STRATEGIC PLANNING: CASE STUDY FOR A DIAGNOSTIC RADIOLOGY CONSTANCY TESTING PROGRAMME IN A MAJOR HOSPITAL IN MALTA

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Abstract— **Medical Physics is a young profession in Malta and the present constancy testing programme at the hospital concerned, younger still. It was therefore felt necessary that a strategic evaluation of the current state of the programme be carried out. The objectives were: (a) to develop a vision statement for the constancy testing programme in diagnostic radiology which complies with the role of the hospital within Maltese society and healthcare system (b) to carry out a SWOT thematic analysis to evaluate the current programme, and (c) to provide recommendations for improvement in terms of a list of strategic objectives. Using a qualitative research approach, data were collected by means of semi-structured interviews with the Medical Physics professionals involved in the programme, direct observations and document analysis. The current programme has several strengths but also several weaknesses, mainly derived from the profession being so young in Malta. Fortunately, several opportunities for programme improvement are available, however, some threats do exist. By keeping patient service in mind and taking strategic management approaches, continuous quality improvement of the constancy testing programme can be assured.**

Keywords—**Constancy testing programme, evaluation, medical imaging devices, quality improvement, SWOT.**

All statements made regarding the operations at the hospital concerned or the findings of the study reflect the opinions of those interviewed.

I. Introduction

An effective constancy testing programme for medical imaging devices is crucial for ensuring high-quality images, high diagnostic accuracy and optimising patient doses. Such programmes should be based on general quality management standards [1-3]. A strengths, weaknesses, opportunities, threats (SWOT) analysis is vital for programme quality improvement. SWOT-based strategic planning is used widely in various fields, and healthcare is no exception. Examples include: role development, inter-professional healthcare education at academic medical centres and establishing individual medical strategies for patients with aortic disease, to name a few [4-6].

The Medical Physics (MP) profession is young in Malta, and the present constancy testing programme at the hospital concerned, younger still. So far, no formal, systematic strategic evaluation of the present state of the programme including recommendations for future improvement has been carried out. At present, five MP professionals (MPPs) in the specialty area of Diagnostic and Interventional Radiology (D&IR) manage the constancy testing programme for the modalities in this area. The modalities are: general projection radiography, CT, fluoroscopy, angiography, dental imaging, mammography, bone densitometry, MRI and ultrasound. By working with radiologists, radiographers and engineers, MPPs ensure acceptable performance of such devices.

The objectives of the study were to develop a vision statement for the constancy testing programme for the hospital concerned which is consonant with the role of the hospital within Maltese society and healthcare system, to evaluate the current programme with respect to the developed vision via SWOT analysis and to make recommendations for programme improvement in terms of a list of strategic objectives. The research study provided a golden opportunity for the present MPPs to reflect on their current practices.

II. Materials and methods

Policy statements published by MP organisations, relevant quality standards, European legislation, and other relevant documentation published by standard setting organisations, MP professional organisations, the IAEA and the European Commission (EC) were consulted in order to develop an appropriate vision statement for the constancy testing programme. An inventory of SWOT themes was then developed by means of Semi-Structured Interviews (SSI) with the MPPs involved, observations at the hospital concerned and document analysis of associated documents. All current MPPs participated in the SSIs. The interviews were audio-recorded following their consent; every audio file was transcribed and then the recordings destroyed to ensure data protection. The tool used was a SSI data sheet which was developed in such a way as to encourage the emergence of SWOT themes. For the on-site observations, an extended time period was spent in the hospital to gain in-depth understanding of the tests performed, the working environment and the people involved . Reflective notes were recorded [7].

Data analysis was performed by developing a 'thematic template' to categorise SWOT themes from the data so that useful information may emerge. Template analysis was carried out using NVivo software. NVivo helps code the data in an efficient manner while identifying and organising

suitable themes effectively [8]. For document analysis, data were imported in NVivo and file classifications were used to classify documents accordingly. For the interviews, the data were coded and analysed in a way that results could not be traced back to the individual participants.

III. Results and discussion

This section provides the proposed vision statement for the constancy testing programme and a discussion of the results of the SWOT thematic analysis derived from the interviews, observations and document analysis. External opportunities and threats of the programme were further subcategorised as political, economic, social or technological-scientific (PEST). Every SWOT theme was rated from +1 (low) to +10 (high) for S/O themes and −1 (remote) to −10 (very severe) for W/T themes based on their potential impact on the achievement of the vision. Strategies for achieving the desired vision are also suggested.

Vision statement

The following vision statement expresses the desired future state of the constancy testing programme based on international standards and aspirations of the D&IR team at the hospital concerned:

"Our constancy testing programme will be recognised by all stakeholders as an optimal (effective and time/cost efficient) and comprehensive (i.e., all available modalities tested) constancy testing programme structured in line with internationally accepted guidelines and aimed at ensuring patient safety through the use of the most updated constancy testing protocols and managed by fully-qualified medical physics professionals."

STRENGTHS of the programme

1. Large number of tests performed *(+8)*

The MPPs perform a lot of tests when compared to most countries and hence find a sense of accomplishment, pride, and dedication. These are feelings based on their drive to 'prove' themselves to hospital management and other healthcare professionals (HCP) and make these stakeholders aware of their importance in the hospital and of their scholarly achievements. This drives the participants to improve the quality of the programme. A MPP said, "when we attend international courses, I realise we're quite advanced compared to other countries".

2. Appropriate scheduling of tests *(+2)*

With appropriate test scheduling, risks of costly mistakes are reduced and overall outcomes improved. Tests and tasks that need to be prioritised are easily identified. Given the high number of medical imaging devices in the hospital, the team manages to perform all required tests, though owing to time constraints, perhaps not all to the required level.

3. High quality protocols used *(+7)*

The MPPs pride themselves in using the most up-to-date constancy testing protocol standards that provide appropriate action and tolerance limits, which in turn translate to suitably tight remedial and suspension levels. A participant said, "We feel that the manufacturer's tolerances are sometimes too wide for us to accept during constancy testing because the risk to the patient would be high". On the other hand, another MPP said that the procedure of a standard being bought by the hospital procurement unit sometimes simply took too long, "we need constancy testing standards for the new technology, which we don't always have. The procurement process is sometimes so slow, it's very frustrating".

4. Testing in small teams *(+5)*

The MP team perform constancy tests in groups of two/three. This helps them optimise the time, do tests faster and ensure that the device is not taken out of service for long. It has also been noted that being in teams helps detect certain errors that a single MPP may perhaps not notice.

5. Enough time to perform the testing *(+6)*

The time taken to perform the constancy tests on the devices may take hours to complete. When MPPs request a number of hours allocated for the tests, often (though not always), the radiology team cooperate and "give up the machine". A MPP said, "For the most part if we tell them four hours, they do give us four hours. At most they allocate another time on another day for us, but when we request a time, they give it to us. However, there are exceptions."

6. MPPs feel a general sense of recognition *(+2)*

MPPs feel a sense pride when receiving recognition from other HCP. This makes them more motivated when conducting the tests, as a MPP said, "a radiologist told us, "If it weren't for you, I would have thought there was an issue with the patient, and we would have sent him for further tests". That made us feel that our tests are important and that we're making an impact." Recognition of efforts increases the quality of the constancy testing programme as it translates into greater enthusiasm and motivation for testing.

7. MPPs have high analytical and problem-solving skills *(+10)*

MPPs use their renowned problem-solving and troubleshooting skills in reporting and tackling problems that arise with the recognition of less-than-optimal performance of devices. A MPP said, "we don't run away from problems but face them with open arms as we embrace challenges… that's how we were taught". With

the different background they have from radiologists and radiographers, such as looking at an image from a different perspective which is more quantitative, they feel they are important and of great value as part of the multidisciplinary team.

8. Excellent MP training *(+9)*

The participants had common training according to the official recommended IAEA training programme as required by EU guidelines, at a single centre in the UK [9-11]. Therefore, the MPPs feel they have a shared knowledge between them and know where the team's skills and competences stand. A MPP highlighted that they could speak openly in the team and can perform the tests faster together as a result of this commonality.

9. Determination, competitivity and drive for improvement *(+4)*

The MPPs feel they must strive for higher effectiveness and efficiency so that other HCP may appreciate their work and be aware of the importance of the constancy testing. They are determined to make their presence felt and feel that this must remain so and founded on a cycle of continuous improvement.

10. High knowledge, skills and competences with respect to medical imaging devices *(+10)*

MPPs have high expertise in the safe, effective and scientific use of medical imaging devices and deep understanding of their performance which adds value to clinical problem solving and the technology assessment process. A MPP said, "I feel that the expertise that we have in understanding machines gives us the advantage that we are of value to the diagnostic team". The educational programmes have included units about quality management, professional issues and metrology amongst others, which are directly relevant to constancy testing of medical imaging devices. This gives MPPs the capability of suggesting and applying new technologies. D&IR MPPs have a leading role in the establishment and evaluation of criteria that determine acceptable performance.

11. High competences in radiation patient safety *(+8)*

Given their E&T regarding safety and protection from physical agents, MPPs work with the mindset of patient safety which helps them be extremely careful when conducting the tests, since they understand the subsequent risks involved.

12. High competences in undertaking clinical research *(+5)*

MPPs learned to undertake research frequently in their educational studies since as scientists, they were taught not to 'trust their instinct completely' but provide proof for their claims. Thus, MPPs are fit for carrying out clinical research. This is important, to keep up with the advancements of medical technology and update the constancy testing protocols. Since constancy testing is increasingly becoming quantitative, MPPs' quantitative approach is becoming more valued.

13. Ongoing update of testing protocols, equipment, and test objects *(+8)*

Investment in newer medical technologies leads to direct increases in patient health outcomes. By using newer equipment, MPPs find it easier to conduct tests with increased precision: "nowadays the devices have developed so much that high precision is easily achieved". MPPs keep their constancy testing documents up-to-date and ensure that the process of procurement of QC standards documents is ongoing.

WEAKNESSES of the programme

1. Internationally available standards not always keeping up with progress of medical technology *(−8)*

Most MPPs feel that the internationally used standards they follow to carry out constancy tests progress at a slower rate than the progress of the medical imaging devices at the hospital, so that certain tests which were applicable years ago are not applicable anymore. One MPP stated, "we might be testing something that today does not need any testing, but we cannot be too sure… so it's best to take note and see the context in which these standards had been originally written. On the other hand, there may be tests which are currently not being done but need to be introduced". MPPs also experienced the situation where some tests provided in internationally used standards cannot be carried out because of 'newer' features on the devices at the hospital. Sometimes there has been insistence by authorities on the use of international standards which are outdated, restricting the highly competent professional from introducing innovative techniques in the process.

2. Subjectivity of certain tests *(−6)*

MPPs feel that the element of subjectivity in some constancy tests is too high since some are based on qualitative visual scoring. This makes their comments in reporting not as convincing as when based on objective measures. They feel that this weakens the possibilites of constancy testing. Vague phrases such as "at least one pixel width should be resolvable" [12] and "count the number of grayscale steps" [13] do not provide solid foundations for reliable constancy testing. Automated analysis techniques may eliminate the variability in the results due to the variability in human observer performance [14].

3. Difficult access to devices to perform tests *(−6)*

The participants highlighted that it is sometimes not easy to schedule tests with radiologists which at times results in

difficult access to the devices. Even when managing to book time on a device, there is sometimes the need to set up the equipment for testing all over again because of a device that is needed urgently by radiologists. A MPP said, "we either continue after the exam or reschedule the device for testing". This results in a lack of consistency in the results, even for a particular machine. Another MPP said with disappointment, "You start doing the tests, then something crops up and you have to put everything on hold".

4. Lack of proper handover *(−3)*

There is a lack of clarity when it comes to handing over of annual constancy tests of the devices. A MPP said, "Today I did something myself, the next year another person does it and the year after someone else. There is perhaps not sufficient coordination in the handover sometimes – I do something today and then the job isn't mine anymore, the next person will take care of it." This lack of insufficient long-term scheduling, low feedback and communication leads to poor forecasts of future device trends, loss of time and lower quality for the constancy testing programme. Yet this weakness is not only present among MPPs, but it afflicts many hospital departments.

5. Lack of well-defined acceptance criteria for some tests *(−8)*

For some tests, there are no well-defined thresholds and limits - typically for non-ionising modalities, which may be due to the absence of specific legal requirements to conduct such tests [12]. For example the term 'significant' is often used too loosely - each user must select their own threshold above which they consider a nonuniformity significant [13]. A similar ambiguity exists for spatial resolution tests; "The measurement of spatial resolution (and threshold contrast) is subjective". This weakness defeats the much-needed objectivity in the constancy testing leading to loss of trust in the constancy testing programme as a whole. A MPP also said, "I know something is going on, but I cannot provide proof because there is nothing sufficiently convincing to back me up."

6. Low number of MPPs *(−10)*

The MPPs said there was a lot to be done but the understaffing issue limits the growth of the constancy testing programme and hence there is only so far they can go with programme improvement. The inadequate staffing levels result in the hospital not experiencing the full benefits of the constancy testing programme.

7. Low research activities *(−3)*

Research is limited to when MPPs find time. A MPP said, "time is precious here. We would like to increase research activities, because there is a lot we can expand and improve on." Low research limits expansion and progress of the constancy testing programme since 'outdated methods' are used on 'newer technology' because there is not much time available for them to improve the tests via research. Innovation is therefore often stunted.

8. No or low specialisation *(−5)*

The low number of MPPs available and the high number of devices for testing, limits MPPs from subspecialising into separate modalities. Some MPPs do not manage to understand the reasons behind a fault due to their lack of knowledge about the device and cannot master their understanding because there is no time for doing so. Subspecialisation of MPPs would make available exquisite expertise which would produce a quantum leap in the optimised constancy testing and use of the devices. Lack of subspecialisation may lead to poor programme quality as a participant stated, "Every week you're working on a different device and you start getting confused as to which tests are applicable to which modality." All the MPPs showed interest in being able to subspecialise as they feel that this has become a necessity given the rapid expansion in the quantity and sophistication of imaging device technology - "it's simply impossible to be an expert of all the devices which we test".

9. Insufficient collective decision making *(−4)*

Most participants highlighted that there is insufficient cohesion within the MP team. Being such a small team, this may directly limit improvement of the constancy testing programme since the quality of the team is a highly essential influencing factor. The issues seem to be stemming from past historical events arising before the taking over of the present lead physicist. Through management by objectives, self-management and personal commitment and active member participation, it is possible for a team to overcome such barriers to improved teamwork and communication [15, 16].

10. Low competences in management, leadership and general 'soft skills' *(−3)*

MPPs often find it difficult to bridge the gap from the physics/engineering environment to the economically and politically driven healthcare professions that they need to work with. MPPs are plucked out of the objective view of science into a more subjective, emotional and opinionated viewpoint in the hospital. Leadershp and soft skill training for MPPs is considered important for programme improvement [17].

11. Missing tests *(−6)*

Due to the absence of legal requirements, certain tests, particularly in non-ionising radiation are not done. This is an issue arising from the low awareness of the importance of the tests from the national Commission for the Protection from Ionising and Non-Ionising Radiation and the understaffing issue. However, the EC highlights the importance of tests on non-ionising radiation devices, since the link between non-ionising and ionising radiation

modalities is on the rise. The MPPs expressed the opinion that they would like to do the tests when they have enough manpower to do so as a MPP stated, "sometimes you need the strength of numbers to convince and we are still too few, but hopefully we'll get there."

12. Mixed levels of IT skills *(−3)*

Most MPPs highlighted that IT is important for the future of constancy testing to promote more objectivity in the test results. Knowledge of IT is a strong asset for MPPs since healthcare is becoming increasingly software based. But not all MPPs have these skills - this might limit progress.

13. Insufficient system checks *(−2)*

System checks, which include movement mechanisms, display options, image archive and networking capabilities to PACS, soft-copy and/or hard-copy locations seem to be often overlooked, as was evident from the observations. A MPP highlighted during a mechanical check for an imaging device, "I don't know whether this device's control panel is adjustable or not; it looks stuck, but I'm not sure".

14. No marketing among stakeholders *(−8)*

MPPs step back from publicising and advertising their services to stakeholders; there is an absence of a marketing strategy, which should not only be there, but should be ongoing [17]. Yet, all participants wish there was a higher level of awareness of their profession and role by stakeholders. A MPP stated, "when people ask me what I do for a living, I tell them engineering or applied science because they don't understand." This shows that the MPPs do not know how to describe their role to stakeholders who are not in the field. Other professions in the hospital barely know about the existence of 'medical physics', let alone constancy testing of medical imaging devices. This is a risk for the profession itself, as stakeholders will not know when to seek the advice or the services of the MPP.

OPPORTUNITIES for the programme

Political

1. General political pressure to achieve EU standards in all areas of the country *(+8)*

The general political climate in the country is pushing for the adoption of EU standards in all spheres of life. This drive helps provide an impetus towards more funding and human resources for constancy testing. MPPs stated that they would like to develop the programme in line with ISO 9001. The increase in testing frequency involves having updated SOPs for all modalities with correct versions and referencing. This is an opportunity for a quality jump in the programme as the ISO 9000 family of quality management system (QMS) standards has earned a global reputation as a basis for developing effective and efficient QMSs. ISO TG 176 and BS 70000 provide a step-by-step process of the implementation of a QMS that can be adopted by MPPs for the constancy testing programme [18-20].

Economic

2. Increase in human resources: Traineeship programmes *(+10)*

New trainees are essential assets for the growth of the profession, hence a huge opportunity for current MPPs to expand their team and increase recognition and awareness in the hospital. A new cohort of Masters students is graduating. This opens the opportunity for increased human resources and helping hands, thus increasing time available for work on innovative projects and for improvement of the constancy testing programme.

Social

3. A growing population leading to increased use of diagnostic medical imaging *(+7)*

Attributed to a growing population, there is a dramatic increase in the use and scope of diagnostic imaging which creates pressure for an increase in imaging devices and hence constancy testing. To cater for this increase, an effective programme is required that calls for an urgent need of characterising patterns of imaging use, re-defining "radiology services utilisation" and researching the role of constancy testing in such a milieu.

Technological-scientific

4. AI, test automation and objectivity *(+8)*

Today's world is moving towards AI, to reduce the time taken to perform repetitive tasks, to increase objectivity in the results while reducing human error. Automation has several benefits such as higher quality, improved worker safety, increased workflow rates and professional prestige. The physicists at Mayo clinic in the USA have developed software with algorithms based on digital image processing techniques, to automatically analyse test object images objectively. As an opportunity, a MPP suggested the use of AI to do automatic constancy checking, and the MP job would be performing QC on the AI rather than on the physical devices proper. Another MPP stated that knowledge in IT helps give a strong reputation to the profession in the clinical environment. Current MP postgraduate programmes in Malta include a 10 ECTS unit on Machine Learning (ML) and Pattern Recognition. Background in ML is considered a major strength in extending the role of the MPP.

5. Rapid prototyping ('3D printing') *(+1)*

Custom-made 3D printed test objects and phantoms made of tissue-mimicking material would increase constancy testing possibilities. 3D printing in-house would save on costs, promotes flexibility and drives innovation whilst reducing the carbon footprint.

THREATS to the programme

Political

1. Substitutability and over-commoditisation *(−7)*

MPPs fear substitutability and over-commoditisation with other HCP stepping in to do the MPPs' job regarding constancy testing of imaging devices. However, it is an undisputed fact that the competence of MPPs in such areas surpasses by far that of other HCP. It is up to MPPs to take a proactive stand against over-commoditisation which is not only a threat to the profession but also ultimately to patient safety [17].

Economic

2. Possible loss of team members *(−10)*

Since the MPPs trained overseas were bound by a finite contract as compensation for their training, nothing formally stops them from leaving the profession once the contract ends. Should this take place, the profession in Malta will become endangered since there are currently no trainees and hence no handover to a next generation. Thankfully, the highly successful B.Sc. (Hons.) in Physics, Medical Physics and Radiation Protection set up by the University of Malta is producing successive cohorts of potential human resources for the constancy testing programme.

3. Inadequate resources *(−9)*

Financial and material resources were also a running theme amongst the participants where a MPP said, "The CEO sees the radiologist as the responsible person for signing where money is involved" and hence this limits the acquisition of resources to what the radiologist perceives as necessary even though constancy testing is a responsibility of MPPs. This may limit the progress of the programme, however, there is a move towards setting up an independent MP department directly answerable to the CEO.

Social

4. Low feedback from the multidisciplinary team *(−7)*

The MPPs found that radiologists, radiographers and engineers rarely provided feedback about the functioning of the medical imaging devices after being constancy tested. In addition, owing to possible excessive professional pride or low awareness by other HCP, MPPs are not sought for advice before conditions become critical. Some MPPs experienced the situation of portable devices being transferred to other rooms by other HCP without being informed hence disrupting the constancy testing schedule of those devices.

5. Low awareness of the importance of constancy tests by radiology management *(−3)*

Most MPPs highlighted that the radiology team is not always sufficiently aware of the importance of constancy tests, or as a MPP said, "some are aware of their importance but won't give us time anyway". Another MPP said with frustration, "We studied all that in our educational courses, our hands are full of calluses from the difficulty of the subjects we studied, we've had all that training… you would at least want that they acknowledge what we do". The disappointment in the MPPs may result in risks to the programme since MPP satisfaction is an asset for improvement.

Technological-scientific

6. Insufficient knowledge of 'why' constancy tests fail *(−3)*

For physicists, not knowing why things develop the way they do can be a source of stress. A MPP said, "I'm testing the machine for image quality but I don't know how it does it. And then if it fails? I don't know where to start looking for the problem." The fact that there is currently an unclear definition of the essential parameters describing performance of medical imaging devices and how these may change with technological progress, makes it harder to categorise and understand failures . Not having the time to delve deeply into the devices which they test is a source of loss of self-confidence.

The way forward: Strategic Objectives

Based on this strategic SWOT evaluation exercise, the following strategic recommendations are suggested.

Further Strengthening of Internal Strengths

1. Attend international accredited courses on constancy testing to further develop existing competences and acquire missing ones.
2. Ensure further development of protocols by performing research to improve on or replace those internationally used protocols which are outdated.
3. Encourage team members to set up a table of key success factors of the constancy testing programme and rate them. The leader provides an average rating for the team and sets priorities accordingly.
4. Set up hands-on retraining programmes for all members of the D&IR team to ensure tests are performed as intended, and new/more updated protocols adopted.
5. Set up meetings to schedule discussions. Ensure objectives and goals are written and regularly updated on a board in a common area of the team's premises, as well as on a digital document to keep these visible to all members.

Reducing or Eliminating Internal Weaknesses

6. Develop a Gantt chart to assign time frames to action plans, and a Load chart to have a formal schedule of who needs to conduct which constancy tests and on which modalities. This ensures that the team keeps a continuous track of device trends.
7. Attend team building CPD to promote collaborative work.

8. Attend courses in quantitative approaches to quality management.
9. Develop and implement a profession awareness and marketing strategy.

Grasping External Opportunities

10. Involve oneself in reject analysis of patient images programmes. Where appropriate, link rejects to lack of constancy testing to increase awareness of the importance of the latter.
11. Attend MPP-designed IT courses so that constancy testing may be made more objective and limitations due to lack of IT skills eliminated.
12. Attend courses on CAD modelling and 3D printing to be able to produce custom test-objects.
13. Set up meetings with the radiology team to get to know more about patterns in patient imaging sessions. This helps strengthen scheduling of the programme.
14. Attend courses in leadership in medical physics.

Eliminating External Threats

15. Pro-actively combat counter-productive and unsafe substitutability and over-commoditisation.
16. Set up a feedback system between all team members and an inter-departmental feedback system with the multidisciplinary team. This enhances communication and clarification of procedures and tests of all medical imaging devices.
17. Organise multidisciplinary courses for other HCP to increase MP awareness and knowledge.
18. Set up a Failure Modes and Effects Analysis (FMEA) chart for every imaging modality to help prevent failures while targetting the causes and effects of the failures. This forecasting technique is a safety assessment that ensures past errors or mistakes are not repeated.
19. Set up a Threat Analysis chart of all the threats that the team faces with regards to the constancy testing programme.

IV. Conclusions

The MP team is blessed with inherent strengths based on the MPPs' physics/engineering background but the programme is not sufficiently developed because of issues arising mainly from MP being a fairly young and somewhat inexperienced profession in Malta. Thankfully, the current programme has higher ratings for S/O themes than W/T themes. Whilst relatively positive results have emerged, the programme may be further improved by developing a comprehensive strategic plan including a study of key success factors, analysis of competition from other professions, translating strategies into action plans and establishing accurate controls. This ensures that the conditions for greater success of the programme are delivered. Whilst SWOT analysis has been used extensively as a tool for improving strategies within organisations, nothing has been found in the literature regarding the use of SWOT for improving constancy testing programmes of medical imaging devices. This makes this study a first of its kind.

References

1. ISO. (2015) *Quality management systems – Requirements.* ISO 9001:2015.
2. ISO. (2009) *Managing for sustained success of an organisation – A quality management approach.* ISO 9004:2009.
3. ISO. (2016). *Quality management for medical devices.* ISO 13485:2016.
4. Caruana C. J., Wasilewska-Radwanska M., Aurengo A., Dendy P., Karenauskaite V., Malisan M., Meijer J., Mihov D., Mornstein V., Rokita E., Vano E., Weckstrom M., & Wucherer M. (2010) A comprehensive SWOT audit of the role of the biomedical physicist in the education of healthcare professionals in Europe. *Physica Medica,* 28(2):98-110. https://doi.org/10.1016/j.ejmp.2009.08.001
5. Topor D. R., Dickey C., Stonestreet L., Wendt J., Woolley A., & Budson A. (2018) Interprofessional health care education at academic medical centers: Using a SWOT analysis to develop and implement programming. *MedEdPORTAL,* 14(1). https://doi.org/10.15766/mep_2374-8265.10766
6. Von Kodolitsch Y., Bernhardt A., Robinson P., Kölbel T., Reichenspurner H., Debus S., & Detter C. (2015) Analysis of strengths, weaknesses, opportunities, and threats as a tool for translating evidence into individualized medical strategies (I-SWOT). *AORTA,* 03(03):98-107. https://doi.org/10.12945/j.aorta.2015.14.064
7. Creswell, J. W., & Creswell, J. D. (2018). The Selection of a Research Approach. In *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed., pp. 41-49). SAGE Publications.
8. Zamawe F. (2015) The implication of using NVivo software in qualitative data analysis: Evidence-based reflections. *Malawi Medical Journal,* 27(1):13. https://doi.org/10.4314/mmj.v27i1.4
9. IAEA. (2010) Clinical Training of Medical Physicists Specializing in Diagnostic Radiology. Training Course Series 47. http://wwwpub.iaea.org/MTCD/publications/PDF/TCS-47_web.pdf.
10. Guibelalde E., Christofides S., Caruana C. J., Evans S., Putten W. V., & European Commission. Directorate-General for Energy. (2014). *European guidelines on medical physics expert* (RP No.174). Publications Office of the European Union.
11. Caruana C. J., Grech K. (2016) Cost optimised medical physics education and training: an innovative E&T scheme in Malta. *Medical Physics International Journal,* 4(1):17-19.
12. Jackson E., Bronskill M., Drost D. J., Och J., Pooley R., Sobol W., & Clarke G. (2010) Acceptance testing and quality assurance procedures for magnetic resonance imaging facilities. *AAPM Report No. 100,* 1-31. https://doi.org/10.37206/101
13. Goodsitt M. M., Carson P. L., Witt S., Hykes D. L., & Kofler J. M. (1998) Real-time B-mode ultrasound quality control test procedures. Report of AAPM ultrasound task group No. 1. *Medical Physics,* 25(8):1385-1406. https://doi.org/10.1118/1.598404
14. Rownd J. J., Madsen E. L., Zagzebski J. A., Frank G. R., & Dong F. (1997) Phantoms and automated system for testing the resolution of ultrasound scanners. *Ultrasound in Medicine & Biology,* 23(2):245-260. https://doi.org/10.1016/s0301-5629(96)00205-0
15. Spano R. M., & Lund S. H. (1976) Management by objectives in a hospital social service unit. *Social Work in Health Care,* 1(3):267-276. https://doi.org/10.1300/j010v01n03_02
16. Islami X., Mulolli E., & Mustafa N. (2018) Using management by objectives as a performance appraisal tool for employee satisfaction. *Future Business Journal,* 4(1):94-108. https://doi.org/10.1016/j.fbj.2018.01.001

17. Caruana C. J. (2019) What is strategic and robust leadership, and why is it critical for medical physics in the present environment? In *Leadership and challenges in medical physics: A strategic and robust approach* (pp. 1-12). IOP.
18. Hall R., & Partyka J. (2021) How analytics-and O.R.-driven tools help healthcare organizations move from "tracking" mentality to "delivery and logistics.". *Scheduling for better healthcare.*
19. ISO. (2016) *Selection and use of the ISO 9000 family of standards.* International Organisation for Standardization (ISO). https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100208.pdf
20. BSI. (2017) *Medical physics, clinical engineering and associated scientific services in healthcare. Requirements for quality, safety and competence.* BS 70000:2017.

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