR are increasingly involving themselves in quality control of ultrasound and MRI. There are presently however moves to introduce an MR-LINAC and this would of necessity nudge MPs in RO to involve themselves more in non-ionising radiation devices. Meanwhile only two MPs from RO (66.6%) perceive that MPs are involved in the specification and procurement of all medical devices. This is probably due to the fact that MPs in RO also use a large number of ancillary medical devices (e.g., applicators, moulds and other patient restraint devices).

In Q1.9, participants were asked for which medical device categories are MPs in Malta involved in acceptance testing. The results are shown in Table 4.2. Out of the eight respondents, seven (87.5%) answered that MPs in Malta are involved in the acceptance testing of ionising radiation based medical devices and five out of eight (62.5%) answered non-ionising radiation based medical devices. This means that MPs are again quite strong in these two specific categories of devices. However, again only two out of eight (25%) answered that MPs are involved in the acceptance testing on all medical devices which is a weakness with respect to the vision statement. Overall, the perception

TABLE 4.2: Crosstab for Specialty Area and Device Category of Q1.9.

			Device Category		
			Ionising radiation based medical devices	Non-Ionising radiation based medical devices	All medical devices
Specialty Area	Radiation Oncology	Count	2	1	2
	Diagnostic and Interventional Radiology	Count	3	3	0
	Nuclear Medicine	Count	2	1	0
		Total	7	5	2

is therefore again that MPs in Malta are involved in the acceptance testing of ionising and non-ionising radiation based medical devices but very little outside these two categories. Hence with respect to the vision statement which states that MPs should endeavour to involve themselves in the acceptance testing of all medical devices, the position of the profession is still weak. The profession should strive to expand acceptance testing to all medical devices as discussed earlier.

There are again larger percentages of MPs from D&IR (100%) than MPs from RO and NM (33.3% and 50% respectively) who perceive that MPs are involved in the acceptance testing of non-ionising radiation based medical devices.

In Q1.10, participants were asked for which medical device categories are MPs in Malta involved in commissioning. The results are shown in Table 4.3. All of the participants (100%) answered that MPs in Malta are involved in the commissioning of ionising radiation based medical devices and six out of eight (75%) answered that they are involved in the commissioning of non-ionising radiation based medical devices. This means that MPs are again very strong in these two specific categories of devices. However, none of the participants indicated that they are involved in the commissioning of all medical devices which is a weakness with respect to the vision statement. This could be due to the fact that other healthcare professionals are doing the commissioning on these medical devices or that little is being done. Overall, the perception is therefore that MPs in Malta are involved in the commissioning of ionising and non-ionising radiation based medical devices only. Hence with respect to the vision statement, the MPs should endeavour to involve themselves in the commissioning of all medical devices as discussed previously.

TABLE 4.3: Crosstab for Specialty Area and Device Category of Q1.10.

			Device Category		
			Ionising radiation based medical devices	Non-Ionising radiation based medical devices	All medical devices
Specialty Area	Radiation Oncology	Count	3	2	0
	Diagnostic and Interventional Radiology	Count	3	3	0
	Nuclear Medicine	Count	2	1	0
		Total	8	6	0

All the participants (100%) in the study indicated that MPs in each respective specialty area perceive that MPs in Malta are involved in the commissioning of ionising radiation based medical devices. On the other hand, there are larger percentages of MPs from RO and D&IR (66.7% and 100% respectively) than MPs from NM (50%) who perceive that MPs are involved in the commissioning of non-ionising radiation based medical devices. This can be explained by the fact that PET-MRI is not yet available in Malta.

In Q1.11, participants were asked which medical devices do MPs in Malta perform QA on. The results are shown in Table 4.4. Out of the eight respondents, seven (87.5%) answered that MPs in Malta are involved in the QA of ionising radiation based medical devices and five out of eight (62.5%) answered non-ionising radiation based medical devices. Hence, meaning that MPs are again quite strong in these two specific categories of devices. However, only one of the participants (12.5%) answered that MPs are involved in the acceptance testing of all medical devices which is a weakness with respect to the vision statement. Overall, the perception is therefore that MPs in Malta are again mostly involved in the QA of ionising and non-ionising radiation based medical devices. With respect to the vision statement, which states that MPs should endeavour to involve themselves in the QA of all medical devices, the position of the profession is still weak. The profession should work to increase its involvement in the QA of all medical devices.

There are larger percentages of MPs from D&IR and NM (both 100%) than MPs from RO (66.7%) who perceive that MPs are involved in the QA of ionising radiation based medical devices. This is probably because the MPs in D&IR and NM involve themselves

TABLE 4.4: Crosstab for Specialty Area and Device Category of Q1.11.

			Device Category		
			Ionising radiation based medical devices	Non-Ionising radiation based medical devices	All medical devices
Specialty Area	Radiation Oncology	Count	2	1	1
	Diagnostic and Interventional Radiology	Count	3	3	0
	Nuclear Medicine	Count	2	1	0
		Total	7	5	1

extensively in QA. It might also be because QA in RO might also involve the manufacturer to a higher extent given that the profession is still young in Malta and therefore the level of experience in RO is less than desirable.

In Q1.12, participants were asked for which medical device categories are MPs in Malta involved in decommissioning. The results are shown in Table 4.5. Out of the eight respondents, four (50%) answered that MPs in Malta are involved in the decommissioning of ionising radiation based medical devices, two (25%) answered non-ionising radiation based medical devices, one (12.5%) answered all medical devices, and three (37.5%) answered that they do not partake in the decommissioning of any medical devices. Overall, the perception is therefore that MPs in Malta are barely involved in the decommissioning process with only 50% stating that they are involved with regards to ionising radiation medical devices, whilst 37.5% do not perform this duty on any medical device. However, one must remark that the process of medical device decommissioning is still a grey area in Malta (Caruana C. J., personal communication, September 5, 2022). The 37.5% of the participants that indicated that they do not perform decommissioning on any medical devices correspond to MPs in D&IR. However the duties of a MP in D&IR, according to the Ministry for Health in Malta do include that they should contribute to the decommissioning of medical radiological devices as shown in Subsection 2.4.5 under (f). It could be that MPs are not performing such duties due to other more pressing work. Hence with respect to the vision statement which states that MPs should endeavour to involve themselves in the decommissioning of all medical devices, the position of the profession is very weak. As indicated by the vision statement, MPs should strive to be part of the decommissioning of all medical devices.

TABLE 4.5: Crosstab for Specialty Area and Device Category of Q1.12.

			Device Category			
			Ionising radiation based medical devices	Non-Ionising radiation based medical devices	All medical devices	None of the above
Specialty Area	Radiation Oncology	Count	2	1	1	0
	Diagnostic and Interventional Radiology	Count	0	0	0	3
	Nuclear Medicine	Count	2	1	0	0
		Total	4	2	1	3

In Q1.13, participants were asked which medical devices do they optimise. The results are shown in Table 4.6. Out of the eight respondents, seven (87.5%) answered that MPs in Malta are involved in optimising the clinical use of ionising radiation based medical devices and five out of eight (62.5%) answered non-ionising radiation based medical devices so again MPs are quite strong in these two specific categories of devices. However, only one of the eight participants (12.5%) answered that MPs optimise the clinical use of all medical devices. With respect to the vision statement this is considered as a weakness. Overall, the perception is therefore that MPs in Malta are mostly involved in optimising the clinical use of ionising and non-ionising radiation based medical devices. With respect to the vision statement, which states that MPs should endeavour to involve themselves in optimisation of the clinical use of all medical devices, the position of the profession is still weak. As advised by the EFOMP vision statement, MPs should involve themselves in optimising the clinical use of all medical radiological equipment.

In Q1.14, participants were asked if MPs in Malta provide advice regarding patient risks from medical device associated physical agents including protection from such physical agents for the following categories of physical agents: ionising radiation, non-ionising radiation, and all physical agents (vision statement: "*patient risks from all associated physical agents including protection from such physical agents, installation design and surveillance, and the prevention of unintended or accidental exposures to physical agents*"). The results are shown in Table 4.7. Out of the eight respondents, all (100%) answered that MPs in Malta provide advice in cases of ionising radiation and four out of eight (50%) answered that advice is provided in cases of non-ionising radiation. Hence, meaning that MPs are again quite strong in these two specific categories of devices. However, none of the MPs (0%) provide advice regarding patient risks

TABLE 4.6: Crosstab for Specialty Area and Device Category of Q1.13.

			Device Category		
			Ionising radiation based medical devices	Non-Ionising radiation based medical devices	All medical devices
Specialty Area	Radiation Oncology	Count	2	1	1
	Diagnostic and Interventional Radiology	Count	3	3	0
	Nuclear Medicine	Count	2	1	0
		Total	7	5	1

TABLE 4.7: Crosstab for Specialty Area and Device Category of Q1.14.

			Device Category		
			Ionising radiation based medical devices	Non-Ionising radiation based medical devices	Physical agents
Specialty Area	Radiation Oncology	Count	3	1	0
	Diagnostic and Interventional Radiology	Count	3	2	0
	Nuclear Medicine	Count	2	1	0
		Total	8	4	0

and protection from all physical agents which is a weakness with respect to the vision statement. This indicates that the general notion of physical agents is not well established here but just ionising and non-ionising radiation and in the case of the latter this is limited to only MRI and Ultrasound (US) – but not lasers, ultraviolet, infra-red, visible. As advised by the EFOMP vision statement, the profession should work to increase their knowledge and skills with regards to patient risks and protection from all physical agents.

There is a very high percentage of MPs from RO, D&IR, and NM (all 100%) who perceive that MPs in Malta are involved in providing advice regarding patient risks from ionising radiation. On the other hand, there are larger percentages of MPs from D&IR (66.7%) than MPs from RO and NM (33.3% and 50% respectively) who perceive involvement in patient risk from non-ionising radiation. This is almost certainly because of the involvement of D&IR physicists in MRI and US imaging and the fact that in Malta there is not an MR-LINAC or PET-MRI.

In Q1.15, participants were asked for which medical device categories are MPs in Malta involved in the design and installation of the new facilities. The results are shown in Table 4.8. All of the participants (100%) answered that MPs in Malta are involved in the design and installation of ionising radiation based medical devices and five out of eight (62.5%) answered that they are involved in the design and installation of non-ionising radiation based medical devices. This means that MPs are again very strong in these two specific categories of devices. However, none of the participants indicated that they are involved in the design and installation of all medical devices which is a weakness with respect to the vision statement. This could be attributed to the fact that the MP team in Malta is very small and there is simply not enough physicists to cater for installation and surveillance of all medical devices. Overall, the perception is therefore that MPs in Malta are involved in the design and installation of ionising and non-ionising radiation based medical devices. However, with respect to the vision statement which states that MPs should endeavour to involve themselves in the design and installation of all medical devices, the position of the profession is still weak.

In Q1.16, participants were asked for which of the medical devices do MPs in Malta provide advice regarding the prevention of unintended or accidental exposures to physical agents. The results are shown in Table 4.9. All of the participants (100%) answered that MPs in Malta provide advice regarding the prevention of unintended or accidental exposures of ionising radiation based medical devices. However, three out of eight

TABLE 4.8: Crosstab for Specialty Area and Device Category of Q1.15.

			Device Category		
			Ionising radiation based medical devices	Non-Ionising radiation based medical devices	All medical devices
Specialty Area	Radiation Oncology	Count	3	2	0
	Diagnostic and Interventional Radiology	Count	3	2	0
	Nuclear Medicine	Count	2	1	0
		Total	8	5	0

TABLE 4.9: Crosstab for Specialty Area and Device Category of Q1.16.

			Device Category		
			Ionising radiation based medical devices	Non-Ionising radiation based medical devices	All medical devices
Specialty Area	Radiation Oncology	Count	3	2	0
	Diagnostic and Interventional Radiology	Count	3	0	0
	Nuclear Medicine	Count	2	1	0
		Total	8	3	0

(37.5%) answered that they provide advice regarding the prevention of unintended or accidental exposures of non-ionising radiation based medical devices.

Questions 1.17 to 1.19 queried the participants with regard to the following section of the vision statement "*The Medical Physics profession will be recognised by all healthcare stakeholders as contributing to maintaining and improving the quality, safety and cost-effectiveness of healthcare services through patient-oriented activities requiring expert action*". The responses were analysed by attaching a categorical Likert scale with $+2.0$ = 'Strongly Agree', $+1.0$ = 'Agree', 0.0 = 'Not Sure', -1.0 = 'Disagree', -2.0 = 'Strongly Disagree' and a mean computed. A value between $+0.5$ and $+2.0$ indicated agreement with the statement with a value above $+1.0$ indicating strong agreement. Corresponding negative values indicated disagreement and strong disagreement whilst a value in the range $-0.5 < Mean < +0.5$ indicated a more neutral, indecisive or ambiguous stance. Table 4.10 presents a statistical summary of the results where *N* refers to the number of participants and *Mean* is the average score of the responses.

In Q1.17, participants were asked if the MP profession in Malta is seen by stakeholders as contributing significantly to the over-arching mission of the wider healthcare system of which it forms part. Results show that on average the MPs generally agree (mean Likert score = $+0.75$) with this statement which is a strength with respect to the vision statement.

In Q1.18, participants were asked if the MPs in Malta are aware of what is internationally considered best practice in their specialty area. Results show that the MPs strongly agree (mean Likert score = $+1.50$) that they are well informed of the procedures and techniques

TABLE 4.10: Statistical summary of the results obtained for Q1.17 till Q1.19.

	N	Mean	Strongly Agree %	Agree %	Not Sure %	Disagree %	Strongly Disagree %
Q1.17	8	+0.75	12.5	50	37.5	0	0
Q1.18	8	+1.50	25	75	0	0	0
Q1.19	8	0	12.5	25	25	25	12.5

in their corresponding specialty area. This can be considered as a core competence with respect to the vision statement.

In Q1.19, the participants were asked to what extent they agree with the statement that "*There has never been a shortage of material resources that are required to enable me to deliver my professional services to the healthcare system*". The results were neutral (mean Likert score = 0), with three out of eight (37.5%) participants disagreeing and two out of eight (25%) not being sure with this statement which is worrying because this means that MPs may be suffering from a shortage of the resources necessary for them to deliver an effective and safe service, which can be considered as a weakness of the MP profession in Malta with respect to the vision statement.

In Q1.20 when asked what specific unique benefits the MP profession in Malta provides and to whom (patients, other healthcare professionals, hospital management), the respondents generally agreed that the MP profession provides safe and accurate MP services to patients, other healthcare staff, and the general public. It was also identified that the MP profession provides education to students from various professions. The following are some quotes by the respondents.

"Medical Physics education to students, patient safety advice to healthcare staff, diagnostic systems are up-to-date due to QA testing."
"In Malta, in Nuclear Medicine, the physicists have significant contact with patients, both for radiation protection and therapy aspects."
"Since we are a small country and most clinical physicist are based in the single largest hospital, our impact can reach hundreds of thousands of patients every year."

One respondent noted the integrity and scientific excellence that each specialty strives to provide to the hospital management:

"In-depth knowledge in the specialty area helps hospital management better understand certain requirements for improvement with respect to patient services, provide guidance to hospital management when certain goals are to be reached, and thus help advance patient clinical services in both diagnostic and therapeutic areas."

It is clear from the responses that there is a wide range of people that benefit from services the MP profession in Malta provides which is a strength with respect to the vision statement.

4.4 Questionnaire Section 2: Possible Internal Strengths of the Medical Physics profession in Malta

Questions 2.1 till 2.8 were analysed by attaching the previous Likert scale and their mean score was obtained from the responses. Table 4.11 presents a statistical summary of the results.

In Q2.1 MPs were asked to what extent they agree with the statement that "*Medical Physicists in Malta have a deep techno-scientific expertise regarding medical devices used in their specialty and their clinical use*." The MPs agree that this is a strength of the profession with 37.5% saying they strongly agree (mean Likert score = $+1.25$). With respect to the vision statement a MP should have a deep understanding of medical devices used in their specialty area. MP is the only profession in healthcare with a strong understanding of the technology and optimised clinical application.

In Q2.2, participants were asked to what extent they agree with the statement that "*Medical Physicists in Malta have a deep techno-scientific expertise regarding the protection of patients, workers and the general public from ionising radiation and other physical agents used in their specialty.*" The respondents strongly agree with this statement (mean Likert score = $+1.25$). MPs in Malta consider that they are highly capable of handling such agents which is a strength with respect to the vision statement. Physical agents provide considerable medical benefits, and their usage is steadily rising. However, there is a risk component as well, and when employed by individuals who lack appropriate understanding, they constitute a source of unnecessary risk.

In Q2.3 participants were asked to what extent they agree with the statement that "*Medical Physicists in Malta have strong analytical, problem-solving, and trouble-shooting*

TABLE 4.11: Statistical summary of the results obtained for Q2.1 till Q2.8.

	N	Mean	Strongly Agree %	Agree %	Not Sure %	Disagree %	Strongly Disagree %
Q2.1	8	+1.25	37.5	50	12.5	0	0
Q2.2	8	+1.25	37.5	50	12.5	0	0
Q2.3	8	+1.25	25	75	0	0	0
Q2.4	8	+1.13	12.5	87.5	0	0	0
Q2.5	8	+0.75	0	75	25	0	0
Q2.6	8	+1.25	25	75	0	0	0
Q2.7	8	+1.00	25	50	25	0	0
Q2.8	8	+0.50	0	62.5	25	12.5	0

skills." The survey showed that the respondents strongly agree with this statement (mean Likert score = $+1.25$). MP services require strong problem solving skills. The requisite that MPs possess a first degree with a strong physics and mathematics component guarantees that only those of particularly high analytical skills are allowed to enter the profession.

In Q2.4 participants were asked to what extent they agree with the statement that "*Medical Physicists in Malta have strong mathematical, statistical and data analysis skills.*" MPs in Malta strongly agree that they have such skills (mean Likert score = $+1.13$). MPs lead over all other healthcare specialties in terms of quantitative data analysis, statistics, and mathematics. Quantitative imaging, AI, and machine learning are seeing a surge in therapeutic applications, opening up yet another higher tier dimension. Courses in MP now include deep learning.

In Q2.5 participants were asked to what extent they agree with the statement that "*The Medical Physics profession in Malta has a strong legal foundation.*" From the responses obtained, there is a general consensus, though not very strong, that MPs in Malta do have a strong legal foundation (mean Likert score = $+0.75$). The Maltese authority issued legal Act (L.N.210, 2018) stating MPEs are qualified to provide specialist advice on radiation physics related matters. The MP profession is a legally established health care profession and regulated via the CPCM. Having a profession legally recognised by the local authority is considered a strength with respect to the vision statement.

In Q2.6 participants were asked to what extent they agree with the statement that "*Medical Physicists in Malta have strong scientific research skills.*" There is a strong consensus that MPs have strong scientific research skills (mean Likert score = $+1.25$). MPs have unmatched scientific quantitative research abilities that have been perfected through many years of training. Over the course of their lengthy study and training, MPs are taught concepts including accuracy, reliability, and estimations of uncertainty. Since MPs often have to introduce new technologies in healthcare and since often protocols are not sufficiently optimised, they need to have research skills to drive the use of the technology forward. With the vision statement stating that "*all activities will be based on current best evidence or own scientific research when the available evidence is not sufficient*", this is a critical strength.

In Q2.7 participants were asked to what extent they agree with the statement that "*Medical Physicists in Malta have strong ICT skills.*" On average the results showed that the respondents agree that they possess such a strength (mean Likert score = $+1.00$). Those who answered not sure are probably not aware of the skills of some of their colleagues. MPs in Malta possess extremely high ICT skill levels, particularly programming and this is considered as a strength with respect to the vision statement.

In Q2.8 participants were asked to what extent they agree with the statement that "*Present Medical Physics services in Malta compare well with other EU countries.*" The MPs agree, though not strongly, that services offered locally are similar to those in other EU regions (mean Likert score = $+0.50$).

In Q2.9 the participants were asked whether they believe that the qualification and curriculum framework leading to the certification of MP professionals in Malta was sufficient to ensure the production of high calibre professionals. Where five replied as yes (62.5%) whilst three replied as no (37.5%). When asked in Q2.10, which element of the curriculum can be improved, the respondents generally agreed that part of the clinical training can be enhanced by doing some training at foreign hospitals such that exposure to MP services in other countries is obtained to widen the vision. One respondent proposed that the qualification to apply for a MSc in medical physics should also be changed from "Bachelor in Physics/Engineering to Bachelor in Physics, Medical Physics and Radiation Protection." Although the latter would certainly lead to even more competent professionals, it must be kept in mind that a first degree in physics/engineering is recommended by the 'European Guidelines on the Medical Physics' project (EU Commission, 2014) and EFOMP Policy Statement 12.1 (Caruana et al., 2014). Hence the present Bachelor in 'Physics, Medical Physics and Radiation Protection' may be considered as an ideal compromise (Caruana C.J., personal communication, September 5, 2022).

In Q2.11 the respondents were given the opportunity to highlight any other notable strengths for the MP profession in Malta. The MPs identified the determination, competitivity and drive for improvement with the profession being quite a young team with modern ideas and a very new profession in Malta with many opportunities where to advance. One of the respondents identified that Malta as a small country made it easier for the profession to adapt to new changes:

"Since we are a small country, we can be highly cohesive and adaptable. For example, in Germany things are a bit fragmented because of the many states that are involved, and professionals would be hesitant to comment or commit without approval from all states."

4.5 Questionnaire Section 3: Possible Internal Weaknesses of the Medical Physics profession in Malta

Questions 3.1 to 3.10 were of the ordinal categorical scale and a Likert scale mean score was obtained as previously. The following are the questions and their respective result. Table 4.12 presents a statistical summary of the results.

In Q3.1 participants were asked to what extent they agree with the statement that "*One of the problems that the profession faces in Malta is the absence of a universally known mission statement for the profession for Malta.*" The majority of the MPs are not sure whether this is a weakness of the profession (mean Likert score = $+0.38$). Lack of a mission statement that is brief, unambiguous, universally recognised, and most importantly, easily marketable is one of the issues the profession could be currently dealing with. A mission statement would serve as a guide for the MPs and should be quickly implemented to show the importance of the role to healthcare management and even society at large. This can be considered as a weakness, according to the vision statement the MPs should be recognised by all healthcare stakeholders, and this cannot be achieved without a known mission statement.

In Q3.2 participants were asked to what extent they agree with the statement that *The Medical Physics profession in Malta has a narrow range of specialisations.*" On average, the respondents are quite neutral about this statement (mean Likert score = -0.38). The

TABLE 4.12: Statistical summary of the results obtained for Q3.1 till Q3.10.

	N	Mean	Strongly Agree %	Agree %	Not Sure %	Disagree %	Strongly Disagree %
Q3.1	8	+0.38	12.5	12.5	75	0	0
Q3.2	8	-0.38	12.5	25	37.5	25	0
Q3.3	8	-0.13	12.5	12.5	37.5	25	12.5
Q3.4	8	+0.25	12.5	25	50	0	12.5
Q3.5	8	+0.50	0	75	12.5	0	12.5
Q3.6	8	-0.63	12.5	0	25	37.5	25
Q3.7	8	0	12.5	25	25	25	12.5
Q3.8	8	-0.25	0	25	25	50	0
Q3.9	8	+0.75	12.5	62.5	12.5	12.5	0
Q3.10	8	+0.63	25	37.5	12.5	25	0

use of ionising radiation in D&IR, NM, and RO remains the primary clinical MP specialty in Malta. The focus of the profession should be broadened to include all physical agents and medical equipment as indicated by the vision statement so it can be considered as a weakness if MPs do not specialise in all physical agents.

In Q3.3 participants were asked to what extent they agree with the statement that ”*The Medical Physics profession in Malta still has not realised the importance of strategic and robust leadership.*” Results showed that on average the MPs are quite neutral about this statement (mean Likert score = -0.13). Strategic leadership is important as it allows for the desired vision to be developed and achieved. Perhaps there needs to be a debate on the development of strategic leadership for the profession in Malta.

Q3.4 stated that ”*Medical Physicists in Malta have low marketing skills leading to too low profile of the profession within healthcare.*” Results show that the participants are not sure whether as a profession they have low marketing skills (mean Likert score = $+0.25$). One respondent that strongly disagreed stated that:

“Medical physicists have gone a long way to prove the importance of the profession in healthcare.”

However, results show that many MPs in Malta might struggle with the idea of promoting and advertising their services. This is a weakness with respect to the vision statement because the profession should be recognised by all healthcare stakeholders as being a profession that improves the quality, safety, and cost-effectiveness of healthcare services.

One respondent however stated that this issue is being targeted:

“We are trying to improve this by being actively involved in Allied healthcare matters where we interact with key individuals from many different professions.”

In Q3.5 participants were asked to what extent they agree with the statement that ”*Medical physicists in Malta take part in regional/international networking.*” The MPs agree at a very basic level with this statement (mean Likert score = $+0.50$). Regional and international networking is an integral way to strengthen the profession’s professional and political position. With networking, the profession would achieve a more harmonised perception of itself and its role in the healthcare world today.

In Q3.6 participants were asked to what extent they agree with the statement that ”*The lack of an independent MP department will negatively impact the achievement of the vision.*” Results show that the participants disagree (mean Likert score = -0.63). The options for the profession to develop and perform strategic planning depend on where the MP group is located within the organisational structure of healthcare management. One respondent even argued that:

“There are of course many benefits to having an independent MP department. This can only be realised once we have enough staff and a sufficient number of PhDs.”

However, it appears that the MPs in Malta currently do not consider it to be an important issue. One respondent even argued that:

“In terms of SL 585.01, having a MP department will not change the current work being done within healthcare.”

This suggests that there is a significant amount of mutual assistance and cross-fertilisation of ideas between the three specialties thus the three specialties do not feel isolated from each other. However not having an independent department does mean that there is little direct communication with the CEO of the hospital, and everything needs the approval of the respective medical chair.

In Q3.7 participants were asked to what extent they agree with the statement that ”*There is a reluctance by some Medical Physicists in Malta to be part of the wider healthcare* *picture.*" On average, the respondents are not sure whether their peers are reluctant to be part of the wider healthcare picture (mean Likert score = 0). Some MPs could tend to believe that physics is the only thing that matters and that they do not need to worry about other disciplines because they do not consider them as vital. However, inter-professional teamwork and cooperation is the future. Overall, with respect to the vision statement this can be seen as a weakness.

In Q3.8 participants were asked to what extent they agree with the statement that "*Medical Physicists in Malta have insufficient communication and pedagogical skills.*" The MPs are neutral on this issue (mean Likert score = -0.25). MPs should have sufficient communication skills, as this would help the profession market its services and its vision to other professions and management.

In Q3.9 participants were asked to what extent they agree with the statement that "*Research by Medical Physicists in Malta has barely taken off.*" The MPs in Malta generally agree with the idea that research by MPs is still far behind (mean Likert score = $+0.75$). Research has barely taken off in Malta due to either other work/personal commitments or else lack of motivation. This is considered as a weakness with respect to the vision statement.

In Q3.10 participants were asked to what extent they agree with the statement that "*Our work duties in Malta are too overwhelming to be able to have enough free time to enrol in new training courses or attend conferences regarding the profession.*" The MPs generally agree with the idea that their work duties are too much and to the extent that they have no free time to further increase their knowledge and skills in the profession (mean Likert score = $+0.63$). One of the respondents stated:

"We are essentially a start-up operating within a larger government organisation. There is foundational work to be completed and more staff to be recruited before we can reach a steady working state to be able to take on higher level duties."

This is considered as a weakness for the profession with respect to the vision statement since the MP team in Malta will not have sufficient time to involve itself in new training courses and seminars.

As a general note, most of the possible weaknesses presented in the questionnaire obtained, on average, a neutral result from the participants as shown in Table 4.12. More research needs to be done to unravel the actual situation.

In Q3.11 when asked whether there are any legal problems that might hinder the idea of the profession from achieving this vision, three replied as yes (37.5%) whilst five replied as no (62.5%). Some issues were raised with regard to the involvement of a MP when using some modalities:

"Currently the MP/MPE is not legally required for acceptance testing of radiological medical equipment. Involvement of the MPE determined by the modality, leaving the lower dose-per-patient modalities with lacking MPE oversight (these modalities however have a very high dose to the population due to the high number of imaged patients). Additionally, there is currently no enforcement for MPE involvement in dental and cone-beam computed tomography (CBCT) systems."

With respect to the vision statement this is a weakness for the profession since it states that MPs should be involved in the acceptance testing of all medical devices, regardless of area of specialty. In fact it is strictly not in conformance with EU directive 2013/59/EURATOM (2013).

However, the majority believe that there are no legal problems that can hinder the profession from achieving this part of the vision and this issue regarding acceptance testing will eventually resolve itself when there are more MPs once the bachelor's students graduate.

In Q3.13 and Q3.14 the respondents were given the opportunity to highlight any other notable weaknesses for the MP profession in Malta and explain how they could be eliminated. Some MPs considered that there is a lack of engagement by MPs in the development of the profession, and this can be eliminated with good leadership. Clinical work is overwhelming, leaving no time for independent research to be done and that there is a lack of sufficient MPs in Malta. They stated that such issues can be solved by employing more MP staff, by having a better structure in the department such as introducing the idea of dosimetrists in radiotherapy and more automated software to ease the work of the MPs. Also, one respondent raised the issue of expanding the knowledge and skills which depends on work done in own free time:

“Maintenance and growth in the profession is difficult for most as since we are again quite young, there are many ‘big life projects’ such as housing, marriage, children that impact the amount of free time that could otherwise be dedicated to extracurricular work such as involvement in professional societies, development of high quality presentations and courses to keep a high standard.”

4.6 Questionnaire Section 4: Possible External Opportunities for the Medical Physics profession in Malta

Questions 4.1 till 4.11 were also based on an ordinal categorical Likert scale. Table 4.13 presents a statistical summary of the results.

In Q4.1 participants were asked to what extent they agree with the statement that ”*The Medical Physics profession can expand as a result of the increase in number and sophistication of hospital medical devices.*” The MPs in Malta strongly agree that the profession can grow if there is investment in hospital medical devices (mean Likert score = $+1.13$). MPs must make the most of the opportunities presented by the fast increase in the variety and sophistication of medical equipment. One respondent even stated that: “If we are proactive, we can be at the forefront for adoption of these technologies.” Any other medical or healthcare profession falls well short of the amount of competence that the MP profession possesses in this field. Though advances in AI and theranostics are significant, relatively few members of the healthcare industry are familiar with these words, let alone be qualified to optimise their usage or conduct acceptance testing and quality control. This is seen as an opportunity with respect to the vision statement. The utilisaion of lasers, biomedical optics, and nanotechnology are all rapidly developing, and the profession should carefully consider increasing its participation in these fields.

In Q4.2 participants were asked to what extent they agree with the statement that ”*Medical Physicists in Malta should link up with patient organisations and project themselves as patient advocates regarding safety standards in healthcare.*” The MPs are not sure whether they should link up with patient organisations as patient advocates regarding safety standards in healthcare (mean Likert score = $+0.25$). This could be due to the overwhelming work duties already at hand.

In Q4.3 participants were asked to what extent they agree with the statement that ”*Medical Physicists in Malta should link up with occupational health and safety organisations*

TABLE 4.13: Statistical summary of the results obtained for Q4.1 till Q4.11.

	N	Mean	Strongly Agree %	Agree %	Not Sure %	Disagree %	Strongly Disagree %
Q4.1	8	+1.13	25	62.5	12.5	0	0
Q4.2	8	+0.25	12.5	25	37.5	25	0
Q4.3	8	+0.13	12.5	25	25	37.5	0
Q4.4	8	+1.25	50	37.5	0	12.5	0
Q4.5	8	+1.00	50	25	12.5	0	12.5
Q4.6	8	+0.50	25	37.5	12.5	12.5	12.5
Q4.7	8	0	0	37.5	25	37.5	0
Q4.8	8	+0.38	12.5	50	0	37.5	0
Q4.9	8	+1.13	37.5	50	0	12.5	0
Q4.10	8	+1.50	50	50	0	0	0
Q4.11	8	+1.63	62.5	37.5	0	0	0

and environmental groups and project themselves as occupational/public advocates with regard to safety from physical agents." The MPs are neutral about this statement (mean Likert score = $+0.13$). This could be because currently occupational/public safety falls under the duties of a RPE. However, this is a great opportunity for MPs that are interested in expanding their role since it is legally required that healthcare professionals' education and training curriculum include competences regarding protection against physical agents. With respect to the vision statement this approach can be seen as an opportunity as it mentions that a MP should take the added function of the role of a RPE.

In Q4.4 participants were asked to what extent they agree with the statement that "*The Medical Physics profession should create further opportunities for itself by exerting pressure on legislators to recognise that patient safety should not be limited to ionising radiation and strive to ensure that the rigorous standards of safety to be found in ionising radiation are extended to other areas such as magnetic resonance imaging, lasers and in the future nanodevices.*" There was a strong agreement between the participants that the legislators should recognise that patient safety is not limited to ionising radiation only but is extended to areas such as magnetic resonance imaging, lasers and nanodevices (mean Likert score = $+1.25$). Such legislations would further strengthen the legal basis of the profession. For instance, the EU has implemented laws for staff safety related to electromagnetic radiation, but there is no specific legislation for patients as there is for ionising radiation. This is a chance for MPs to raise awareness of these challenges among the broader public, pushing the field into the public eye and increasing its visibility. The vision statement also mentions that a MP should take on at expert level the added function of protection from workers and the general public from physical agents (e.g., MRSE and LSE) so this would be an opportunity for the profession to expand its role.

In Q4.5 participants were asked to what extent they agree with the statement that "*Due to the escalating cost of healthcare, the need for efficient use of medical devices and Health Technology Assessment is vital, and we as Medical Physicists need to take this opportunity and involve ourselves in such issues, as it would raise our profile with health economists.*" Results show that participants agree with this statement (mean Likert score = $+1.00$). This is seen as an opportunity with respect to the vision statement which indicates that MPs should provide cost-effective healthcare services. Health economics, which is the practise of utilising limited resources in the best way, is very important as healthcare costs are on the rise whilst patient expectations rise as well. This is an opportunity for MPs to be involved in clinical trials and health technology assessment. One respondent noted:

"Involvement in clinical patient pathways to emphasise that examinations are really justified."

In Q4.6 participants were asked to what extent they agree with the statement that "*The rapid expansion in the number of home-use, self-testing and wearable devices are not only a clinical opportunity for Medical Physicists but also can be turned into a business opportunity. Shops selling such devices should be manned by Medical Physicists who can give advice to customers on the most appropriate devices to purchase, proper and safe use, re-calibration frequencies and other information. Medical Physicists can also offer quality control services for such devices.*" The MPs generally agreed, though not strongly, that self-testing and wearable devices can be turned into a business opportunity (mean Likert score = $+0.50$). One respondent who strongly disagreed argued that this should be the role of a biomedical engineer. A medical gadget designed for users at home is one that is used outside of a setting where professionals provide healthcare, these devices can be used to gather information for tracking a user's health, example heart rate. According to the vision statement this would be a great opportunity for the profession as MPs can provide QC services to such equipment in addition to offering recommendations on which gadget should be bought.

In Q4.7 participants were asked to what extent they agree with the statement that "*The Government of Malta makes available a lot of funding for me to able to develop my* *competences.*" The participants have come to a consensus that they are not sure whether such fundings are available (mean Likert score = 0). This could be since very few to none are actively involved in research hence the government would not receive requests for funding from MPs leading to such grants being used somewhere else.

Q4.8 stated, "*I take part in IPEM courses.*" The majority of the participants do take part in IPEM courses with five respondents (62.5%) agreeing on taking such courses whilst three respondents (37.5%) do not. Q4.9 stated, "*I take part in EFOMP school for medical physics experts.*" All (87.5%) except one (12.5%) of the respondents take part in EFOMP courses. Q4.10 stated, "*I take part in IAEA courses.*" All the respondents (100%) partake in IAEA courses. Q4.11 stated, "*I take the opportunity to go to conferences regarding the profession.*" All the respondents (100%) attend conferences regarding the MP profession. Taking part in these courses organised by these organisations is a great opportunity for the profession in Malta. The vision statement encourages MPs to take any opportunity that allows them to expand their scope of practice and these courses can help the profession do just that.

In Q4.12 the MPs were asked whether there are opportunities for research in their specialty area. Six replied as yes (75%) whilst two replied as no (25%). The respondents that replied with a no are both from RO. However, one of the participant that replied with a yes is also from RO. This could indicate that there are opportunities in all specialty areas however some MPs might not be sufficiently informed. It also indicates that there is more push for research in D&IR and NM. The MPs in Malta fully agree that they have strong scientific research skills as suggested by the results obtained in Section 4.4, Table 4.11, Q2.6, so these abilities should not be left unattended.

In Q4.13 and Q4.14 the respondents were asked to highlight any other notable opportunities for the MP profession in Malta and explain how the profession would benefit. The respondents agreed they should get more involved with foreign organisations such as EFOMP and IAEA and the knowledge gained can be used in Malta as well as participating in public relations activities to show the public the importance of having MPs. Lecturing and project supervision was also mentioned such that there would be an increase in awareness and knowledge within the university. One respondent also mentioned the importance of being part of the RPC:

"Having a say within the radiation safety authority as a stakeholder in deciding certain standards and legal notices."

4.7 Questionnaire Section 5: Possible External Threats to the Medical Physics profession in Malta

Questions 5.1 till 5.5 were of the ordinal categorical Likert scale and their mean score was obtained from the responses. Table 4.14 presents a statistical summary of the results.

In Q5.1 participants were asked to what extent they agree with the statement that "*The BSc(Hons) Physics, Medical Physics and Radiation Protection has solved the threat of low number of medical physicists due to low number of Physics/Engineering graduates.*" The majority of the MPs seem to agree that by introducing a BSc in Medical Physics solves the threat of low physics/engineering graduates (mean Likert score = $+0.75$). When there are not enough physics/engineering students, it is critical that undergraduate students are found without relying on other sources. A consistent supply of physics/engineering graduates is essential for the profession. With more members, the MP profession in Malta will be able to be more involved in the clinical use of present and future medical devices and physical agents which is a strength with respect to the vision.

In Q5.2 participants were asked to what extent they agree with the statement "*Malta needs more Medical Physicists to achieve western European standards in my specialty area.*" The MPs agree that an increase in staff is required for a specialty area to prosper (mean Likert score = $+1.00$). A lack of MPs is a threat as it would not allow the profession to achieve what is being proposed by the vision statement.

In Q5.3 participants were asked to what extent they agree with the statement "*Austerity economics and unrestrained commoditisation, are a threat to the Medical Physics profession in Malta.*" The respondents agree (mean Likert score = $+0.75$). Austerity would lead to a very low yearly intake of MPs, with the profession looking at a small rate of growth which would be a threat because the workload is steadily increasing but staffing levels are not. The political leadership of the profession has actively countered the threat of commoditisation.

In Q5.4 participants were asked to what extent they agree with the statement "*There is role poaching from other professions in Malta.*" The participants have mixed views on

TABLE 4.14: Statistical summary of the results obtained for Q5.1 till Q5.5.

	N	**Mean**	**Strongly Agree %**	**Agree %**	**Not Sure %**	**Disagree %**	**Strongly Disagree %**
Q5.1	8	+0.75	37.5	25	25	0	12.5
Q5.2	8	+1.00	12.5	75	12.5	0	0
Q5.3	8	+0.75	25	25	50	0	0
Q5.4	8	+0.50	25	37.5	12.5	12.5	12.5
Q5.5	8	+0.38	0	62.5	12.5	25	0

this. In fact, 25% strongly agree, 37.5% agree, 12.5% are not sure, 12.5% disagree, and 12.5% strongly disagree (mean Likert score = $+0.50$). Role-poaching can be very harmful to the profession and inter-professional relations. One of the respondents even argued that when some MPs only do routine constancy testing, people from other professions might get the idea that they are able to perform such duties: “We have for many years only really been performing machine QC. This has given the impression that our job can be done by other healthcare professionals as well as some machine technicians.” With respect to the vision this is a threat to the quality of services that should be offered by MPs.

In Q5.5 participants were asked to what extent they agree with the statement ”*The profession is facing unfair competition from other professions.*” Again, there are mixed views on this issue. Having 62.5% agree, 12.5% are not sure, and 25% disagree (mean Likert score = $+0.38$). The respondents have stated that other professions such as technicians have been doing some MP work. One of the respondents argued that they are faced with this problem because they are short staffed meaning that they are not able to be present at all times to intercept such incidents and do the work themselves.

In Q5.6 and Q5.7 the respondents were asked to highlight any other notable threats that the MP profession in Malta is facing and explain how the profession can reduce their impact respectively. A few concerns were raised with regards to the CPCM, more specifically that the clinical training programme in Malta which is decided by the CPCM is still pending recognition, threatening the possibility for new MP trainees to kickstart their two year clinical training. Two respondents agreed that an independent MP council should be established by MAMP to deal with the recognition of traineeship programmes, qualification entry requirements, and professional clinical registration. Not having own MP council is not a major threat to the profession with respect to the vision. However, delays in the approval of clinical training does pose a threat for the growth of the profession.

Another respondent mentioned the threat of having the private sector loosely enforced by the authorities and that the MP association should have regular meetings with said authorities. With regards to acceptance testing and commissioning, one respondent stated:

"Acceptance testing and commissioning is not required to be done by an MPE by law."

Followed by:

"There should be peer pressure to restrict acceptance testing to engineers for installation purposes with the hospital MPE being present and MPE for commissioning and putting the equipment into clinical use."

The vision statement proposes that acceptance testing and commissioning of all medical devices be performed by a MPP, so this issue needs to be tackled by the profession.

4.8 Questionnaire Section 6: Concluding Questions

The participants were asked whether they have any ideas on how the vision statement presented in Section 4.2 could be developed further. In which 100% of the participants replied with no. When asked about if the MP profession in Malta is prepared to face the challenges of future technologies in Q6.3, the participants are ambivalent 50% agree, 37.5% are not sure, and 12.5% disagree (mean Likert score = $+0.38$). Table 4.15 presents the results obtained for Q6.3. Some MPs might not be entirely sure whether the profession can face future technologies because they are not certain what other physicists are doing in other specialties. Strategic leaders with a vision are needed.

The questionnaire concluded by asking the MPs if they would like to mention any points regarding the MP profession in Malta which were not covered by the survey. Where 100% of the participants responded with no.

TABLE 4.15: Statistical summary of the results obtained for Q6.3.

	N	**Mean**	**Strongly Agree %**	**Agree %**	**Not Sure %**	**Disagree %**	**Strongly Disagree %**
Q6.3	8	+0.38	0	50	37.5	12.5	0

4.9 Summary: Strengths of the Medical Physics profession in Malta with respect to the vision statement

1) Most MPs are certified by the RPC as MPEs.
2) Most MPs are certified by the RPC as RPEs.
3) MP profession recognised by stakeholders as being a contributor to healthcare.
4) High knowledge and skills in specialty areas.
5) MPs provide education to students.
6) MPs have sufficient scientific expertise regarding medical devices used in their specialty area and their clinical use.
7) MPs have strong competences regarding the protection of patients, workers and the general public from ionising radiation and other physical agents used in their specialty.
8) MPs have strong analytical, problem-solving, and trouble-shooting skills.
9) MPs have strong mathematical, statistical, and data analysis skills.
10) Strong legal foundation for the profession.
11) MPs have strong scientific research skills.
12) MPs have strong ICT skills.
13) Services in Malta compare well with other EU countries.
14) High level qualification and curriculum framework leading to the certification of a MP.
15) Young team that is able to adapt with deterministic views striving for improvement.
16) MPs take part in regional/international networking.
17) Introduction of a B.Sc.(Hons) degree in Physics, Medical Physics and Radiation allowing for the profession to grow.

4.10 Summary: Weaknesses of the Medical Physics profession in Malta with respect to the vision statement

1) No MPs certified as a MRSE nor as a LSE.
2) Shortage of material resources.
3) MPs are mainly involved in the specification and procurement of ionising and non-ionising radiation based medical devices rather than all medical devices.
4) MPs in Malta are involved in the acceptance testing of ionising and non-ionising radiation based medical devices but this is not entrenched in law and not to all medical devices.
5) MPs in Malta are involved in commissioning but this is not entrenched in law. None of the participants indicated that they are involved in the commissioning of medical devices other than radiation based devices.
6) The perception is that MPs in Malta are mostly involved in the QA of ionising and non-ionising radiation based medical devices and not all medical devices.
7) MPs in Malta are little involved in the decommissioning process of modalities.
8) As a MP profession, it is mostly involved in optimising the clinical use of ionising and non-ionising radiation based medical devices only.
9) MPs are able to provide advice regarding patient risks and protection from ionising and non-ionising radiation but not from all physical agents.
10) MPs are involved in the design and installation of radiation devices but not all medical devices.
11) Lack of a universally acknowledged easy to promote mission statement for the profession.
12) Narrow range of specialties.
13) Insufficient robust leadership and strategic skills.
14) Low marketing skills.
15) Some MPs are reluctant to be part of the wider healthcare picture.
16) Some MPs have insufficient communication and pedagogical skills.

17) Low level of research on professional and educational issues.

18) Low number of MPs.

4.11 Summary: Opportunities of the Medical Physics profession in Malta with respect to the vision statement

1) Increase in number of hospital medical devices.

2) Link up with patient organisations as patient advocates regarding safety standards in healthcare.

3) Link up with occupational health and safety organisations and environmental groups and project themselves as occupational/public advocates with regard to safety from physical agents.

4) Exerting pressure on legislators to recognise that patient safety is not limited to ionising radiation.

5) Raise profile with health economists.

6) Self-testing and wearable devices can be turned into a business opportunity.

7) Research grants from the Government of Malta.

8) Involvement in IPEM/EFOMP/IAEA courses and conferences.

9) Research activities in each specialty area.

10) Scientific visits and fellowship programs to other hospitals.

11) Lecturing and project supervision at the University of Malta.

12) Being included as a stakeholder in RPC allows for deciding certain standards and legal notices.

4.12 Summary: Threats of the Medical Physics profession in Malta with respect to the vision statement

1) Low number of MPs limiting achievable EU standards.

2) Austerity economics.

3) Role poaching from other professions.

4) The private sector having very loose enforcing from the authority.

5) Lack of MP council.

4.13 List of strategic objectives for the profession

The following strategic objectives are being proposed based on the SWOT analysis.

4.13.1 Strengthening of Internal Strengths

1) Pursue the available regional/international approved courses on the MP profession in general to upgrade the current skills and learn new ones.

2) MPs should involve themselves more in the education of all healthcare professionals and research using all medical devices and protection from all physical agents, rather than limiting their function to ionising and non-ionising radiation based medical devices.

3) Exchange experiences between specialty areas to further increase cohesion between MPs. Schedule discussions for each specialty area and exchange written reports, say annually, outlining the objectives, goals, any obstacles, and the accomplishments of each specialty. These reports can then be presented at the MAMP annual conference.

4) Include more specialty areas, e.g., physiological measurement, and prepare prospective MP students more for the traineeship in the MSc curriculum in Malta.

4.13.2 Reducing Internal Weaknesses

1) The main competences outlined in the suggested mission statement must get the MP members attention and any weaknesses eliminated. The MPs should not waste valuable time on areas such as daily constancy testing that can be easily replaced

by other disciplines, but rather be focused on higher order competences such as quantitative methods, advanced optimisation, ICT, personalised medicine and future technologies. Focusing on higher order competences renders replacement more difficult and ensures the growth of the MP profession.

2) Exert pressure on local legislators such that the key competences mentioned in (1) are regulated such that a MP is involved by law.

3) Attend courses in LSE and MRI, more specifically, a course for MRSE. IPEM offers these courses remotely.

4) In order to succeed in the modern world, MPs ought to take steps to improve their limited strategic planning, advertising, and public relations skills. They cannot afford to limit their operations to the walls of their laboratories and offices; instead, they must become active participants in the larger society that surrounds them. While MPs should be proud of their scientific achievements, they should also understand the value of other skills acquired from other fields, such as business and economics. At MAMP conferences, specific courses should be organised on these subjects. Materials must be created to direct and assist MPs in pitching their expertise to stakeholders.

5) The MP profession should adopt the vision statement and focus all its planning in this direction.

4.13.3 Grasping Available Opportunities

1) The MP members ought to be using their relationships with external organisations to request that training and education in technical competences that are necessary for the cost-effective use of medical devices and safety concerns involving physical agents be imposed through adequate legislation for the benefit of the healthcare industry.

2) Attend courses organised by country/regional/international organisations particularly those involving new technologies such as nanotechnology.

3) Apply for funds such that there is a push in research activities in each specialty area.

4) Link with the RPC such that the profession has a stronger presence and MPs can exchange views with the commission on a regular basis.

5) MAMP should encourage its members to take part in European Network for Training and Education of Medical Physics Experts (EUTEMPE) (EUTEMPE, n.d.) consortium and EFOMPs European School for Medical Physics Experts (ESMPE) courses.

Courses are available for such areas as leadership, advanced quality control, radiation protection and advanced MRI, all of which would elevate the competences of MPs in Malta to exceptional levels. The European Nuclear Education Network (ENEN+) (ENEN+, n.d.) consortium will be making funds available for scholarships for participants to these courses.

4.13.4 Countering External Threats

1) Insist with the CPCM that approval of training schemes be accelerated. Lack of MPs in Malta is the root of several problems that the profession is facing, an increase in MPs would allow for the vision statement to be realised.

2) Take proactive measures to combat any attempt in introducing the idea that MPs can be replaced by other members of other professions, which is very hazardous for the MP profession.

3) Exert pressure on legislators to impose stricter regulations on the private sector with respect to the employment of MPs.

4.14 Conclusion

This chapter presented the results from the SWOT analysis with respect to the vision statement based on the data obtained from the semi-structured anonymous questionnaire. The data gathered was then thoroughly discussed and suggested strategic objectives for the MP profession in Malta were offered. Chapter five will present conclusions of the study and recommendations for the professional practice and future research.

Chapter 5

Conclusions and Recommendations

5.1 Introduction

A summary of the findings in this study are presented in Section 5.2. Section 5.3 and 5.4 present possible recommendations for the professional practice and future research respectively in relation to the dissertation.

5.2 Summary of Conclusions from the Study

The main findings of the study are listed hereunder:

a) The MPs provided a comprehensible viewpoint of the profession, they pointed out several strengths and most of the respondents mentioned several goals that they would like to see in fruition for the MP profession in Malta. The participants also pointed some weaknesses, ways in which the profession can grow by grasping available opportunities, whilst highlighting the external threats they are currently facing.

b) There are both merits and issues in the present state of the MP profession. The MP profession is endowed with strong competences, each specialty area having a team of high calibre professionals due to their analytical and scientific expertise owing to their backgrounds in physics and engineering. This allows the MPs to grasp in-depth understanding of medical devices and be highly trained with regards to the protection of patients and the general public from ionising radiation and other physical agents. However, due to the problems brought on by the fact that MP members are still a relatively new and small profession in Malta, most of the possible advancements have still not been realised. MPs have very strong involvement in ionising and non-ionising radiation based medical devices, overall, the perception is that the profession is very weak when it comes to having MPs involved in other medical devices and other associated physical agents, which is a weakness with respect to the vision statement. On the other hand, several opportunities that can help in eliminating weaknesses were also recognised. The MPs identified the possibility of attending courses provided by several international organisations such that their competences could be improved, whilst also identifying ways in which the profession can further improve its profile. However, some threats were also derived from the questionnaire. The MPs acknowledge the fact that even though there are many opportunities, the lack of new MPs might hinder the profession from achieving EU standards. Other threats mentioned were role poaching from other healthcare professionals and austerity economics.

c) Based on the perspective of the local MPs in Malta, the SWOTs of the profession were analysed, and a list of strategic objectives were presented. The list consisted of ways to further strengthen internal strengths, reduce internal weaknesses, grasp available opportunities, and counter external threats of the profession.

5.3 Recommendations for Professional Practice

Recommendations for the MP professional practice in Malta are:

a) The MP profession and MAMP should consider adopting the strategic objectives suggested by this study.

b) Till more MPs are forthcoming, MPs should offer to dedicate more of own time in pursuing activities such as involvement in professional societies, development of high quality presentations, collaborative research with other departments abroad, and courses to further develop standards.

c) Following the transition to local MP clinical training, the future of the MP profession in Malta depends on the present local MPs. With each passing year, the intricacy of procedures in RO, D&IR, and NM is rising. In order to reflect the shifting environment in hospitals abroad and in Malta, it is crucial that training programmes and competences be constantly evaluated and updated.

5.4 Avenues for Future Research

Recommendations for future research are:

a) Clarify the SWOTs further by including in-depth interviews with both MPs and other stakeholders. It is important to study not only how MPs see themselves but also how they are seen by other stakeholders.

b) Carrying out a SWOT study of the MP profession from the perspective of MPs across Europe. This study was conducted from the viewpoint of the MPs in Malta, incorporating the various perspectives of other MPPs across an entire continent would have more far reaching effects and the outcome will surely allow for the development of a highly comprehensive strategic plan for the MP profession at a European level.

5.5 Conclusion

The objectives of this study were to develop a vision statement for the MP profession in Malta, to identify the SWOTs of the MP profession with respect to that vision as perceived by the MPs themselves and to generate a strategic plan for the way forward. These objectives have been largely achieved. However in-depth interviews with both MPs and other stakeholders would certainly lead to a more sophisticated and comprehensive strategic plan.

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Appendix A

EU Directive 2013/59/Euratom Article 57(1b) and Article 83(2)

3. Member States shall ensure that for each medical or biomedical research project involving medical exposure:

(a) the individuals concerned participate voluntarily;

(b) these individuals are informed about the risks of exposure;

(c) a dose constraint is established for individuals for whom no direct medical benefit is expected from exposure;

(d) in the case of patients who voluntarily accept to undergo an experimental medical practice and who are expected to receive a diagnostic or therapeutic benefit from this practice, the dose levels concerned shall be considered on an individual basis by the practitioner and/or referrer prior to the exposure taking place.

4. Member States shall ensure that the optimisation includes the selection of equipment, the consistent production of adequate diagnostic information or therapeutic outcomes, the practical aspects of medical radiological procedures, quality assurance, and the assessment and evaluation of patient doses or the verification of administered activities, taking into account economic and societal factors.

5. Member States shall ensure that:

(a) dose constraints are established for the exposure of carers and comforters, where appropriate;

(b) appropriate guidance is established for the exposure of carers and comforters.

6. Member States shall ensure that in the case of a patient undergoing treatment or diagnosis with radionuclides, the practitioner or the undertaking, as specified by Member States, provides the patient or their representative with information on the risks of ionising radiation and appropriate instructions with a view to restricting doses to persons in contact with the patient as far as reasonably achievable. For therapeutic procedures these shall be written instructions.

These instructions shall be handed out before leaving the hospital or clinic or a similar institution.

Article 57

Responsibilities

1. Member States shall ensure that:

(a) any medical exposure takes place under the clinical responsibility of a practitioner;

(b) the practitioner, the medical physics expert and those entitled to carry out practical aspects of medical radiological procedures are involved, as specified by Member States, in the optimisation process;

(c) the referrer and the practitioner are involved, as specified by Member States, in the justification process of individual medical exposures;

(d) wherever practicable and prior to the exposure taking place, the practitioner or the referrer, as specified by Member States, ensures that the patient or their representative is provided with adequate information relating to the benefits and risks associated with the radiation dose from the medical exposure. Similar information as well as relevant guidance shall be given to carers and comforters, in accordance with point (b) of Article 56(5).

2. Practical aspects of medical radiological procedures may be delegated by the undertaking or the practitioner, as appropriate, to one or more individuals entitled to act in this respect in a recognised field of specialisation.

Article 58

Procedures

Member States shall ensure that:

(a) written protocols for every type of standard medical radiological procedure are established for each equipment for relevant categories of patients;

(b) information relating to patient exposure forms part of the report of the medical radiological procedure;

(c) referral guidelines for medical imaging, taking into account the radiation doses, are available to the referrers;

(d) in medical radiological practices, a medical physics expert is appropriately involved, the level of involvement being commensurate with the radiological risk posed by the practice. In particular:

(i) in radiotherapeutic practices other than standardised therapeutic nuclear medicine practices, a medical physics expert shall be closely involved;

(ii) in standardised therapeutical nuclear medicine practices as well as in radiodiagnostic and interventional radiology practices, involving high doses as referred to in point (c) of Article 61(1), a medical physics expert shall be involved;

(iii) for other medical radiological practices not covered by points (a) and (b), a medical physics expert shall be involved, as appropriate, for consultation and advice on matters relating to radiation protection concerning medical exposure.

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4. The radiation protection expert may be assigned, if provided for in national legislation, the tasks of radiation protection of workers and members of the public.

Article 83

Medical physics expert

1. Member States shall require the medical physics expert to act or give specialist advice, as appropriate, on matters relating to radiation physics for implementing the requirements set out in Chapter VII and in point (c) of Article 22(4) of this Directive.

2. Member States shall ensure that depending on the medical radiological practice, the medical physics expert takes responsibility for dosimetry, including physical measurements for evaluation of the dose delivered to the patient and other individuals subject to medical exposure, give advice on medical radiological equipment, and contribute in particular to the following:

(a) optimisation of the radiation protection of patients and other individuals subject to medical exposure, including the application and use of diagnostic reference levels;

(b) the definition and performance of quality assurance of the medical radiological equipment;

(c) acceptance testing of medical radiological equipment;

(d) the preparation of technical specifications for medical radiological equipment and installation design;

(e) the surveillance of the medical radiological installations;

(f) the analysis of events involving, or potentially involving, accidental or unintended medical exposures;

(g) the selection of equipment required to perform radiation protection measurements;

(h) the training of practitioners and other staff in relevant aspects of radiation protection;

3. The medical physics expert shall, where appropriate, liaise with the radiation protection expert.

Article 84

Radiation protection officer

1. Member States shall decide in which practices the designation of a radiation protection officer is necessary to supervise or to perform radiation protection tasks within an undertaking. Member States shall require undertakings to provide the radiation protection officers with the means necessary for them to carry out their tasks. The radiation protection officer shall report directly to the undertaking. Member States may require employers of outside workers to designate a radiation protection officer as necessary to supervise or perform relevant radiation protection tasks as they relate to the protection of their workers.

2. Depending on the nature of the practice, the tasks of the radiation protection officer in assisting the undertaking, may include the following:

(a) ensuring that work with radiation is carried out in accordance with the requirements of any specified procedures or local rules;

(b) supervise implementation of the programme for workplace monitoring;

(c) maintaining adequate records of all radiation sources;

(d) carrying out periodic assessments of the condition of the relevant safety and warning systems;

(e) supervise implementation of the personal monitoring programme;

(f) supervise implementation of the health surveillance programme;

(g) providing new workers with an appropriate introduction to local rules and procedures;

(h) giving advice and comments on work plans;

(i) establishing work plans;

(j) providing reports to the local management;

(k) participating in the arrangements for prevention, preparedness and response for emergency exposure situations;

(l) information and training of exposed workers;

(m) liaising with the radiation protection expert.

3. The task of the radiation protection officer may be carried out by a radiation protection unit established within an undertaking or by a radiation protection expert.

Appendix B

List of knowledge, skills and competences for the MPE as specified by the EU guidelines for the MPE project

	Knowledge **(facts, principles, theories, practices)**	**Skills** **(cognitive and practical)**	**Competence** **(responsibility and autonomy)**
Scientific Problem Solving Service	K1. Explain statutory and institutional requirements for Medical Physics Services in own area of medical physics practice with respect to Scientific Problem Solving Service. K2. Use physics, concepts, principles and theories to explain in detail and quantitatively, the structure, functioning, characteristics, strengths and limitations and use of the medical devices used in own area of medical physics. K3. Explain in detail and quantitatively the properties of ionising radiations (electromagnetic,electrons, ions, neutrons) and other physical agents (e.g., electrical energy, static electric / magnetic fields, non -ionising electromagnetic radiation, vibration, sound and ultrasound, heat energy and laser) to be found in the healthcare environment. K4. Explain quantitatively using biological models the beneficial and/or adverse biological effects of ionizing radiations and the various physical agents associated with medical devices, the factors influencing the magnitude of the biological effect and the way these can be manipulated to improve clinical outcomes e.g., in the case of ionizing radiation this would include radiobiological models, radiation epidemiology, mutagenesis, carcinogenesis (including leukaemogenesis), genetic effects on offspring from irradiation of gametes, teratogenic effects on the conceptus, skin effects, eye cataracts, cell survival curves, linear-quadratic model, absorbed dose, type of radiation (RBE, radiation weighting factor), tissue radiosensitivity (LET, RBE, tissue weighting factor), dose rate, presence of radiosensitisers, oxygen and radioprotectors, age, dose-effect relationships. K5. Explain the application of the terms deterministic/stochastic, early/late and teratogenic/genetic effects in relation to each physical agent. K6. Explain the main sources of evidence from within the general physics, medical physics and healthcare literature (e.g., the Cochrane Collaboration) essential for the carrying out of a systematic survey in own area of medical physics practice.	S1. Apply the general concepts, principles, theories and practices of physics to the solution of clinical problems concerning the optimised clinical use of medical devices and safety / risk management with respect to associated ionizing radiations and other physical agents. S2. Use the general concepts, principles, theories and practices of physics to analyze the research literature concerning the optimised use of medical devices and safety / risk management with respect to ionizing radiations and other associated physical agents. S3. Use physics research skills to develop the experimental evidence base for the optimal use of medical devices and safety / risk management from associated ionizing radiations and physical agents when present evidence is insufficient. S4. Use the general concepts, principles, theories and practices of physics to ensure effective and safe practice in own area of medical physics practice. S5. Use the general concepts, principles, theories and practices of physics for the transfer of new medical devices and associated techniques to the clinical environment in an effective, safe and economical manner. S6. Design quantitative clinical and biomedical studies based on rigorous statistical design. S7. Use statistical packages for the analysis of clinical and biomedical data.	C1. Take responsibility for statutory and institutional requirements for Medical Physics Services in own area of medical physics practice with respect to Scientific Problem Solving Service. C2. Take responsibility for the setting-up and organization of a Medical Physics Service in own area of medical physics practice. C3. Take responsibility for applying the general concepts, principles, theories and practices of physics to the solution of clinical problems concerning the optimal use of medical devices and management of risk from associated ionizing radiations and other physical agents in own area of medical physics practice. C4. Take responsibility for applying the general concepts, principles, theories and practices of physics to analyze the research literature concerning the optimal use of medical devices and management of risk from associated ionizing radiations and other physical agents and to transfer relevant published research results to the clinical environment in own area of medical physics practice. C5. Take responsibility to apply the general concepts, principles, theories and practices of physics for the selection and insertion of new medical devices within own area of medical physics practice and to facilitate the effective, safe and economical use of said devices. C6. Take responsibility to apply physics research skills to develop the evidence base for the optimal use of medical devices in own area of medical physics practice when present evidence is insufficient.

	Knowledge (facts, principles, theories, practices)	**Skills** (cognitive and practical)	**Competence** (responsibility and autonomy)
Dosimetry Measurements (and other physical agents as approp.)	K7. Explain and explain the statutory and institutional requirements of Medical Physics Services with respect to Dosimetry Measurements (including non-ionising radiations as appropriate). K8. Define and explain the dosimetric quantities (including units and inter-relationships) used to assess beneficial or adverse biological effects for ionizing radiations and the various types of physical agents in own area of medical physics practice (*use ICRU 85, 2011 definitions for ionizing radiation*). K9. Define patient dosimetric quantities for each clinical procedure in own area of medical physics practice and explain the method used for their measurement / calculation. K10. Explain the relationship between the various dosimetric quantities used (e.g., between energy fluence, kerma and absorbed dose for photon beams including the concept of charged particle equilibrium). K11. Define operational quantities (including units and inter-relationships) used in personal dosimetry e.g., ambient H*(10), directional H'(0.07, angle) and personal dose equivalents i.e., depth dose equivalent $H_P(10)$ and skin dose equivalent $H_P(0.07)$ for external photon radiation and explain the method used for their measurement / calculation. K12. Explain in detail and quantitatively the structure, operation and advantages / disadvantages of the various types of patient and personal dosimeters and area monitors available for the various types of ionising and non-ionising radiation including criteria for selection (e.g., accuracy, precision, uncertainties, linearity, any dose rate / energy / directional dependence, spatial resolution, physical size, read out convenience and convenience of use), management, calibration, traceability (including international traceability framework) and user protocols (in the case of ionizing radiation dosimetry include cavity theory). K13. Explain the principles of biological monitoring / dosimetry.	S8. Select and use instruments for dosimetric quantities for the various types of ionizing radiations and other physical agents for patients, workers and public in own area of medical physics practice. S9. Develop rigorous dosimetry protocols in own area of medical physics practice. S10. Interpret the results of dosimetry measurements. S11. Maintain calibration of dosimetry instruments. S12. Implement cross-calibration procedures for dosimetry instruments. S13. Convert dosimetry quantities measured in air or other medium to relevant dosimetric quantities in tissue.	C7. Take responsibility for statutory and institutional requirements for Medical Physics Services in own area of medical physics practice with respect to Dosimetry Measurements (including non-ionising radiations as appropriate). C8. Design and equip an appropriate space for the measurement of dosimetric quantities for the various types of ionizing radiations and physical agents for patients, workers and public in own area of medical physics practice. C9. Take responsibility for the selection, acceptance testing, commissioning and quality control of instruments for the measurement of dosimetric quantities for ionizing radiations and other physical agents in own area of medical physics practice. In the case of acceptance testing this should be done in cooperation with the vendor. C10. Take responsibility for the handling, management, calibration and maintenance of dosimetry instruments in own area of medical physics practice. C11. Take responsibility for dosimetric investigations and the supervision of dosimetry measurements.

	Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
Patient Safety / Risk Management	K14. Explain the statutory and institutional requirements for Medical Physics Services in own area of medical physics practice with respect to Patient Safety / Risk Management. K15. Explain the classification of medical devices based on patient risk. K16. Explain the principles of patient risk management as applied to medical devices and associated ionizing radiations and other physical agents in own area of medical physics practice. K17. Explain the beneficial and possible adverse biological effects (including mechanisms) to patients of ionizing radiations and other physical agents including the factors impacting the magnitude of the biological effect. K18. Explain the possible impact of human factors with regard to patient safety in the use of medical devices and associated ionizing radiations and other physical agents. K19. Explain the difference between deterministic/stochastic, early/late and teratogenic/genetic effects of the various ionizing radiations and other physical agents in relation to patient risk. K20. Explain relevant international, EU, national and local legislation, recommendations and documentation regarding risk from ionizing radiations and other physical agents with the purpose of hazard prevention and emergency preparedness in the healthcare environment with regard to patient safety / risk management. K21. Explain the procedures for the prevention, investigation and handling of adverse incidents (including use of Root Cause Analysis / Failure Modes and Effects Analysis or alternative methodology; recommendations of appropriate remedial actions) with respect to patients in own area of medical physics practice. K22. Explain the process and practical implementation of patient risk assessments in own area of medical physics practice, using techniques for the qualitative and quantitative assessment of risk. K23. Name and explain the function of the main National, European and International organizations concerned with protection of patients from ionizing radiations and other physical agents (e.g., ICRP, ICNIRP, IAEA, EC, WHO, UNSCEAR). K24. Explain how research exposures are managed in own area of medical physics practice including the processes of ethical review and including the use of dose constraints where appropriate. K25. Explain the requirements for, and the practical implementation of, appropriate systems for the monitoring of doses to patients from ionizing radiations and other physical agents in own area of medical physics practice.	S14. Calculate patient risk from measurement data of the dosimetry quantities used to assess adverse biological effects for the various types of ionizing radiations and other physical agents. S15. Assess patient risks from given procedures in own area of medical physics practice from measured patient dose data and dose-effect relationships. S16. Apply the principles of justification (risk / benefit assessment), optimization (including ALARA) and the setting up of reference levels to protect the patient from unnecessary risk from ionizing radiations and other physical agents. S17. Apply the various means of dose reduction (appropriate source strengths, exposure time, distance, shielding) in protocol optimization. S18. Calculate risks to the unborn child in the case of exposure to ionizing radiations and other physical agents. S19. Develop an organisational policy to achieve regulatory compliance for patient safety from ionizing radiations and other physical agents in own area of medical physics practice. S20. Investigate incidents to determine the cause(s) and recommending appropriate remedial action with respect to patient safety in own area of medical physics practice. S21. Conduct critical examinations (interlocks, warning systems, safety design features and barriers) related to patient safety in own area of medical physics practice.	C12. Take responsibility for statutory and institutional requirements for Medical Physics Services in own area of medical physics practice with respect to Patient Safety / Risk Management. C13. Inventorise sources of ionizing radiations and other physical agents present in the hospital environment with respect to patient safety. C14. Take responsibility for the ongoing optimization of existing and newly introduced protocols in own area of medical physics practice with respect to patient protection and in accordance with the latest published evidence or own research when the available evidence is not sufficient. C15. Carry out an ionizing radiation and other physical agent dose audit with respect to patient safety in own area of medical physics practice. C16. Take responsibility for the development of patient safety teams in own area of medical physics practice. C17. Implement corrective procedures with regard to patient safety in own area of medical physics practice. C18. Take responsibility for the planning for emergency situations with regard to patient safety in own area of medical physics practice. C19. Implement a detailed organisational policy to support the safety of patients in own area of medical physics practice. C20. Take responsibility for the establishment and use of appropriate reference levels with respect to risks from ionizing radiations and other physical agents. C21. Develop contingency plans for emergency procedures with respect to patient safety in own area of medical physics practice. C22. Take responsibility for the design of a new facility (including waiting and resting rooms) in own area of medical physics practice taking into consideration patient safety. C23. Take responsibility for the surveillance of installations with respect to protection of patients from ionizing radiations and other physical agents. C24. Investigate in conjunction with the vendor technical factors leading to accidental/unintended exposures.

	Knowledge (facts, principles, theories, practices)	**Skills** (cognitive and practical)	**Competence** (responsibility and autonomy)
Patient Safety / Risk Management (cont.)	K26. Explain the principles and practice of contingency planning and the implementation of emergency procedures with respect to patient safety in own area of medical physics practice. K27. Explain the key considerations for the design of a new facility (including waiting and resting rooms) with regards to patient safety in own area of medical physics practice. K28. Explain the functioning of safety systems (e.g., interlocks) found in own area of medical physics practice with respect to patient safety. K29. Explain how the application of good safety practices and the use of appropriate devices and techniques are used to optimize clinical protocols. K30. Explain quantitatively and in detail the interactions with organic matter of ionising and non-ionising electromagnetic radiations, particulate radiation, ultrasound and electric and magnetic fields at the molecular, cellular, tissue and macroscopic levels in relation to patient risks. K31. Define the radiation dosimetry quantities used in patient risk assessment and their use in the radiation protection of patients. K32. Explain the principles of the design of radiation safety plans with respect to patient safety in own area of medical physics practice. K33. Explain the fundamental characteristics and limitations of the various models / algorithms used in the quantification of patient doses from external sources of ionising radiation. K34. Explain compartmental / bio-kinetic models and the fundamental characteristics and limitations of the MIRD model and algorithms for internal radionuclide patient dosimetry.	S22. Give advice on the choice and use of protective equipment related to patient safety in own area of medical physics practice. S23. Assess patient risks for a given experimental procedure.	C25. Take responsibility for the management of good and safe practice in the use of ionising radiation beams and sealed / unsealed sources in own area of medical physics practice in relation to patient safety.

	Knowledge (facts, principles, theories, practices)	**Skills** (cognitive and practical)	**Competence** (responsibility and autonomy)
Occupational & Public Safety / Risk Management *(when there is an impact on medical exposure or own safety)*	K35. Explain statutory and institutional roles of Medical Physics Services with respect to Occupational and Public Safety / Risk Management in own area of medical physics practice *when there is an impact on medical exposure or own safety*. K36. Explain the possible adverse biological effects (including mechanism) to workers / public from ionizing radiations (and other physical agents if approp) including the factors impacting the magnitude of the biological effect. K37. Explain the principles of occupational risk audit and management, hazard prevention and emergency preparedness as applied to ionizing radiations (and other physical agents if approp) associated with the use of medical devices in own area of medical physics practice. K38. Explain relevant international, European, national and local legislation, recommendations and documentation regarding risk from ionizing radiations and other physical agents with regard to occupational and public safety in own area of medical physics practice. K39. Explain how the principles of justification, optimization (including ALARA), and risk limitation are used for occupational and public protection from the deleterious effects of ionizing radiations and other physical agents. K40. Name and explain the function of the main National, European and International organizations concerned with protection of workers and the general public from ionizing radiations and other physical agents (e.g., ICRP, ICNIRP, IAEA). K41. Explain how sites and facilities are designed to ensure protection of workers and the general public. K42. Explain and explain the procedures for the prevention, investigation and handling of adverse incidents with respect to workers/public in own area of medical physics practice. K43. Explain quantitatively and in detail the interactions with organic matter of ionising and non-ionising electromagnetic radiations, particulate radiation, ultrasound and electric and magnetic fields at the molecular, cellular, tissue and macroscopic levels in relation to occupational / public risks. K44. Define and measure or calculate the operational quantities (including units and inter-relationships) used in personal dosimetry in own area of medical physics practice (e.g., ambient, directional and personal dose equivalents at recommended depth, annual limit on intake, derived air concentration).	S24. Perform occupational / public risk assessment based on facility survey and estimated / measured dosimetry data in own area of medical physics practice. S25. Assess occupational risk from given procedures in own area of medical physics practice from ionizing radiations and other physical agents using measured occupational dose data and dose-effect relationships. S26. Carry out a risk audit with respect to occupational / public safety from ionizing radiations and other physical agents in own area of medical physics practice. S27. Evaluate facilities/systems/procedures in terms of occupational / public safety from ionizing radiations and other physical agents in own area of medical physics practice. S28. Assess occupational risks for a given experimental procedure.	C26. Take responsibility for statutory and institutional requirements for Medical Physics Services in own area of medical physics practice with respect to Occupational and Public Safety / Risk Management *when there is an impact on medical exposure or own safety*.

	Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
Occupational & Public Safety / Risk Management (cont.)	K45. Explain the possible impact of human factors with regard to occupational / public safety in use of medical devices and associated ionizing radiations and other physical agents. K46. Explain the roles of occupational / public safety personnel associated with ionizing radiations and other physical agents such as Radiation Protection Expert and Radiation Protection Officer as defined in European, national and local legislation / documentation. K47. Explain the scope, objectives, structure and content of formal systems of work ('local rules'). K48. Explain in quantitative terms the various means of dose reduction for external radiation (source strengths, exposure times, distance, shielding) and internal radionuclides with respect to occupational / public safety. K49. State current dose limits and constraints for workers / public. K50. Explain the process and practical implementation of occup./ public risk assessments in own area of medical physics practice, using techniques for the qualitative and quantitative assessment of risk. K51. Explain the key considerations for the design of a new facility (including waiting and resting rooms) with regards to occupational / public safety in own area of medical physics practice. K52. Explain the principles and practice of contingency planning and the implementation of emergency procedures with respect to occupational / public safety in own area of medical physics practice. K53. Explain suitable processes for the reporting of radiation incidents involving workers / members of the general public in the context of own area of medical physics practice, using root cause analysis and/or other tools to determine the underlying cause(s). K54. Explain the requirements for, and the practical implementation of, appropriate systems for the monitoring of radiation dose to the worker, including extremity doses and dose limits for pregnant and lactating workers, and young workers; and for the public; including selection, management and calibration of devices used to measure such doses, dose records and techniques for dose measurement. K55. Explain how the application of good radiation safety practice and the use of appropriate personal protective equipment minimises worker and public doses in medicine. K56. Explain the principles radiation safety plan design with respect worker / public safety in own area of medical physics practice. K57. Explain the functioning of safety systems found in own area of medical physics practice vis-a-vis occupational / public safety.		

	Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
Clinical Medical Device Management	K58. Explain the purpose and practical implementation of formal systems of work ('local rules') with regard to safety in own area of medical physics practice. K59. Explain statutory and institutional requirements for Medical Physics Services with respect to Clinical Medical device Management in own area of medical physics practice. K60. Define / explain medical device terminology. K61. Survey the medical devices used in own area of medical physics practice and explain their purpose, modular structure and detailed functioning. K62. Explain the scope and function of national, European and International medical device standard setting bodies. K63. Explain the Medical Device Directives and associated documentation. K64. Explain the meaning of 'acceptability criteria' as applied to medical devices. K65. Explain and discuss the principles of medical device design with respect to clinical effectiveness and safety, including human-factors. K66. Explain the function of ICT hardware and software associated with devices including digital communications networks (LAN, WAN, network typologies, protected subnets for 'mission critical' devices including firewalls) and systems (e.g., PACS) and data exchange standards used in medicine (e.g., DICOM, DICOM-RT). Include discussions regarding hardware configuration, operating systems, IP terminology, port assignment, ftp, telnet, ping testing, network gates/ router procedures, virus infection risks (types, routes of propagation, and precautionary measures). K67. Explain relevant data and ICT security standards for collection, storage and transmission of data and Data Protection Legislation K68. Explain the operational relationships between hospital information systems (HIS) and information systems specific to own area of medical physics practice (e.g., RIS for imaging). K69. Explain and explain in detail the DICOM standard including its application to own area of medical physics practice. K70. Explain data warehousing for archiving and storage and relevant legislation regarding time such information must be kept. K71. Discuss medical device software standards and types of software licensing. K72. Explain the principles of medical device connectivity, connectivity standards and problems with interoperability.	S29. Use appropriate physical / software test objects / phantoms, data acquisition protocols, data recording forms, national / European / international protocols to measure the performance indicators of medical devices in own area of medical physics, assess deviations from acceptable values (as indicated by manufacturer and international / European / national standard setting bodies), evaluate the relevance of deviations for clinical practice and suggest actions for restoring default performance. S30. Evaluate technical specifications of commercial devices in own area of medical physics practice. S31. Carry out acceptance testing, commissioning and constancy testing procedures in own area of medical physics practice. S32. Adapt national and international acceptance testing, commissioning and QC standards to specific devices/device limitations where appropriate. S33. Evaluate whether medical device service agreements (including software updates) are adequate to ensure service continuity and patient and occupational safety in own area of medical physics practice.	C27. Take responsibility for statutory and institutional requirements for Medical Physics Services with respect to Clinical Medical Device Management in own area of medical physics practice. C28. Take responsibility for medical device (including software, information systems, PACS) management including planning, evaluation of clinical needs, specification for tender purposes, evaluation of tendered devices, acceptance testing, commissioning, constancy testing (including setting of warning and suspension levels), maintenance, decommissioning, installation design and surveillance, and service contract management in own area of medical physics practice. In the case of acceptance testing this should be done in cooperation with the vendor. C29. Participate in the procurement of new devices in own area of medical physics practice. C30. Take responsibility for the maintenance of quality control records. C31. Organize infrastructures for distribution, archiving and retrieval of images. C32. Organize infrastructures for display and reading of images and for the reporting and archiving of findings. C33. Pursue corrective actions with minimum interference with departmental functionality. C34. Establish and plan QA/QC procedures in appropriate support of the specific activity in own area of medical physics practice. C35. Take responsibility for the development of an institutional quality assurance / quality control medical device service as required by European and national medical device standard setting bodies in own area of medical physics practice. C36. Take responsibility for the development and ongoing update of departmental quality control protocols for medical devices in own area of medical physics practice.

	Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
Clinical Medical Device Management (cont.)	K73. Explain the effects of ionizing radiations and other physical agents on the workings of medical devices in general and in own area of medical physics practice (e.g., electromagnetic interference / compatibility). K74. Define and explain the principles of quality, quality assurance, quality control, performance indicators, constancy testing, quality control tests, test frequency, tolerances, and action criteria with respect to medical devices. K75. Explain the principles of medical device (including associated software) management including planning, evaluation of clinical needs, specification for tender purposes, evaluation of tendered devices, procurement, acceptance testing, commissioning, constancy testing, maintenance and decommissioning; service contract management. K76. Explain the functions of the major International and European standard (e.g., IEC, CENELEC) setting bodies (and others such as NEMA) for medical devices and explain the various types of documentation issued by these bodies and their use in medical device management. K77. Explain in detail international, national and local protocols for assessing the performance of medical devices in own area of medical physics practice. K78. Explain the principles of business planning, inventory control, auditing, benchmarking and handling of service contracts as applied in medical device management. K79. Explain and discuss the main properties of biomaterials relevant to medical device design.	S34. Analyze the medical devices used in own area of medical physics practice and investigate their design, functioning, associated signal / image processing, safety features, typical specifications and performance indicators. S35. Design and test physical and technical methods for quality control of devices in own area of medical physics practice. S36. Identify sources of device malfunctioning in own area of medical physics practice. S37. Autonomously acquire and analyze in detail the literature and user / technical manuals for medical devices in own area of medical physics practice. S38. Interpret and apply local occupational protection rules as applicable to medical device QC procedures. S39. Evaluate and participate in the selection of medical devices in a tender in own area of medical physics practice. S40. Utilize PACS and DICOM in own area of medical physics practice. S41. Apply available systems resources (e.g., RIS, PACS, DICOM data) to QA data elaboration and record. S42. Implement cross-institutional quality control procedures for devices. S43. Perform a documented risk assessment for devices not within suspension levels. S44. Design rooms to accommodate specific devices in own area of medical physics practice.	C37. Participate in the installation of new devices in own area of medical physics practice. C38. Negotiate device acceptance with provider and own department management following acceptance tests. C39. Organize, manage and train quality control teams in own area of medical physics practice. C40. Decide if actions are required on a medical device to restore default performance. C41. Define warning and suspension levels for devices.

	Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
Clinical Involvement	K80. Explain statutory and institutional requirements for Medical Physics Services in own area of medical physics practice with respect to Clinical Involvement. K81. Explain the principles of anatomy, physiology, biology (including radiobiology), pathology as related to the main clinical applications in own area of medical physics practice. K82. Explain trauma / development of diseases, diagnosis, treatment and follow-up relevant to own area of medical physics practice, including primary healthcare and screening programmes. K83. Explain the International Classification of Diseases (ICD). K84. Explain how medical devices/ ionizing radiations and other physical agents are used for the solution of clinical problems in own area of medical physics practice. K85. Explain the clinical applications and target clinical outcomes in the use of medical devices in own area of medical physics practice. K86. Explain clinical guidelines in own area of medical physics practice. K87. Explain the patient's perspective in clinical processes in own area of medical physics practice. K88. Explain the risk/benefit justification of procedures in own area of medical physics practice. K89. Explain protocol optimization principles in own area of medical physics practice. K90. Explain the design principles, the relevant legislation issues and approval procedures for clinical trials. K91. Explain the principles and implementation of Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) and Good Laboratory Practice (GLP) in own area of medical physics practice. K92. Explain general indications and contra-indications for the use of devices in own area of medical physics practice. K93. Understand the nature of anatomical/ pathological medical images as the visualization of the 3D distribution of physical variables. K94. Survey the main sources of evidence from within the general physics, medical physics and general healthcare (e.g., the Cochrane Collaboration) literature essential for the carrying out of a systematic survey in own area of medical physics practice. K95. Explain concepts in health informatics such as unique patient identifier, medical record and disease coding (e.g., ICD10). K96. Explain safety and risk related issues associated with the use of ICT in own area of medical physics practice.	S45. Recognize anatomical / pathological structures of the human body in projection / tomographic and 3D medical images relevant to own area of medical physics practice. S46. Recognize physiological processes in nuclear / molecular images. S47. Participate in clinical discussions within multidisciplinary teams in own area of medical physics practice. S48. Participate in the design of patient plans in own area of medical physics practice when appropriate. S49. Adhere to procedures regarding hygiene. S50. Participate in patient preparation and positioning prior to data acquisition when appropriate. S51. Analyze critically protocol proposals in terms of feasibility, effectiveness and safety. S52. Handle and analyze medical images including the extraction of parametric data / images. S53. Set up devices, experiments and protocols for the measurement of physical variables relevant to clinical practice. S54. Operate medical devices in own area of medical physics practice effectively and safely.	C42. Take responsibility for statutory and institutional requirements for Medical Physics Services in own area of medical physics practice with respect to Clinical Involvement. C43. Oversee daily patient safety / risk management involving medical devices and associated ionizing radiations and other physical agents in own area of medical physics. C44. Participate in the evaluation and optimization of clinical procedures and protocols and risk elimination / reduction in own area of medical physics practice in both routine and non-routine procedures. C45. Advise physician in image interpretation and quantification when appropriate. C46. Take responsibility for semi-quantitative and quantitative data for clinical application. C47. Advise on different patient diagnosis / treatment schedule options when appropriate. C48. Participate in the definition of the limits of acceptability of clinical procedures. C49. Advise on the most appropriate procedure with respect to risk/benefit ratio. C50. Supervise procedures for paediatric investigations in relation to dose optimization. C51. Advise other healthcare professionals on optimization and safety of individual patient examination / treatment and examination / treatment protocols. C52. Live up to demands imposed by duty of confidentiality, professional secrecy, ethical standards. C53. Represent medical physics in clinical conferences. C54. Take responsibility for the prevention, investigation and handling of adverse incidents (including use of Root Cause Analysis / Failure Modes and Effects Analysis or alternative methods; recommendations of appropriate remedial actions) with respect to patients in own area of medical physics practice.

	Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
Clinical Involvement (cont.)	K97. Explain patient flows and management of clinical processes in own area of medical physics practice. K98. Explain the use of information / communication standards in medicine such as HL7, SNOMED, IHE. K99. Explain the use of Patient Administration Systems, the Electronic Patient Record and Order Communication systems. K100. Explain security and privacy issues related to electronic patient information systems. K101. Explain the purpose and implementation of local systems for formal incident reporting and internal review with regard to risk management.		

	Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
Development of Service Quality and Cost-Effectiveness	K102. Explain statutory and institutional requirements for Medical Physics Services with respect to development of Service Quality and Cost-effectiveness in own area of medical physics practice. K103. Explain the principles of business, strategic planning and cost effectiveness in the case of Medical Physics Services. K104. Define and explain the principles of quality, continuous quality improvement, quality audit and total quality management systems as applied to aspects of clinical audits involving medical devices and associated ionizing radiations and other physical agents. K105. Explain why the holistic development of a service depends on the quality assurance of the parts. K106. Explain why the development of service quality for an area of medical practice requires input from various healthcare professionals. K107. Explain responsibilities of other healthcare professionals involved in QA activities in own area of medical physics practice. K108. Explain the intentions and principles of QA systems like ISO 9000 and formal systems for external accreditation by expert/professional bodies. K109. Define quality objectives in own area of medical physics practice. K110. Explain the institutional framework of QA activity and regulation in own area of medical physics practice. K111. Explain the functions of the major International and European standard setting bodies for healthcare quality; explain the various types of documentation issued by these bodies and explain its use for service quality development. K112. Explain the principles of Evidence Based Medicine and explain how the evidence base can be used to improve service quality. K113. Explain the purpose and implementation of local systems for formal incident reporting and internal review with regard to improvement of service quality.	S55. Participate in development of service quality and cost-effectiveness in own area of medical physics practice. S56. Define quality objectives in own area of medical physics practice. S57. Define, measure and optimize appropriate quality indicators in own area of medical physics practice. S58. Set up a service quality development strategy for own area of medical physics practice. S59. Prepare a business and strategic plan for the development of Medical Physics Services in own area of medical physics practice. S60. Apply the principles of business, strategic planning and cost effectiveness in own area of medical physics practice. S61. Set up and continuously develop a feedback system for ongoing improvement of quality (based on assessment of non-conformities and accident analysis) in own area of medical physics practice. S62. Apply available resources (such as those in RIS/PACS systems) to elaboration and recording of quality related data. S63. Measure quality management performance and improvements in own area of medical physics practice. S64. Participate in the reporting, review and analysis of incidents.	C55. Take responsibility for statutory and institutional requirements for Medical Physics Services with respect to Development of Service Quality and Cost-Effectiveness in own area of medical physics practice, whilst being aware that improvement of the service as a whole depends on the inputs of other healthcare professionals. C56. Advise on the technical aspects impacting the clinical effectiveness and safety of new medical devices or techniques prior to their introduction into clinical practice. C57. Participate in the design and implementation of QA systems in own area of medical physics practice. C58. Take responsibility for using the methodologies of Evidence Based Medicine to investigate ways of improving service quality within own area of medical physics practice. C59. Assume responsibility for quality management audits involving medical devices and associated ionizing radiations and other physical agents. C60. Take responsibility for the design and implementation of a monitoring system for Medical Physics Services in own area of medical physics practice. C61. Take responsibility for the development and implementation of a business and strategy plan for Medical Physics Services in own area of medical physics practice. C62. Take responsibility for the formal review and analysis of incidents within own area of medical physics practice.

	Knowledge (facts, principles, theories, practices)	**Skills** (cognitive and practical)	**Competence** (responsibility and autonomy)
Expert Consultancy	K114. Explain statutory and institutional requirements for Medical Physics Services in own area of medical physics practice with respect to Expert Consultancy. K115. Explain the role of a consultant. K116. Explain the role of scientists as consultants in healthcare. K117. Explain the general role of the MPE as consultant in own area of medical physics practice. K118. Discuss the specific ethical issues involved in delivering a consultancy service in own area of medical physics practice (including conflict of interest issues).	S65. Apply MPE consultancy skills to specific scenarios in own area of medical physics practice. S66. Identify and manage ethical issues involved in delivering a consultancy service in own area of medical physics practice (including conflict of interest issues).	C63. Take responsibility for statutory and institutional requirements for Medical Physics Services in own area of medical physics practice with respect to Expert Consultancy including responsibility for associated ethical issues commensurate with level of personal expertise. C64. Produce and/or audit reports as an independent provider for organizations other than one's own. C65. Design and evaluate continuous professional courses in own area of medical physics practice for organizations other than one's own.
Educ. of Healthcare Professionals (including Medical Physics trainees)	K119. Explain statutory and institutional requirements for Medical Physics Services with respect to the education and training of healthcare professionals (including Medical Physics trainees) in own area of medical physics practice. K120. Discuss the application of the principles of knowledge transfer to the case of healthcare professionals. K121. Discuss the principles of modern adult pedagogy and apply them to the medical device and ionizing radiations and other physical agents educational needs of healthcare professionals (including continuous professional development activities) and including training associated with the introduction of new devices and techniques. K122. Discuss methods for developing and delivering ionizing radiations and other physical agents education and training learning outcomes for addressing the learning needs of specific healthcare professionals in specific clinical environments. K123. Discuss the factors which impact the choice of learning outcomes and methods of knowledge transfer to the case of medical device and ionizing radiations and other physical agents knowledge for specific healthcare professionals in specific clinical environments (such as previous education and training and the usability and safety features of devices). K124. Explain the content of appropriate programmes for healthcare professionals involving the optimised clinical use of medical devices and protection from ionizing radiations and other physical agents in own area of medical physics practice .	S67. Set up an inventory of learning outcomes tailored to the specific learning needs of specific healthcare professionals in specific clinical environments in conjunction with the leaders of the respective healthcare professions. S68. Prepare effective and efficient modes of knowledge transfer activities specific to the specific learning needs of specific healthcare professionals in specific clinical environments in conjunction with the leaders of the respective healthcare professions. S69. Prepare effective modes of assessment appropriate for the various healthcare professions. S70. Carry out own pedagogical research when the evidence base for education and training of healthcare professions is insufficient.	C66. Take responsibility for statutory and institutional requirements for Medical Physics Services in own area of medical physics practice with respect to the Education (including continuous professional development) of Healthcare Professionals (including Medical Physics trainees). C67. Take responsibility for the education of healthcare professionals (including Medical Physics trainees) regarding the optimised clinical use of medical devices and safety from ionizing radiations and other physical agents in specific clinical environments in own area of medical physics practice. C68. Take responsibility for the education of healthcare professionals (including Medical Physics trainees) in performing QC procedures related to medical devices in own area of medical physics practice. C69. Take responsibility for the education of healthcare professionals (including Medical Physics trainees) regarding protection from ionizing radiations and other physical agents including the use of personal dose monitors and personal protection equipment. C70. In conjunction with other healthcare professionals take responsibility for ensuring that referrers are knowledgeable of current referral criteria in own area of medical physics practice. C71. Take responsibility for raising public awareness of safety issues regarding ionizing radiations and other physical agents in own area of medical physics practice.

	Knowledge (facts, principles, theories, practices)	Skills (cognitive and practical)	Competence (responsibility and autonomy)
Health Technology Assessment	K125. Explain statutory and institutional requirements for Medical Physics Services in own area of medical physics practice with respect to Health Technology Assessment (HTA). K126. Explain the principles of HTA as applied to medical devices and procedures in own area of medical physics practice. K127. Explain the steps for the carrying out a HTA, including use of primary data and secondary sources. K128. Define the roles and responsibilities of all professionals involved in an HTA project in own area of medical physics practice. K129. Explain the issues that should be considered in an HTA project in own area of medical physics practice. K130. Explain the value of HTA reports for policy makers at the European, national, regional and facility levels. K131. Explain the importance of HTA reports in controlling cost in relation to benefit for the considered technology in own area of medical physics practice. K132. Apply research methodologies and statistical techniques used at the interface between physical and biomedical science in clinical trials involving medical devices and/or ionizing radiations and other physical agents. K133. Discuss the ethical issues associated with clinical trials involving medical devices and/or ionizing radiations and other physical agents. K134. Explain how to apply for approval from a hospital and /or university based ethics committee for a clinical trial involving medical devices and /or ionizing radiations and other physical agents. K135. Explain the fundamentals and design models of clinical trials in own area of medical physics practice.	S71. Perform a systematic review of the existing evidence base to evaluate the clinical effectiveness and safety of a new medical device or new procedure involving medical devices / ionizing radiations and other physical agents. S72. Communicate HTA reports to policy makers. S73. Interpret the statutory and institutional requirements of Medical Physics Services in HTA activities. S74. Design and monitor the medical physics components of clinical trial protocols in own area of medical physics practice. S75. Perform statistical analysis and report on clinical trials involving medical physics services. S76. Assemble a suitable physics team for a specific HTA project. S77. Conduct the technical components of an HTA project in own area of medical physics practice.	C72. Take responsibility for statutory and institutional requirements for Medical Physics Services in own area of medical physics practice with respect to Health Technology Assessment (HTA). C73. Use the methodologies of HTA to carry out a HTA in conjunction with other healthcare professionals. C74. Take responsibility for the technical component of a HTA related to medical devices and /or ionizing radiations and other physical agents. C75. Take responsibility for the technical component of a clinical trial related to medical devices and /or ionizing radiations and other physical agents. C76. Take responsibility and communicate with relevant authorities with regards to safety from ionizing radiations and other physical agents in the case of clinical trials. C77. Apply for approval from a hospital and /or university based ethics committee for a clinical trial involving medical devices and /or ionizing radiations and other physical agents. C78. Take responsibility for the evaluation of a clinical trial protocol. C79. Ensure good clinical practice (GCP) compliance of activities within clinical trials. C80. Advise on and take responsibility for the preclinical device aspects of the ethical review of a clinical trial. C81. Assume the responsibility of statistical and other mathematical data processing and recording in a clinical trial.

	Knowledge (facts, principles, theories, practices)	**Skills** (cognitive and practical)	**Competence** (responsibility and autonomy)
Innovation	K136. Explain statutory and institutional requirements for Medical Physics Services with respect to Innovation in own area of medical physics practice. K137. Define innovation as the development of new devices (including software), modification of existing devices (including software) and the development of new techniques using devices for the solution of hitherto unresolved clinical problems. K138. Explain the importance of ongoing horizon scanning for new and emerging technologies. K139. Explain the methodology of horizon scanning for new and emerging technologies. K140. Discuss the opportunities for innovation in own area of medical physics practice.	S78. Apply the methodology of horizon scanning (including survey of specific information sources) for new and emerging technologies to own area of medical physics practice.	C82. Take responsibility for statutory and institutional requirements for Medical Physics Services with respect to Innovation in own area of medical physics practice. C83. Take responsibility for the development of new devices (including software) and modification of existing devices (including software), including their implementation and evaluation in response to clinical needs in own area of medical physics practice. C84. Take responsibility for legal issues involved in the development of medical devices (including software) in own area of medical physics practice.

Appendix C

Competences of a MPP specific to the specialties of Radiation therapy, Nuclear Medicine, and Diagnostic and Interventional Radiology as specified by IAEA

TABLE 2. SUMMARY OF THE ROLES AND RESPONSIBILITIES OF CLINICALLY QUALIFIED MEDICAL PHYSICISTS SPECIFIC TO THE SPECIALTIES OF RADIATION THERAPY, NUCLEAR MEDICINE, AND DIAGNOSTIC AND INTERVENTIONAL RADIOLOGY

Area of responsibility	Radiation therapy	Nuclear medicine	Diagnostic and interventional radiology
(a) *Installation design, technical specification, acceptance, commissioning and maintenance of equipment*	(i) Be an essential part of the team for shielding and installation design of new or modified radiation therapy rooms, ensuring that safety requirements are complied with; (ii) Lead the development of equipment specifications; (iii) Have responsibility for the acceptance and commissioning of equipment, including radiation therapy treatment and imaging units, brachytherapy sources and treatment planning systems; (iv) Provide advice on equipment decommissioning.	(i) Be an essential part of the team for the shielding and installation design of new or modified facilities, ensuring that safety requirements are complied with; (ii) Lead the development of equipment specifications; (iii) Have responsibility for the acceptance and commissioning of equipment; (iv) Provide advice on equipment decommissioning.	(i) Be an essential part of the team for the shielding and installation design of new or modified facilities, ensuring that safety requirements are complied with; (ii) Lead the development of equipment specifications; (iii) Have responsibility for the acceptance and commissioning of equipment; (iv) Provide advice on equipment decommissioning.

TABLE 2. SUMMARY OF THE ROLES AND RESPONSIBILITIES OF CLINICALLY QUALIFIED MEDICAL PHYSICISTS SPECIFIC TO THE SPECIALTIES OF RADIATION THERAPY, NUCLEAR MEDICINE, AND DIAGNOSTIC AND INTERVENTIONAL RADIOLOGY (cont.)

Area of responsibility	Radiation therapy	Nuclear medicine	Diagnostic and interventional radiology
(b) *Radiation safety and protection of patients, staff and the general public*	(i) Develop the clinical radiation safety programme for radiation protection of patients, staff and the public; (ii) Participate in the investigation of radiation incidents and accidents; (iii) Develop procedures for verifying the integrity, safe operation and use of radiation therapy equipment and accessories.	(i) Develop the clinical radiation safety programme for radiation protection of patients, staff and the public; (ii) Participate in the investigation of radiation incidents and accidents; (iii) Develop procedures for verifying the integrity, safe operation and use of nuclear medicine equipment and radioactive sources.	(i) Develop the clinical radiation safety programme for radiation protection of patients, staff and the public; (ii) Participate in the investigation of radiation incidents and accidents; (iii) Develop procedures for verifying the integrity, safe operation and use of diagnostic and interventional radiology equipment and accessories.

TABLE 2. SUMMARY OF THE ROLES AND RESPONSIBILITIES OF CLINICALLY QUALIFIED MEDICAL PHYSICISTS SPECIFIC TO THE SPECIALTIES OF RADIATION THERAPY, NUCLEAR MEDICINE, AND DIAGNOSTIC AND INTERVENTIONAL RADIOLOGY (cont.)

Area of responsibility	Radiation therapy	Nuclear medicine	Diagnostic and interventional radiology
(c) *Patient radiation dosimetry*	(i) Acquire the data needed for the clinical use of treatment units (part of the acceptance and commissioning process for entry into service); (ii) Develop tables of data for clinical use; (iii) Establish and perform procedures for patient dose calculation and verification; (iv) Have overall responsibility for the treatment planning calculations; (v) Perform patient dose verifications including in vivo dosimetry.	(i) Perform activity measurements and calculation of the dose received by different organs following the administration of radiopharmaceuticals in the various clinical procedures; (ii) Perform patient specific dose calculations, establishing tolerances.	(i) Establish procedures for estimating the absorbed dose in patients during different clinical procedures; (ii) Perform patient specific dose calculations, establishing tolerances; (iii) Perform patient dose estimations to establish diagnostic reference levels, or to verify conformity with recommended diagnostic reference levels.

TABLE 2. SUMMARY OF THE ROLES AND RESPONSIBILITIES OF CLINICALLY QUALIFIED MEDICAL PHYSICISTS SPECIFIC TO THE SPECIALTIES OF RADIATION THERAPY, NUCLEAR MEDICINE, AND DIAGNOSTIC AND INTERVENTIONAL RADIOLOGY (cont.)

Area of responsibility	Radiation therapy	Nuclear medicine	Diagnostic and interventional radiology
(d) *Optimization of physical aspects of medical procedures*	(i) Optimize the treatment planning process, including image acquisition and treatment delivery; (ii) Develop a quality management programme for radiation therapy imaging, dose calculation and treatment delivery systems.	(i) Optimize data acquisition processes and procedures to improve image quality while minimizing radiation dose to patients; (ii) Assist nuclear medicine medical practitioners in evaluating examination efficacy and in image quality and perception studies.	(i) Optimize data acquisition techniques and procedures to improve image quality while minimizing radiation dose to patients; (ii) Assist diagnostic and interventional radiology medical specialists in evaluating examination efficacy and in image quality and perception studies.

TABLE 2. SUMMARY OF THE ROLES AND RESPONSIBILITIES OF CLINICALLY QUALIFIED MEDICAL PHYSICISTS SPECIFIC TO THE SPECIALTIES OF RADIATION THERAPY, NUCLEAR MEDICINE, AND DIAGNOSTIC AND INTERVENTIONAL RADIOLOGY (cont.)

Area of responsibility	Radiation therapy	Nuclear medicine	Diagnostic and interventional radiology
(e) *Quality management of the physical and technical aspects*	Participate as a team member in designing and implementing a quality management programme, being responsible for: (i) Developing institutional policies and procedures related to the use of radiation; (ii) Establishing and implementing a quality assurance programme for treatment units, treatment planning systems, dosimetry equipment and radiation therapy imaging equipment; (iii) Calibrating radiation generators and brachytherapy sources according to a well established code of practice; (iv) Performing risk assessment, identifying potential radiation exposures, and developing action procedures for such events. (v) Investigating unintended or accidental medical exposures.	Participate as a team member in designing and implementing a quality management programme, being responsible for: (i) Developing institutional policies and procedures for the continuous optimization of radiation use; (ii) Establishing and implementing a quality assurance programme with appropriate elements for the handling and measurement of radioactive sources and regulatory compliance of imaging and dosimetry equipment; (iii) Performing risk assessment, identifying potential radiation exposures and developing action procedures for such events; (iv) Investigating unintended or accidental medical exposures.	Participate as a team member in designing and implementing a quality management programme, being responsible for: (i) Developing institutional policies and procedures for the continuous optimization of radiation use; (ii) Developing and implementing procedures for the initial and continuing evaluation of the imaging and associated equipment, as well as calibration of patient dosimetry equipment; (iii) Calibrating X ray units according to a well established code of practice; (iv) Ensuring compliance of imaging radiation equipment with government and accreditation agency regulations and recommendations.

TABLE 2. SUMMARY OF THE ROLES AND RESPONSIBILITIES OF CLINICALLY QUALIFIED MEDICAL PHYSICISTS SPECIFIC TO THE SPECIALTIES OF RADIATION THERAPY, NUCLEAR MEDICINE, AND DIAGNOSTIC AND INTERVENTIONAL RADIOLOGY (cont.)

Area of responsibility	Radiation therapy	Nuclear medicine	Diagnostic and interventional radiology
(f) *Collaboration with other clinical professionals as key team members*	(i) Provide consultation to radiation oncology medical practitioners to establish optimal treatment technique; (ii) Supervise technologists in the implementation of new clinical procedures, including assistance in set-up and correct treatment delivery.	(i) Provide consultation to nuclear medicine medical practitioners on special cases of diagnostic exploration or treatment and assist to establish the optimized approach for each case; (ii) Assist to introduce new clinical procedures, develop methods for their quality assurance and control, and supervise their implementation.	(i) Provide consultation to diagnostic and interventional radiology medical practitioners on special cases of diagnostic or interventional procedures and assist to establish the optimized approach for each case; (ii) Assist to introduce new clinical procedures, develop methods for their quality assurance and control, and supervise their implementation.

Appendix D

Occupational and Public Radiation Protection as specified by IAEA

(ii) Supervision of technologists in the implementation of new clinical procedures: Medical physicists are responsible for supervising the introduction of new clinical imaging procedures in their institution. They are also responsible for developing methods for QC for the new procedures.

4.3. OCCUPATIONAL AND PUBLIC RADIATION PROTECTION

The BSS [3] assign specific responsibilities to the medical physicist for medical exposures and the patient's radiation protection, both intrinsically related to therapeutic and diagnostic procedures using ionizing radiation discussed in previous sections. The BSS [3] also introduce the term 'radiation protection officer' (RPO) for:

> "A person technically competent in radiation protection matters relevant for a given type of practice who is designated by the registrant, licensee or employer to oversee the application of relevant requirements."

In many clinical environments, medical physicists have responsibilities not only for the safety of the patient, but also for the protection of the staff and the public, as well as for the safety of radioactive sources. As stated jointly by the IOMP and the International Radiation Protection Association [10], all medical physicists receive adequate training in radiation protection and, as part of their assigned duties, many act as RPOs in health facilities and/or participate as members of the radiation safety committee. One of the specialties of medical physics is medical health physics (radiation protection in medicine). Medical physicists trained in this specialty and working mostly in large teaching hospitals undertake the role of RPOs, which may require a higher level of training and more experience in radiation protection.

The main roles and responsibilities of CQMPs in radiation protection in the workplace and for the public are described in this section. They are classified into two major areas, namely safety of the staff and the public, and safety of radioactive sources.

4.3.1. Safety of the staff and the public

(a) *Installation design, technical specification, acceptance and commissioning of equipment, including the establishment of criteria for acceptable performance*: CQMPs collaborate in the shielding design of installations and ensure compliance with safety requirements, classify work areas into supervised and controlled areas, help to develop and define the technical specifications for the purchase of new equipment for radiation protection and safety inspections, and develop procedures for the initial and continued evaluation of such equipment. They advise on practical methods to reduce the dose to the staff and the public who work or are in areas adjacent to rooms where radiation equipment is installed or radioactive sources used. In addition, they are responsible for designating the areas in which pregnant, occupationally-exposed women may not work. They also perform calculations and surveys to verify the adequacy of the existing shielding in these rooms using their relevant dimensions, occupancy factors and workload, and establish criteria for the access to rooms that are controlled, with limited access to members of the public, supervising their implementation. CQMPs are also responsible for supervising the installation of new radiation protection equipment and for performing acceptance testing and commissioning of such equipment, including related computer systems, their algorithms, data and results.

(b) *Radiation safety programme for the protection of staff and the general public*: CQMPs have responsibilities in the development and implementation of a clinical radiation safety programme for the hospital, including policies and procedures for the radiological protection and safety of the workers and the public. CQMPs carry out hazard assessment of the facilities and procedures, and establish whether the existing procedures are adequate (taking into account the type of radiation sources), the dose rates to which staff members may be exposed, the results of personnel dosimetry obtained for similar activities, control measures in place, and the need for personal protection devices, such as lead aprons, thyroid shields, goggles and other devices. They ensure that the latter are correctly used and tested periodically for integrity. CQMPs have responsibilities in establishing policies and procedures for the safe transport of radioactive material, for precautions in cases of contamination or spillage of unsealed radionuclides, for the management of radioactive waste and for the integrity and proper operation of survey meters and other measuring equipment, as required by the regulations

(c) *Radiation dosimetry*: CQMPs organize and provide personnel dosimetry and monitoring systems at a local level, following the local legislative procedures. Records of personnel dosimetry and of estimated doses received by members of the public are maintained for the period of time specified in national regulations. They also have responsibilities in investigating anomalous exposures and determine whether any radiological hazard is present, and if so to what extent, particularly when hazards result from gamma rays emitted by radioactive sources or from ionizing radiation emitted by equipment used for diagnosis or treatment. They develop procedures and contingency plans to deal with unintended or accidental exposures, and make recommendations on actions required to minimize the likelihood of such unintended exposures happening again. In addition, they provide the required surveys, interpret their results and evaluate compliance with the appropriate regulatory bodies.

(d) *Optimization of the physical and technical aspects of radiation safety procedures*: CQMPs carry out radiation protection and safety audits, and identify whether appropriate licences exist. They ensure that radiation areas are properly designated and warning signs are in place, and that radiological checks of the working areas provide evidence for compliance with the existing radiation protection policies and procedures, as well as with regulatory and accreditation agency rules and recommendations.

(e) *Quality management of the physical and technical aspects of radiation safety equipment*: CQMPs have responsibilities in developing, implementing and supervising the physical aspects of the quality management programme for the equipment used for radiation protection of the staff and the public. Related tasks include:

  (i) Developing institutional policies and procedures for the safe and optimal use of equipment used for radiation detection and measurement.

  (ii) Establishing QA programmes and performing QC for all of the radiation protection equipment: CQMPs are responsible for the selection, periodic calibration and QC processes used to establish the correct operation of equipment used for radiation surveys, as well as for the associated systems used for environmental monitoring, as required by the regulations.

  (iii) Carrying out risk assessment and management: CQMPs are responsible for the integrity of the survey meters and other equipment used to measure the radiation levels to which staff and/or the public is exposed, and for establishing methods to minimize the radiation dose to the staff and the public, thus reducing the associated risks.

(f) *Collaboration with other clinical professionals*: CQMPs work with other clinical professionals, including medical practitioners, technologists and nursing staff, on special cases that may be encountered in the clinical environment and may compromise the safety of the staff and the public, e.g. an accident during the transport of radioactive materials. In such cases, the members of the public and/or the driver that may be involved, injured or contaminated are brought to the hospital for observation and possible treatment. The role of the CQMP, acting in most cases as RPO, is essential in providing instructions on the actions to be taken for triage and decontamination of such victims without spreading the contamination, and to prevent unnecessary radiation exposure of staff members and other patients during treatment. Collaboration between medical practitioners and medical physicists helps to establish the optimal approach for each case, and the CQMP provides advice on safety for the best and safest outcome of such special situations.

(g) *Education and training*: CQMPs provide education and continuous training to clinical staff on radiation safety and radiological protection. They ensure that training programmes are in place and deliver lectures and practical training to staff on the basic principles of radiation safety, including the classification of controlled and supervised areas, the expected exposure resulting from different diagnostic or therapeutic procedures using radiation sources, and establish and promote a safety culture and the concept of defence in depth.

4.3.2. Safety of radioactive sources

(a) CQMPs establish procedures for the safe transport of radioactive sources and equipment that emit or use radiation within the hospital complex, taking into account all regulatory requirements and safety considerations. This includes transfer of ownership of sources during delivery or disposal.

(b) CQMPs develop a programme of physical security for radioactive sources, including procedures for receiving, storing securely, stock-taking and controlling their fixed or temporary location at the hospital. They plan and supervise regular inventories of all of the radioactive sources, ensuring their safe disposal as radioactive waste when relevant, according to national and international safety regulations and recommendations.

(c) CQMPs perform risk assessments and identify possible accidents or losses of radioactive sources, develop action procedures to be followed in the event of such occurrences and carry out exercises to verify that they can be implemented correctly.

5. STAFFING AND ORGANIZATION OF A MEDICAL PHYSICS SERVICE

Staffing requirements for providing medical physics services supporting the efficient and safe care of patients need to be defined using criteria consistent with current medical practice. The impact of the continuous development of medical technology and its applications, as well as changes in the regulatory requirements worldwide, make most previous recommendations on staffing outdated. Although

Appendix E

Subsidiary Legislation 585.01, 2018, Regulation 107

undertaking the performance of the tasks of radiation protection of workers and members of the public.

(5) Where a radiation protection expert is consulted pursuant to the requirements of these regulations the undertaking shall appoint that radiation protection expert in writing and shall include in that appointment the scope of the advice which the radiation protection expert is required to give.

Radiation Protection Experts.

106. (1) Radiation protection experts need to be recognized by the Commission and will need to meet the following generic criteria:

(a) have a degree in radiography, medicine, or other physical science or a suitable combination of other qualifications and experience; and

(b) sufficient work experience directly concerned with radiation protection practice; and

(c) undertake continued professional development.

(2) The Commission shall issue detailed requirements for different applications based on the generic criteria given in the above.

(3) Radiation protection experts shall need re-certification by the Commission.

Medical physics experts.

107. (1) Medical physics experts are to act or give specialist advice, as appropriate, on matters relating to radiation physics for implementing the requirements set out in Part VII and in paragraph (b) of regulation 31(1).

(2) Depending on the medical radiological practice, the medical physics expert shall take responsibility for dosimetry, including physical measurements for evaluation of the dose delivered to the patient and other individuals subject to medical exposure, give advice on medical radiological equipment, and contribute in particular to the following:

(a) radiation protection programme;

(b) development of safety culture;

(c) optimisation of the radiation protection of patients and other individuals subject to medical exposure, including the application and use of diagnostic reference levels;

(d) the definition and performance of quality assurance programmes of the medical radiological equipment;

(e) testing of medical radiological equipment;

(f) the preparation of technical specifications for medical radiological equipment and installation design;

(g) the surveillance of the medical radiological installations;

(h) the analysis of events involving, or potentially involving, accidental or unintended medical exposures;

(i) the selection of equipment required to perform radiation protection measurements;

(j) the training of practitioners and other staff in relevant aspects of radiation protection.

(3) The medical physics expert shall, where appropriate, liaise with the radiation protection expert.

Approval certificates.

108. The Commission shall issue approval certificates for medical physics experts for a validity period of not greater than a period of five years in a specialty (radiotherapy, nuclear medicine, diagnostic and interventional radiology)

Meetings.

109. (1) Medical physics experts shall meet the following criteria for initial certification by the Commission:

(a) be registered by the Council for the Professions complimentary to Medicine in Malta as a medical physicist; and

(b) have attained European Qualifications Framework (EQF) Level 7 (ex: Master with 90-120 European Credit Transfer and Accumulation System (ECTS)); and

(c) two years structured accredited clinical training in Medical Physics in specialty (radiotherapy, nuclear medicine, diagnostic and interventional radiology); and

(d) two years documented full time work experience, within the preceding 28 months, in specialty (radiotherapy, nuclear medicine, diagnostic and interventional radiology) with documented CPD.

(2) Medical physics experts shall meet the following criteria for re-certification by the Commission:

(a) 48 months full time work experience in their specialty during the valid approval period, but not necessary 48 consecutive months.

(b) Documented CPD since the last certificate issued.

Radiation protection officer.

110. (1) All undertakings and employers of outside workers shall designate a radiation protection officer.

Appendix F

Characteristics that suggest the need for strategic planning

Perera, et al., (2012) outlined five characteristics that when combined, suggest the need for strategic planning. These are:

a) Clientele who are more aware and demanding: Assuming patients are the profession's only direct or indirect clients, it stands to reason that in the years ahead, the profession will be caring for patients who are more informed and more capable of selecting their healthcare provider. This is a choice that has implications for funding.
b) Increasing numbers of competent and professional rivals: On a global scale, it is becoming easier to locate highly trained experts; the high degree of specialisation and quality across these professionals is becoming more common
c) Limited organisational resources: The increasing responsibility to spend resources rationally, enabling only the finest and most effective professionals to persist, is one potential reaction to this circumstance.
d) The client is given more attention than the service: Organisations prioritise on the patient receiving a good service and getting the greatest outcomes rather than just performing tasks as efficiently as feasible. It is not only about what, but also about how a task should be performed.
e) Size and intricacy of the organisation: The population has grown in number, meaning that the requirements have also grown, and there are now more diagnostic and treatment choices available, which has caused organisations to physically expand in size and organisational complexity to rise.

Appendix G

List of processes for creating a strategic plan by using SWOT methodology

The following list outlines the processes for creating a strategic plan using the SWOT methodology (Caruana, 2020):

a. Choose the values that will guide the activity in strategic planning.
b. Create or revise the present strategic mission statement.
c. While keeping the purpose of the vision in mind, create a desirable future vision for the profession.
d. Do a gap analysis to determine the gaps between the existing condition of the profession and the anticipated future vision.
e. Conduct a situational analysis of the profession's SWOTs in relation to the desired vision.
f. Determine and rank a number of strategic objectives for bridging the gaps and moving closer to the desired vision.
g. Create a thorough strategic action plan to accomplish each of the strategic goals.
h. Carry out the plan.
i. Control and evaluate the plan and iterate if necessary.

Appendix H

Five points to follow for the development of effective questions

The following list provides the criteria to follow for the development of effective questions as outlined by Floyd J. Fowler, Jr. (1995):

a) Detailing the goals of the question and outlining the types of responses that are necessary to attain those goals.
b) Ensuring that each participant has a similar understanding of the question's context. All respondents should be able to understand the question's key terms and have the same perspective of those notions.
c) Ensuring that participants are asked questions for which they have the answers. Finding the solutions is impacted by at least three different sorts of challenges.:
    - Not possessing the information required to address the question.
    - Possessing the information but not being able to recall it precisely or to the level of specificity required by the question.
    - The difficulty of precisely dating events for questions concerning interactions or occurrences during a certain time period.
d) Presenting questions that respondents can respond to in the way that the question specifies. It is possible to ask participants queries to which they know the answer, but they are unable to respond in the manner the researcher desires because the researcher's preferences do not align with the reality that the participant is expressing.
e) Asking queries that respondents would not object in responding. This is required to gather responses that can be combined to produce statistical information. The question must also be able to be stated effectively so that every person would understand what it meant.

Appendix I

Questionnaire

Questionnaire

Please mark the boxes with a ☑ as appropriate.

Section 1: General Questions

1.1 Which gender do you identify with?
- Male ☐
- Female ☐
- Other ☐

1.2 Which undergraduate degree did you pursue?
- Physics ☐
- Electrical Engineering ☐
- Mechanical Engineering ☐

1.3 Which area do you specialise in?
- Radiation Oncology ☐
- Diagnostic and Interventional Radiology ☐
- Nuclear Medicine ☐

1.4 Are you certified as a Medical Physics Expert by the Commission for Protection from Ionising and Non-Ionising Radiation?
- Yes ☐
- No ☐

1.5 Are you certified as a Radiation Protection Expert by the Commission for Protection from Ionising and Non-Ionising Radiation?
- Yes ☐
- No ☐

1.6 Are you certified as MR Safety Expert (MRSE) by any accredited organisation?
- Yes ☐
- No ☐

1.7 Are you certified as Laser Safety expert by any accredited organisation?
- Yes ☐
- No ☐

1.8 Medical physicists in Malta are involved in the specification and procurement of (tick all that apply):
- Ionising radiation based medical devices ☐
- Non-ionising radiation based medical devices ☐
- All medical devices ☐
- None of the above ☐

1.9 Medical physicists in Malta are involved in acceptance testing of (tick all that apply):
- Ionising radiation based medical devices ☐
- Non-ionising radiation based medical devices ☐
- All medical devices ☐
- None of the above ☐

1.10 Medical physicists in Malta are involved in the commissioning of (tick all that apply):

Ionising radiation based medical devices ☐
Non-ionising radiation based medical devices ☐
All medical devices ☐
None of the above ☐

1.11 Medical physicists in Malta carry out quality assurance of (tick all that apply):

Ionising radiation based medical devices ☐
Non-ionising radiation based medical devices ☐
All medical devices ☐
None of the above ☐

1.12 Medical physicists in Malta are involved in the decommissioning of (tick all that apply):

Ionising radiation based medical devices ☐
Non-ionising radiation based medical devices ☐
All medical devices ☐
None of the above ☐

1.13 Medical physicists in Malta are involved in optimising clinical use of (tick all that apply):

Ionising radiation based medical devices ☐
Non-ionising radiation based medical devices ☐
All medical devices ☐
None of the above ☐

1.14 Medical physicists in Malta provide advice regarding patient risks from medical device associated physical agents including protection from such physical agents in the following cases (tick all that apply):

Ionising radiation ☐
Non-ionising radiation ☐
All physical agents ☐
None of the above ☐

1.15 Medical physicists in Malta are involved in the design and installation of new facilities of (tick all that apply):

Ionising radiation based medical devices ☐
Non-ionising radiation based medical devices ☐
All medical devices ☐
None of the above ☐

1.16 Medical physicists in Malta provide advice regarding the prevention of unintended or accidental exposures to physical agents from (tick all that apply):

Ionising radiation based medical devices ☐
Non-ionising radiation based medical devices ☐
All medical devices ☐
None of the above ☐

1.17 The medical physics profession in Malta is seen by stakeholders as contributing significantly to the over-arching mission of the wider healthcare system of which it forms part:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

1.18 I feel that I am aware of what is internationally considered best practice in my specialty area of Medical Physics:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

1.19 There has never been a shortage of material resources that are required to enable me to deliver my professional services to the healthcare system:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

1.20 What do you believe are the specific unique benefits the Medical Physics profession in Malta provides and to whom (patients, other healthcare professionals, hospital management)? Please explain.

____
____

Section 2: Possible Strengths of the MP profession in Malta

2.1 Medical Physicists in Malta have a deep techno-scientific expertise regarding medical devices used in their specialty and their clinical use:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

2.2 Medical Physicists in Malta have a deep techno-scientific expertise regarding the protection of patients, workers and the general public from ionising radiation and other physical agents used in their specialty:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

2.3 Medical Physicists in Malta have strong analytical, problem-solving, and trouble-shooting skills:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

2.4 Medical Physicists in Malta have strong mathematical, statistical and data analysis skills:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

2.5 The Medical Physics profession in Malta has a strong legal foundation:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

2.6 Medical Physicists in Malta have strong scientific research skills:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

2.7 Medical Physicists in Malta have strong information and communication technology skills:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

2.8 Present Medical Physics services in Malta compare well with other EU countries:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

2.9 Do you consider that the qualification and curriculum frameworks leading to the certification of Medical Physics professionals in Malta (Bachelor in Physics/Engineering, Masters in Medical Physics, and 2 years clinical training) are sufficient to ensure the production of high calibre professionals?

Yes ☐
No ☐

2.10 Which element might be improved and how?

____

____

2.11 Are there any other notable strengths that you can highlight for the MP profession in Malta?

____

Section 3: Possible Weaknesses of the MP profession in Malta

3.1 One of the problems that the profession faces in Malta is the absence of a universally known mission statement for the profession for Malta:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment.

____

3.2 The Medical Physics profession in Malta has a narrow range of specialisations:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment

____

2.9 Do you consider that the qualification and curriculum frameworks leading to the certification of Medical Physics professionals in Malta (Bachelor in Physics/Engineering, Masters in Medical Physics, and 2 years clinical training) are sufficient to ensure the production of high calibre professionals?

Yes ☐
No ☐

2.10 Which element might be improved and how?

____

____

2.11 Are there any other notable strengths that you can highlight for the MP profession in Malta?

____

Section 3: Possible Weaknesses of the MP profession in Malta

3.1 One of the problems that the profession faces in Malta is the absence of a universally known mission statement for the profession for Malta:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment.

____

3.2 The Medical Physics profession in Malta has a narrow range of specialisations:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment

____

3.3 The Medical Physics profession in Malta still has not realised the importance of strategic and robust leadership:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

Please feel free to add comment

____

3.4 Medical Physicists in Malta have low marketing skills leading to too low profile of the profession within the healthcare:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

Please feel free to add comment

____

3.5 Medical physicists in Malta take part in regional/international networking:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

Please feel free to add comment

____

3.6 The lack of an independent MP department will negatively impact the achievement of the vision:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

Please feel free to add comment

____

3.7 There is a reluctance by some Medical Physicists in Malta to be part of the wider healthcare picture:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

Please feel free to add comment

____

3.8 Medical Physicists in Malta have insufficient communication and pedagogical skills:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

Please feel free to add comment

____

3.9 Research by Medical Physicists in Malta has barely taken off:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

Please feel free to add comment

____

3.10 Our work duties in Malta are too overwhelming to be able to have enough free time to enrol in new training courses or attend conferences regarding the profession:

- Strongly Agree ☐
- Agree ☐
- Not Sure ☐
- Disagree ☐
- Strongly Disagree ☐

Please feel free to add comment

____

3.11 Are there any legal problems which may hinder us from achieving the vision?

Yes ☐
No ☐

3.12 If in 3.11 you answered YES, what do you consider are the problems?

____

3.13 Are there any other notable weaknesses that you can highlight in the MP profession in Malta?

____

3.14 How can these weaknesses be eliminated?

____

Section 4: Opportunities of the MP profession in Malta

4.1 The Medical Physics profession can expand as a result of the increase in number and sophistication of hospital medical devices:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment

____

4.2 Medical Physicists in Malta should link up with patient organisations and project themselves as patient advocates regarding safety standards in healthcare:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment

____

4.3 Medical Physicists in Malta should link up with occupational health and safety organisations and environmental groups and project themselves as occupational/public advocates with regard to safety from physical agents:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment

____

4.4 The Medical Physics profession should create further opportunities for itself by exerting pressure on legislators to recognise that patient safety should not be limited to ionising radiation and strive to ensure that the rigorous standards of safety to be found in ionising radiation are extended to other areas such as magnetic resonance imaging, lasers and in the future nanodevices:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment

____

4.5 Due to the escalating cost of healthcare, the need for efficient use of medical devices and Health Technology Assessment is vital, and we as Medical Physicists need to take this opportunity and involve ourselves in such issues, as it would raise our profile with health economists:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment

____

4.6 The rapid expansion in the number of home-use, self-testing and wearable devices are not only a clinical opportunity for Medical Physicists but also can be turned into a business opportunity. Shops selling such devices should be manned by Medical Physicists who can give advice to customers on the most appropriate devices to purchase, proper and safe use, re-calibration frequencies and other information. Medical Physicists can also offer quality control services for such devices:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment

____

4.7 The Government of Malta makes available a lot of funding for me to be able to develop my competences:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment

____

4.8 I take part in IPEM courses:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

4.9 I take part in EFOMP school for medical physics experts:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

4.10 I take part in IAEA courses:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

4.11 I take the opportunity to go to conferences regarding the profession:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

4.12 Are there opportunities for research in your work area?

Yes ☐
No ☐

Please feel free to add comment

____

4.13 Are there any other notable opportunities that you can highlight in the MP profession in Malta?

____

4.14 How can we benefit from your aforementioned opportunities?

____

Section 5: Threats of the MP profession in Malta

5.1 The BSc(Hons) Physics, Medical Physics and Radiation Protection has solved the threat of low number of medical physicists due to low number of Physics/Engineering graduates:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

5.2 Malta needs more Medical Physicists to achieve western European standards in my specialty area:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

5.3 Austerity economics and unrestrained commoditisation, are a threat to the Medical Physics profession in Malta:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment.

____

5.4 There is role poaching from other professions in Malta:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment

____

5.5 The profession is facing unfair competition from other professions:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

Please feel free to add comment

____

5.6 Are there any other notable present or future threats that you can highlight in the MP profession in Malta?

____

5.7 How can we eliminate or reduce the impact of these threats?

____

Section 6: Concluding Questions

6.1 Do you have any ideas on how this vision statement can be developed further?

Yes ☐
No ☐

6.2 If in 6.1 you answered YES, what are these ideas?

____

6.3 As a profession we are well prepared to face the challenges of future technologies:

Strongly Agree ☐
Agree ☐
Not Sure ☐
Disagree ☐
Strongly Disagree ☐

6.4 Thank you for dedicating your time in filling this questionnaire. Are there any other points which I have not mentioned regarding this subject that you think would be helpful for me to know?

Yes ☐
No ☐

6.5 If in 6.4 you answered YES, what are these points?

____

Thank you for your time.

Appendix J

Questionnaire Evaluation Sheet

Questionnaire Evaluation Sheet

Please mark the boxes with a ☑ as appropriate.

1. Do you think the questionnaire was too short/long/appropriately long given the research subject?

   Too short ☐
   Too long ☐
   Appropriately long given the research subject ☐

2. Was it easy to follow the general instructions of the questionnaire?

   Yes ☐
   No ☐

   If you answered NO, which instructions were not clear and why?

   ____

   ____

3. In your opinion was the questionnaire well structured?

   Yes ☐
   No ☐

   If you answered NO, what would you suggest should be improved?

   ____

   ____

4. Were there any questions that you did not understand?

   Yes ☐
   No ☐

   If you answered YES, kindly specify which and suggest improvement.

   ____

   ____

5. Did you find any objection in answering any particular question/s?

   Yes ☐
   No ☐

   If you answered YES, kindly specify which.

   ____

   ____

6. Were there any questions which you consider could have been omitted?

   Yes ☐
   No ☐

If you answered YES, can you kindly specify which and your reason as to why they should be removed?

____

____

7. Do you have any further comments or suggestions?

____

____

Thank you for your feedback.

From the responses obtained, seven out of eight participants (87.5%) perceived the questionnaire to be appropriately long given the research subject whilst one participant (12.5%) found it too long. The general instructions of the questionnaire were easy to follow as perceived by all the participants (100%). Moreover, the questionnaire was perceived by all (100%) as being well structured. When asked if there were any questions which the participants did not understand, one participant (12.5%) identified Q3.6 "*The lack of an independent MP department will negatively impact the achievement of the vision*", however they did not specify how the question could have been improved. None of the participants found objection in answering any questions. Lastly, none of the participants thought that a question could have been omitted.

Appendix K

FREC Approval

L-Università ta' Malta

Jason Schembri <jason.schembri.17@um.edu.mt>

FHS-2022-00075 Jason Schembri

Rita Pace Parascandalo <rita.pace-parascandalo@um.edu.mt> 27 May 2022 at 07:50
To: Jason Schembri <jason.schembri.17@um.edu.mt>
Cc: Research Ethics HEALTHSCI <research-ethics.healthsci@um.edu.mt>, Carmel J Caruana <carmel.j.caruana@um.edu.mt>

Dear Jason,

your recently submitted amendments have been reviewed. Approval for your study is granted oBo FREC. You may proceed with your study and collect the data.

Good luck

Regards
Dr Rita PP

L-Università ta' Malta

Dr Rita Pace Parascandalo PhD (UCLan)
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Senior Lecturer, Department of Midwifery

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