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MeDCare

Healthcare Technology Competences and Barrier Analysis in Tunisia

MeDCare

Medical Technology & Digital Health Care Technician

Deliverable D2.1, Work Package 2

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MeDCare

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Healthcare Technology Competences and Barrier Analysis in Tunisia

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Executive summary

Purpose and scope. This report is deliverable D2.1 of the MeDCare project (Erasmus+ Capacity Building in the field of Vocational Education and Training, grant agreement no. 101242512). It answers the question on which work package 3 builds the new qualification: what competences an EQF level 5 medical technology and digital health care technician needs in Tunisia, how far the existing training provides them, and what stands in the way of teaching them. It integrates the three strands of evidence produced by work package 2: the desk study on policy, labour market and training provision (ATFP, 2026), two focus groups with thirteen system and market actors (Elemtiez, 2026a, 2026b) and twenty-six interviews with healthcare organisations, the vocational training provider and the authorities (ATAS, 2026). The analysis followed a reflexive thematic approach, with a competence perimeter of twenty-seven cards derived from the ESCO occupation profiles 2149.5 (bioengineer) and 2149.5.1 (biomedical engineer) and narrowed to EQF level 5, and a typology of institutional, pedagogical, technological and socio-economic barriers.

Context. The Brevet de technicien supérieur in biomedical equipment maintenance is anchored in a structured body of legislation and sits at level 4 of the Tunisian national classification of qualifications; its learning outcomes are argued to align with EQF level 5 in autonomy, problem solving and responsibility, but no formal referencing links the two frameworks and no domestic route carries its graduates into higher education. The specialty is delivered by a single public centre in Tunis. The programme in use dates from 2008; the 2019 revision, with thirty-six modules and 2,454 hours, awaits accreditation, and neither covers medical informatics or digital health. The biomedical teaching body is small and close to a retirement horizon of 2027 to 2028, the training equipment dates largely from the centre's foundation around 2000, and demand for the qualification exceeds the places available. The public-sector workforce of 234 biomedical technicians is about 65% female, against a predominantly male applicant pool, and depends on suppliers for the most specialised tasks. Digital adoption in the facilities is uneven: maintenance management systems, remote radiology reading and, in a few hospitals, electronic patient records are in place, while telemedicine, interoperability and structured cybersecurity practice remain at an early stage.

Competence mapping. The twenty-seven cards held in the field: both focus groups and the employers recognised them, and the exercise added competences at the margins rather than overturning the framework. The technical core of the profession (biomedical engineering principles, maintenance and repair, calibration and testing) is essential for both groups, present in the current training and carries the strongest employer signals; its priority for reinforcement is nonetheless high, because coverage is rated only partial and the equipment is ageing. The digital health domain is the decisive finding: health information systems, telemedicine, connected devices, remote diagnostics, data protection, electronic health records and medical software are rated essential or important and covered by no module of either programme, and all but data

protection and electronic health records are named by employers at recruitment; five of its eight cards are high priority to reinforce. The managerial and transversal domain is present but under-reinforced, with documentation and communication with clinical staff among the competences employers name most often. Four cards remain contested (problem solving, good manufacturing practices, cybersecurity, evidence-based practice) and ten emergent competences were recorded, among them applied artificial intelligence, predictive maintenance, device regulation and conformity, and the reading of manufacturer documentation.

Barriers and enablers. Four barriers form the structural core of the analysis: insufficient continuing professional development for trainers and outdated or insufficient equipment, attested by all three stakeholder categories and by both focus groups; weak digital and connected-device competences in training, attested by the provider, by healthcare organisations and by both focus groups; and the length of administrative and qualification-approval procedures, attested by all three categories and by focus group 1. Together with the lag of the curriculum behind healthcare technology, they describe one mechanism: technology moves faster than the programme, the equipment and the trainers can follow, and the procedures lengthen every correction. The other barriers concern the single-provider structure, the recognition and progression gap, the quality of work-based learning, the staffing and workload of maintenance units, the costs of mobility, accommodation and certification borne by learners from other governorates, and the motivation of younger technicians. No formal gender-based barrier was reported in access to the training or to employment; the indirect, practical and socio-cultural obstacles concern travel, shift hours, the handling of heavy equipment and workplace attitudes. The enablers are substantial: a sound technical foundation of graduates and technicians, their ready employability, established placements and partnerships, supplier training on newly acquired equipment, serviceable workshops and premises, participatory governance between the training and health authorities, and a stated institutional appetite for digital health.

Recommendations and draft profile. The findings converge with the ETF recommendations for Tunisia and with the European entrepreneurship competence framework on the need for partnerships in the skills ecosystem, trainer development, work-based learning and transversal competences. The report organises the stakeholder-tested competences into seven clusters, from which it derives the draft profile of the Medical Technology and Digital Health Care Technician at EQF level 5: biomedical maintenance and diagnosis; connected devices, health information systems and remote support; data protection and basic cybersecurity; quality, safety, regulation and documentation; clinical context, communication and teamwork; professional autonomy, project and resource management and continuous development; and an orientation to emerging technologies. Each unit is described with learning outcomes in knowledge, skills and responsibility and autonomy. Ten recommendations address the curriculum developers of work package 3: a modular architecture built on the seven units, a practice-first pedagogy, structured work-based learning, simulation

where equipment cannot be owned, trainer development before the digital units are delivered, technical English as an enabling competence, learning outcomes defined with healthcare organisations, assessment in authentic situations, a recognition of prior learning route aligned with the European counterparts of the double degree, and ESCO occupation 3114.1.5 as the reference occupation. Eight address the authorities: the referencing of the national framework to the EQF, a bilateral recognition framework with Italy, a shorter cycle of qualification revision, a progression route to higher education, the renewal and development of the teaching body, the renewal of training equipment, mobility support for learners from other governorates and a graduate tracer system. Six address the provider and the healthcare organisations: placement partnership agreements, supplier training that reaches the whole team and the trainers, maintenance organised by equipment family, protected time for continuing development and self-assessment against the Tunisian framework for entrepreneurial VET centres.

Use of the report. Work package 3 receives a stakeholder-tested competence perimeter, a barrier and enabler analysis, seven clusters and a draft profile of seven units, and three sets of recommendations. The profile is a draft, to be completed by work package 3 before the modules, the assessment framework and the certification process are built from it. Work package 3 is also expected to take into account the cross-cutting themes to which the MeDCare project is committed, namely sustainability and energy efficiency, the One Health approach and the DigComp, LifeComp and GreenComp frameworks, which the fieldwork did not raise.

The evidence has the limits stated in chapter 1: one training provider, which is also the only provider of the specialty; healthcare organisations located in Greater Tunis; the vocational training side of governance more fully represented than the health side; the absence of learners and recent graduates among the participants; and the small number of women among the focus group participants, which limits what the evidence can support on gender. Within those limits, the three strands of evidence agree on what the qualification should contain and on what stands in the way of teaching it.

Keywords: biomedical equipment maintenance; digital health; competence mapping; EQF level 5; vocational education and training; Tunisia; barrier analysis; curriculum development; health technology; Erasmus+ capacity building.

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Abbreviations

Abbreviation	Meaning
AI	artificial intelligence
ATAS	*Association tunisienne d'assistance sociale* (Tunisia)
ATFP	*Agence tunisienne de la formation professionnelle*, Tunisian Agency for Vocational Training
BTP	*Brevet de technicien professionnel*
BTS	*Brevet de technicien supérieur*
CB-VET	Capacity Building in the field of Vocational Education and Training (Erasmus+)
CENAFFIF	*Centre national de formation de formateurs et d'ingénierie de formation*, National Centre for the Training of Trainers and Training Engineering
CETMBH	*Centre des études techniques et de maintenance biomédicale hospitalière*
CPD	continuing professional development
CSFEMEB	Sectoral Centre for Electricity and Maintenance of Biomedical Equipment, Tunis
D2.1	deliverable 2.1 of the MeDCare project (this report)
EACEA	European Education and Culture Executive Agency
EHR	electronic health record
EntreComp	European Entrepreneurship Competence Framework
EQF	European Qualifications Framework
ESCO	European classification of skills, competences, qualifications and occupations
ETF	European Training Foundation
FG1, FG2	focus group 1 (system actors), focus group 2 (market actors)
HIS	health information system
INT-HF, INT-VET, INT-LA	interview codes: healthcare facilities, VET providers, local and regional authorities
IoT	Internet of Things
ITS	ITS Nuove Tecnologie per la Vita (Italy), project coordinator
MEFP	Ministry of Vocational Training and Employment (Tunisia)
N1 to N27	the twenty-seven competence cards of the study (annex A)
NQF	national qualifications framework
SO-A, SO-B, SO-C	specific objectives of the study (section 1.2)
SQ1 to SQ4	research sub-questions (section 1.2)
T2.1 to T2.5	tasks of work package 2
VBI	CIPFP Vicente Blasco Ibáñez (Spain)
VET	vocational education and training
WP2, WP3	work package 2, work package 3

Chapter 1. Introduction and methodology

1.1 Project context and purpose of the report

MeDCare (Medical Technology and Digital Health Care Technician, project no. 101242512) is a Capacity Building in the field of Vocational Education and Training project co-funded by the Erasmus+ programme of the European Union (ERASMUS-EDU-2025-CB-VET-SMC). Its general objective is to enhance the quality, relevance and responsiveness of the Tunisian vocational education and training (VET) system in the biomedical and digital healthcare sectors by developing and implementing a double-degree VET programme for Medical Technology and Digital Health Care Technicians at level 5 of the European Qualifications Framework (EQF), aligned with Industry 4.0 standards and with European and Tunisian VET frameworks. The partnership brings together ITS Nuove Tecnologie della Vita (ITS, Italy, coordinator), Elemtiez Formation (Elemtiez, Tunisia), the Tunisian Agency for Vocational Training (*Agence tunisienne de la formation professionnelle*, ATFP, Tunisia), CIPFP Vicente Blasco Ibáñez (VBI, Spain), OpenCom (Italy) and the *Association tunisienne d'assistance sociale* (ATAS, Tunisia).

The project responds to two needs identified in the Tunisian healthcare sector. The first is the migration of healthcare professionals, driven by working conditions, pay, job insecurity, obsolete infrastructure and limited access to advanced training, with a loss of qualified staff and of the public investment made in their training. The second is the digitalisation of the healthcare system, which requires new skills in management, engineering and information technology and a VET offer able to supply them. Both needs point to the same gap: a technician able to maintain and manage medical technology in a digitalising hospital, trained to a level that is recognised in Tunisia and in Europe.

Work package 2, Healthcare Technology Competences and Barrier Analysis, led by OpenCom, serves the project's second specific objective: to assess the healthcare technology competence needs and to analyse the implementation barriers in Tunisia's medical sector, through systematic research for training development. It was organised in five tasks: the research design and methodology (T2.1, OpenCom), a desk study on policy, labour market and training provision (T2.2, ATFP), two expert focus groups for competence mapping (T2.3, Elemtiez), a stakeholder consultation through semi-structured interviews (T2.4, ATAS) and the data analysis and report writing that produced this deliverable (T2.5, OpenCom, with the contribution of all partners).

This report, deliverable D2.1, is the evidence base on which work package 3, led by ITS with VBI, defines the learning outcomes, the modules and the assessment framework of the EQF level 5 qualification. It describes the policy, labour-market and training context (chapter 2), maps the competences the qualification should cover (chapter 3), analyses the barriers to and enablers of its implementation (chapter 4) and, in chapter 5, brings the findings together into priority competence clusters, a draft competence profile and

recommendations for curriculum development and for policy. Gender and inclusion are treated as a transversal dimension in chapters 2 to 4. The report is written so that chapter 5 can be used by the curriculum developers without returning to the field material; the evidence behind every statement is cited to a source that the reader can consult, and the annexes reproduce the instruments and the analytical grid.

1.2 Research questions and objectives

The overarching research question of the study is: what are the competence needs, skills gaps and implementation barriers for establishing an EQF level 5 qualification in medical technology and digital health care in Tunisia's healthcare sector? It was broken down into four research sub-questions, each with a primary data source, and into three analytical synthesis objectives that structure chapter 5. Table 1.1 sets them out together with the chapter that answers each.

Table 1.1. Research sub-questions, their components, primary data source and the chapter that answers them.

Sub-question	What it asks	Components	Primary source	Chapter
SQ1 Policy and structural context	What is the current regulatory, institutional and labour-market landscape for biomedical technology training and practice in Tunisia?	SQ1.1 National policies, strategies and VET frameworks governing biomedical technology education. SQ1.2 Structure of the healthcare technology workforce (size, distribution, qualification levels). SQ1.3 Relation of the national qualifications framework to EQF level 5 for this profile.	Desk study (T2.2)	2
SQ2 Competence mapping	Which technical, managerial and transversal competences are required for an EQF level 5 medical technology and digital health care technician in the Tunisian context?	SQ2.1 Competences of the narrowed ESCO perimeter (occupations 2149.5 and 2149.5.1) confirmed as relevant by Tunisian professionals. SQ2.2 Additional competences emerging from practice, especially in digital health, telemedicine, connected devices and health informatics. SQ2.3 Competences currently taught in Tunisian biomedical VET programmes and the gaps.	Focus groups (T2.3)	3
SQ3 Barriers and enablers	Which institutional, pedagogical, technological and socio-economic barriers hinder the implementation of advanced biomedical technology training in Tunisia?	SQ3.1 Skills deficits identified by healthcare facilities in their biomedical technology staff. SQ3.2 Constraints faced by VET providers in delivering industry-aligned training (infrastructure, curricula, trainer capacity). SQ3.3 Regulatory and institutional barriers identified by the authorities for establishing new EQF level 5 qualifications.	Stakeholder interviews (T2.4)	4
SQ4 Gender and inclusion (cross-cutting)	Which gender-specific and inclusion-related barriers affect access to biomedical technology training and employment in Tunisia?	SQ4.1 Gender-based disparities in enrolment, completion and employment. SQ4.2 Institutional, cultural or structural factors limiting women's participation. SQ4.3 Measures for gender-responsive	All sources	2, 3 and 4

Sub-question	What it asks	Components	Primary source	Chapter
		curriculum design and equitable access.		
SO-A, SO-B, SO-C Analytical synthesis objectives	To align the field findings with the ETF recommendations for Tunisia's VET reform (SO-A); to identify priority competence clusters for the draft competence profile (SO-B); to formulate implementation conditions and recommendations for curriculum development in work package 3 (SO-C).		Triangulated findings of chapters 2 to 4; ETF reference documents	5

Four features of this structure shape the reading of the report. First, the sub-questions were assigned to a primary data source, but every chapter draws on all three strands where they bear on its question; chapter 2, for instance, uses the interviews where they update the documentary picture, and chapter 3 uses the interviews alongside the focus groups. Second, the fourth sub-question on gender and inclusion is cross-cutting: it was built into every data collection instrument through a common block of questions and is reported within chapters 2, 3 and 4 and not in a chapter of its own. Third, the synthesis objectives are not fieldwork questions: they are the goals of the analysis in task T2.5, and they are answered in chapter 5 from the triangulated findings of chapters 2 to 4. Fourth, five formal research objectives operationalise the work package's scope: to map the policy, institutional and labour-market context (RO1); to identify and validate the technical, managerial and transversal competences required at EQF level 5 (RO2); to analyse barriers and enablers (RO3); to examine the gender and inclusion dimensions of access to training and employment (RO4); and to produce evidence-based recommendations and a draft competence profile for curriculum development (RO5).

1.3 Key concepts and reference frameworks

Three reference frameworks run through the report and are defined here: the European Qualifications Framework and its levels 4 and 5; the Tunisian national classification of qualifications and the two vocational diplomas, BTP and BTS, that the study compares with it; and the ESCO occupation profiles from which the competence perimeter was drawn.

1.3.1 The European Qualifications Framework and levels 4 and 5

The European Qualifications Framework (EQF) is a common reference framework of eight levels, established by the Council Recommendation of 22 May 2017 on the European Qualifications Framework for lifelong learning (2017/C 189/03), which replaced the Recommendation of 2008. Each level is defined by learning outcomes, that is by what a learner knows, understands and is able to do at the end of a learning process,

described in three categories: knowledge, skills, and responsibility and autonomy. National qualifications frameworks are referenced to the EQF through a formal process, so that a qualification placed at a given national level can be read against the corresponding EQF level across Europe (Council of the European Union, 2017). The learning-outcomes approach on which the EQF rests is documented by Cedefop in its European handbook on defining, writing and applying learning outcomes (Cedefop, 2017).

Level 5 is the level of the MeDCare qualification. The Recommendation describes it as: comprehensive, specialised, factual and theoretical knowledge within a field of work or study and an awareness of the boundaries of that knowledge; a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems; and the capacity to exercise management and supervision in contexts of work or study activities where there is unpredictable change, and to review and develop performance of self and others (Council of the European Union, 2017, annex II).

Level 4, the level to which the existing Tunisian diploma is argued to correspond, is described as: factual and theoretical knowledge in broad contexts within a field of work or study; a range of cognitive and practical skills required to generate solutions to specific problems in a field of work or study; and the capacity to exercise self-management within the guidelines of work or study contexts that are usually predictable but are subject to change, and to supervise the routine work of others, taking some responsibility for the evaluation and improvement of work or study activities (Council of the European Union, 2017, annex II). The difference between the two levels therefore lies less in the technical content than in the breadth and awareness of the knowledge, in the move from specific to abstract problems, and in the degree of autonomy and supervisory responsibility. These are the terms in which chapters 3 and 5 read the competences of the profile.

1.3.2 The Tunisian national classification of qualifications, the BTP and the BTS

Tunisia classifies its qualifications through the national classification established by Decree 2009-2139 of 8 July 2009, which links diplomas to seven levels of skill expressed as learning outcomes and requires training institutions to keep their qualifications consistent with the descriptors of the level concerned (ATFP, 2026, section I.2). The vocational training system organised by Law 2008-10 of 11 February 2008 delivers its diplomas in three successive cycles. The two that matter for this study are the *Brevet de technicien professionnel* (BTP), the professional technician diploma, and the *Brevet de technicien supérieur* (BTS), the higher technician diploma, which is the highest of the three cycles; admission to the BTS requires an approved BTP or a baccalaureate in a compatible stream (ATFP, 2026, section I.2). In the biomedical field the existing qualification is the BTS whose diploma the National Report renders as Higher Technician in Biomedical Equipment Maintenance, placed at level 4 of the national classification and delivered at a single public centre, the Sectoral Training Centre for Electricity and Maintenance of Biomedical Equipment in Tunis (CSFEMEB), which also delivers the BTP in the same field (ATFP, 2026, sections I.2 and III; sections 2.2 and 2.6 of this

report). No formal referencing links the Tunisian classification to the EQF; the National Report argues, from a reading of the learning outcomes, that national level 4 aligns with EQF level 5 in autonomy, problem solving and responsibility, a position examined in section 2.2.

1.3.3 The ESCO occupation profiles 2149.5 and 2149.5.1 and the competence perimeter

ESCO, the European classification of skills, competences, qualifications and occupations, describes each occupation by a set of essential and optional skills and knowledge. The MeDCare project anchors the qualification to ESCO occupation 2149.5, bioengineer, read together with its narrower occupation 2149.5.1, biomedical engineer, which ESCO also labels biomedical engineering specialist and which is the occupation that the project documents designate under that name. The bioengineer profile as ESCO defines it is broader than, and in its core different from, medical technology: its essential skills concern adjusting and approving engineering designs, developing bioremediation techniques and performing scientific research, and its essential knowledge concerns the bioeconomy, biological chemistry, biotechnology, genetics, synthetic biology and the life sciences. Medical technology appears in its optional layer, in items such as medical device materials, laboratory techniques, computer simulation, the interpretation of 2D and 3D plans, documentation of analysis results and compliance with safety legislation (ESCO, occupation 2149.5). The biomedical engineer profile places biomedical engineering, medical devices materials and test procedures among its essential knowledge and adds the professional competences of project management, personal professional development and professional interaction in research and work environments (ESCO, occupation 2149.5.1).

The study therefore did not take these profiles as a description of the target occupation but as a point of departure to be narrowed and downscaled. The perimeter was restricted to the maintenance and management of medical and biomedical technology, digital health, health informatics and connected medical devices; the areas outside this scope, such as bioremediation, food science and pharmaceutical manufacturing, were excluded; and the competence descriptions were written at EQF level 5, that is at the level of a technician who applies procedures, adapts methods to solve problems, plans the work of a small team and evaluates the quality of the work performed, not at the level of a design engineer or a researcher. The result was a set of twenty-seven competences in three domains: ten technical, eight in digital health and nine managerial and transversal. Nineteen of them derive from the two ESCO profiles, each traceable to one or more of their skill or knowledge items (annex A, Table A.3), and eight, the whole digital health domain, were added by the project because neither ESCO profile addresses the digitalisation of medical technology. The set is reproduced in annex A, and its use as the instrument of the focus groups and as the reading frame of the interviews is described in sections 1.4 and 3.1. Narrowed in this way and written at EQF level 5, the perimeter corresponds closely to the ESCO occupation 3114.1.5, medical device engineering technician, the technician-level counterpart of the biomedical engineer, whose essential skills and knowledge cover ten of

the nineteen ESCO-derived cards directly (ESCO, occupation 3114.1.5; annex A, Table A.3); section 5.5 returns to this correspondence.

1.4 Research design and methods

The study is qualitative and exploratory (Hernández Sampieri, Fernández Collado and Baptista Lucio, 2014; Creswell and Poth, 2018). It works from an interpretive-constructivist position (Guba and Lincoln, 1994), on the understanding that competence needs, skills gaps and implementation barriers are not fixed quantities waiting to be measured but are shaped by institutional cultures, professional practice and policy history, and are best reached through the accounts of the people who work in the field. This suits the object of the research, since the EQF 5 profile of a Medical Technology and Digital Health Care Technician does not yet exist as a formal qualification in Tunisia and offers no established baseline to measure against. The quantitative material drawn from the desk study, such as applications to the training, the public-sector workforce and training hours, is used to describe the context in which the qualitative findings sit; it is reported as the sources give it and is not analysed statistically, so the study is not a mixed-methods study in the strict sense.

The work was carried out in four phases, each tied to a WP2 task and each building on the one before. The desk study (T2.2) came first and established the policy, institutional and labour-market baseline, and with it a first reading of where the competence gaps lay. Two expert focus groups (T2.3) then took those preliminary findings as their starting point and mapped the required competences in detail. The stakeholder interviews (T2.4) widened the picture, adding the institutional, pedagogical and regulatory views on what stands in the way of developing those competences and what might help. The synthesis (T2.5) drew the strands together, testing the field evidence against the ETF reference frameworks to arrive at the draft competence profile and the recommendations for WP3. Because each phase fed the next, the design gathered evidence in layers rather than in parallel; how that evidence was then coded and triangulated is set out in section 1.6.

The desk study drew on a structured template, organised by research sub-question so that what was extracted could be carried straight into the analysis. It ran in three modules, one on the policy and regulatory framework, one on healthcare technology sector data and one on the VET system and training provision. A separate template was completed for each source document, and OpenCom brought the individual templates together into a synthesis grid that feeds the context analysis in chapter 2.

The focus groups were the main instrument for mapping competences. Two groups were convened, planned as one of practice actors and one of system actors and kept apart so that the two perspectives could later be read against each other (section 1.5.3 reports the composition actually obtained), each run by a facilitator following a structured protocol. A session moved through six parts, from an opening and an open discussion, through the card-sorting exercise, to the questions on barriers and enablers, an exchange on gender and

inclusion, and a close. The card-sorting was the heart of it. Participants first sorted the cards by relevance, separating what is essential at EQF 5 from what is useful but not critical and what does not belong at this level; they judged how far each retained competence is already covered by Tunisian VET; they added competences of their own on blank cards; and they ranked the five they thought most important. The set they worked with held 27 predefined cards and 4 blank ones. The predefined cards fell into ten technical, eight digital health and nine transversal competences; 19 were taken from the ESCO occupation profiles 2149.5 and 2149.5.1, and the remaining 8, covering digital health, were added by the MeDCare consortium. All were printed in both French and Arabic and colour-coded by domain (annex A).

The interviews followed a different logic. Three guides were used, one for healthcare facilities, one for VET providers and one for local and regional authorities. They shared the same five blocks, an opening, an institutional profile, the core questions, a block on gender and inclusion and a close, and differed only in the core questions, which were written for each type of respondent (research design, T2.1). The block on gender and inclusion was put to every interviewee, so that this transversal dimension was covered in the same way across all three groups. Unlike the focus groups, the interviews used no cards or other set exercise, the aim being to keep their evidence distinct and to leave room for a fuller narrative.

The competence perimeter behind both the cards and the analysis rests on the ESCO occupation profiles 2149.5 (bioengineer) and 2149.5.1 (biomedical engineer), narrowed and downscaled to EQF 5 for this study; how that perimeter was arrived at is set out in section 3.1. What the fieldwork actually yielded, and where it departed from the design described here, is reported in section 1.5.

1.5 Sampling: planned and achieved

This section sets out the sampling approach defined for the study and the sample actually achieved across all data-collection activities, and it states the deviations from plan together with their implications for how the findings of the report should be read. The wider discussion of trustworthiness and limitations is provided in section 1.8.

1.5.1 Planned sampling design

The study used purposive, non-probabilistic sampling, consistent with its qualitative and exploratory design. The aim was not statistical representativeness but sufficient informational richness and triangulation across stakeholder perspectives to identify convergent themes and meaningful divergences. Three activities produced the primary and contextual data. Two focus groups of five participants each (n=10) were planned, one bringing a practice perspective and the other a system perspective. Thirty interviews were planned through stratified purposive sampling across three categories: fifteen healthcare facilities and hospitals, ten VET providers, and five local and regional authorities. A criterion-based desk study, with no fixed number of documents, provided the contextual and secondary-quantitative baseline.

The stratification criteria specified, for healthcare facilities, a mix of public and private and of large and medium establishments, a geographic spread across at least three governorates, and at least two facilities with known digital-health adoption; for VET providers, a mix of ATFP centres and other institutions and at least one private provider; and for authorities, officials responsible for VET governance, qualification frameworks or healthcare-workforce planning, including both employment-ministry and health-ministry officials. The focus groups were to aim for a minimum of 40% women across the two sessions combined. The design required any deviation from these targets to be documented in this report together with its analytical implications.

1.5.2 Achieved sample

The two focus groups were held with thirteen participants; twenty-six interviews were completed, fifteen with healthcare facilities, seven with VET providers and four with authorities; and the desk study produced the National Report covering all three modules. Table 1.2 sets the achieved sample against the plan.

Table 1.2. Planned and achieved sample, by data-collection activity.

Activity	Planned	Achieved (as documented)	Implication for the report
Focus groups (T2.3)	2 groups of 5 (n=10); FG1 a practice perspective, FG2 a system perspective	2 groups, 13 participants (5 and 8); composition inverted; 3 of 13 participants women	Number exceeded; composition inverted; women 3 of 13, below the 40% target
Interviews, healthcare facilities (Guide A)	15; public and private, large and medium; at least 3 governorates; at least 2 with digital-health adoption	15, all in Tunis: 7 public hospitals and institutes, 3 private clinics, 3 Ministry of Health structures, 2 laboratory-equipment companies; digital-health adoption reported by INT-HF-01, INT-HF-09 and INT-HF-13	Number met; all establishments in Tunis, so the geographic-spread criterion was not met; regulator and supplier sub-groups reported separately
Interviews, VET providers (Guide B)	10; ATFP centres and other institutions; at least 1 private provider	7, all from CSFEMEB (6 trainers, one of them retired, and the pedagogical coordination)	7 of 10 planned, all from one institution; the VET evidence is read as a case study of the sole provider
Interviews, local and regional authorities (Guide C)	5; employment-ministry and health-ministry officials; national and regional	4; two senior officials of the Ministry of Vocational Training and Employment (one joint session), the national training agency, and the sectoral centre's management; no health-ministry official	4 of 5 planned; no Ministry of Health official; that perspective is reached through the three Ministry of Health structures interviewed as healthcare organisations (INT-HF-01, 06, 15)
Desk study (T2.2)	Modules A, B and C; no fixed number of documents	National Report covering all three modules, with figures on applications, gender and workforce	Figures reproduced as orders of magnitude read from the National Report (section 2.5)

Source: planned figures and criteria from the Research Design (T2.1, sections 2.3, 4.1.2 to 4.1.4); focus-group figures from the Focus Group 1 and 2 Analytical Reports, section 1; interview figures from the 26 interview sheets (INT-HF-01 to 15, INT-VET-01 to 07, INT-LA-01 to 04) and their header forms; desk-study coverage from the National Report.

1.5.3 Deviations and their implications

Focus groups. The two sessions were held with thirteen participants rather than ten, so the numerical target was exceeded. Two features are to be documented. First, the composition was inverted relative to the plan: the group intended to gather a practice perspective in fact assembled system actors (a ministry directorate, standardisation officials and trainers), while the group intended to gather a system perspective assembled market actors (companies, distributors, regulatory-affairs and telemedicine specialists). The two perspectives were therefore both obtained, but not in the sessions originally assigned to them. Second, only three of the thirteen participants were women, below the 40% target; this shortfall limits what the focus-group material can support on gender and is noted again in section 1.8.

Healthcare facilities. The numerical target of fifteen was met, and the sample covers the intended range of institutional types: seven public hospitals and institutes, three private clinics, three Ministry of Health structures and two private laboratory-equipment companies, spanning large and medium establishments, and three of the fifteen report active digital-health adoption, namely an electronic-medical-record pilot hospital (INT-HF-09), a hospital developing digital archiving, electronic records and the transfer of laboratory results between services (INT-HF-13), and the Ministry of Health structure reporting the digitalisation of patient records in several hospitals (INT-HF-01). The geographic-spread criterion was not met, as all fifteen establishments are in the Tunis governorate rather than across at least three governorates. The healthcare evidence therefore reflects the Greater Tunis setting, and the sub-groups, in particular the Ministry of Health structures and the laboratory-equipment companies, are kept visible so that regulator and supplier perspectives are not read as hospital perspectives.

VET providers. Seven interviews were completed against a target of ten. All seven respondents belong to a single institution, the Sectoral Training Centre for Electricity and Maintenance of Biomedical Equipment (CSFEMEB), so the intended diversity of provider types, including at least one private provider, was not achieved. This is the most consequential deviation. The VET evidence is therefore presented as an in-depth institutional case study of a single provider, not as a provider landscape, and no claim is made about VET provision beyond that institution. This is consistent with the field observation, reported by the authorities themselves, that this centre is currently the only one providing training in the field.

Local and regional authorities. Four interviews were completed against a target of five. The respondents cover officials responsible for VET governance and qualification frameworks, but no official affiliated with the health ministry was included, so that element of the stratification was not met. The health-ministry perspective is, however, reached indirectly through the three Ministry of Health healthcare respondents (INT-HF-01, 06 and 15); on institutional questions it rests on INT-HF-06 and INT-HF-15, the corresponding block of the INT-HF-01 interview having been left uncovered when the respondent shortened the interview. Two of the four authority respondents, INT-LA-01 and INT-LA-03, both senior officials of the Ministry of

Vocational Training and Employment, were interviewed together in a single joint session at their request, a configuration the design permits; they are counted as two respondents in one session.

Desk study. The desk study produced the National Report covering the three planned modules, and it supplies the contextual and secondary-quantitative baseline used in this report. Section 2.5 reproduces the orders of magnitude read from the National Report figures (ATFP, 2026).

Gender distribution. As required by the design, the gender distribution was recorded. Among the twenty-six interviewees, nine were women, approximately 35%: five of fifteen in the healthcare category, four of seven in the VET category, and none of the four authority respondents. Among the thirteen focus-group participants, three were women, approximately 23%. These distributions are reported here as characteristics of the achieved sample; gender findings themselves are treated in section 4.6.

Completeness of the interview record. Three thematic blocks of one healthcare interview (INT-HF-01) carry no data, because the respondent shortened the interview for lack of time; the affected blocks are treated as absent data. The gap concerns the completeness of the record, not the composition of the sample.

Taken together, these deviations mean that the findings of the report are anchored in the Greater Tunis setting, describe VET provision through a single institution, and represent vocational-training governance more fully than health governance. They remain a sound basis for identifying the barriers and enablers reported by those consulted, provided these boundaries are kept in view. The implications for the overall trustworthiness of the study are discussed in section 1.8.

1.6 Data analysis

The analysis followed three layers that mirror the research sub-questions: a policy and institutional mapping of the desk study material (chapter 2), in which the quantitative figures are presented descriptively; a thematic analysis of the focus group reports and the interview sheets (chapters 3 and 4); and the triangulation and synthesis of chapter 5.

The thematic analysis applied the reflexive approach of Braun and Clarke (2006; 2019), through its six phases from familiarisation to reporting. Deductive codes came from the twenty-seven competences of the perimeter (section 1.3) and from a typology of barriers in four classes, institutional, pedagogical, technological and socio-economic. Inductive codes captured what the framework had not anticipated, notably the emergent competences of section 3.6 and the dependence on suppliers of section 4.4.

Two instruments consolidate the coding. The competence mapping grid (annex C) records, for each competence, the ratings of the two focus groups, the number of healthcare-sector interviews that name it, its coverage in the existing programmes and a reinforcement priority assigned by the rule stated in section 3.5. The barrier and enabler matrix, summarised in Table 4.1, records the evidence of each stakeholder

category and focus group for each barrier or enabler. In both instruments the figures count the sources that mention an item; they do not measure its importance. The findings were then triangulated across data sources, across stakeholder categories and against the three ETF reference documents used in chapter 5: the Key Competence Lighthouse (ETF, 2023a), the Torino Process assessment of policies for human capital development in Tunisia (ETF, 2021) and the Torino Process system monitoring report for Tunisia (ETF, 2023b).

1.7 Ethics and data management

The study followed the ethics protocol of the research design: informed consent, confidentiality, data minimisation and transparency on the use of the data. Participants received an information sheet in French and Arabic and gave written consent to participation, to audio recording and to the use of anonymised data; for online interviews, consent could be given on record. Two respondents declined recording and provided written answers (INT-HF-04, INT-HF-05).

Public institutions are named; hospitals, clinics and companies are given by type; individuals are not identifiable and posts held by a single person are generalised. Interviewees are cited by the code of their sheet and focus group participants by the codes of the analytical reports. Recordings and notes are held on access-restricted project storage, and the recordings are deleted after the validation of the report. As a Capacity Building in VET project, MeDCare was not subject to formal ethical review.

1.8 Trustworthiness and limitations

Trustworthiness was pursued through the four criteria of Lincoln and Guba (1985): credibility, through triangulation and the review of the findings by the Tunisian partners who collected the data; transferability, through the contextual detail of chapter 2 and the description of the sample in section 1.5; dependability, through the documentation of the analytical decisions and counting conventions in the text and the annexes; confirmability, through the citation of every statement to a source the reader can consult and the archiving of the anonymised material.

The study was designed and analysed by OpenCom, working from Italy, with the data collected in French and Arabic by the Tunisian partners, ATFP, Elemtiez and ATAS, each with its own position in the system under study. The deductive framework drawn from ESCO and the EQF descriptors is a European lens on a Tunisian system; the inductive coding and the review by all partners were the means of keeping it in check.

Five limits qualify the findings. The vocational training evidence describes one institution, which is also the only provider of the specialty. No learners or recent graduates took part, so the demand for the qualification and the learners' own view of their competences are known only through application figures and the accounts of trainers and employers. What the report says about learner experience, access, progression and perceived training needs is therefore indirect, read from administrative data and from the accounts of

trainers, employers and authorities. The healthcare organisations interviewed are all in Greater Tunis. No Ministry of Health official was interviewed as an authority, and that perspective is reached through the three Ministry of Health structures interviewed as healthcare organisations. Women were a minority among the participants, three of thirteen in the focus groups and nine of twenty-six interviewees, which limits what the material can support on gender. The departures from the planned sample are set out in section 1.5.

Chapter 2. Context: policy, labour market and training provision in Tunisia

This chapter answers the first research sub-question (SQ1): which national policies, strategies and vocational training frameworks govern biomedical technology education in Tunisia, how the healthcare technology workforce is structured, and how the national qualifications framework relates to EQF level 5 for this profile. It sets the baseline against which chapters 3 and 4 measure competence gaps and barriers. The evidence is the National Report of the desk study (ATFP, 2026) and the desk study on the regulation of private providers (Elemtiez, 2026c); interview material (ATAS, 2026) is used only where it updates or qualifies the documentary sources.

2.1 Legal and regulatory framework of vocational training

The Tunisian vocational training system rests on a structured body of legislation that defines how training is organised, how qualifications are certified and how quality is assured, and that ties provision to the needs of the labour market (ATFP, 2026, section I.2). Five instruments frame the sector in general and the *Brevet de technicien supérieur* (BTS) in biomedical equipment maintenance in particular: Decree 2004-512, Law 2008-10, Decree 2009-2139, Decree 2010-1094 and the Ministerial Order of 5 May 2022.

Decree 2004-512 of 1 March 2004 governs the training establishments placed under the Tunisian Agency for Vocational Training (ATFP), setting the conditions of registration, the study regime and the certification of training (ATFP, 2026, section I.2). Admission to BTS level requires an approved *Brevet de technicien professionnel* or a baccalaureate in a compatible stream. Training is delivered mainly on a work-study or apprenticeship basis, with strong participation by companies, and the official programmes approved by ministerial decree are compulsory in every establishment, subject to a margin of flexibility for short-term special programmes. Assessment rests on end-of-module examinations with retake and catch-up sessions, but failure in three modules ends the learner's course in the specialty. Diplomas are issued by the directors of the establishments and must state the specialty followed, the approval order and the corresponding level in the national job classification, which secures their official recognition and their value on the labour market.

Law 2008-10 of 11 February 2008 is the framework law for vocational training. It defines training as a central lever for the development of human resources and requires that knowledge and skills be matched to the evolution of occupations under economic and technological change, with the responsible ministry tasked to forecast technological transformation and to maintain the national and regional training map (ATFP, 2026, section I.2). The law organises provision in three cycles, of which the BTS is the highest, and requires practical placement in companies, a work-study contract or, under defined conditions, distance delivery. For each diploma it establishes two instruments: a general reference framework, set by decree, fixes the learner's exit

profile, the minimum duration of training and the compulsory general disciplines; a training standard, set by ministerial order, defines the specialty, determines the skills and knowledge required for the diploma, sets the specific conditions of registration and the criteria for assessing prior learning, and is revised periodically on the basis of data from the National Observatory of Skills and Innovative Professions. Any public or private institution that wishes to deliver a regulated specialty must obtain official accreditation from the ministry responsible for vocational training, and where no training standard yet exists an exceptional authorisation may classify the diploma against existing ones. Assessment is both continuous and by a final certification at the end of each cycle, and the law commits the system to bilateral and multilateral cooperation.

Decree 2009-2139 of 8 July 2009 establishes a national classification of qualifications that links diplomas to corresponding levels of skill and is expressed in learning outcomes across seven levels (ATFP, 2026, section I.2). The BTS in biomedical equipment maintenance is placed at level 4, and the learning outcomes the classification defines for that level cover the cognitive and practical skills needed to establish and apply procedures through a problem-solving approach, the ability to communicate clearly and with reasoned judgement in adequate language, the capacity to lead a team under one's responsibility, and the ability to identify one's own training needs and construct a learning path. The decree obliges public and private institutions to guarantee the quality of the qualifications they deliver and their consistency with the descriptors of the level concerned. How this national level 4 relates to level 5 of the European Qualifications Framework, the level at which the MeDCare qualification is defined, is examined in section 2.2.

Decree 2010-1094 of 2 August 2010 sets the general reference framework for vocational training diplomas (ATFP, 2026, section I.2). For the BTS it fixes a minimum of 2,200 hours of initial training, of which 320 hours are a practical placement in a company. The exit profile of the diploma holder is expressed in four registers. Operationally, the holder establishes and applies operating procedures for complex tasks, selects and adapts methods, tools and materials to solve problems, plans and organises the work of a team from general guidelines, integrates information from several sources and evaluates the quality of the work with detailed written and oral reporting. For professional integration, the holder knows the rights and duties of a worker, understands the occupational context and the labour market and communicates in a clear and reasoned way. For the deepening of knowledge, the profile calls for a sense of responsibility, the optimisation of professional performance, an understanding of the underlying techniques and technologies, creativity and initiative, an attachment to quality standards and an entrepreneurial disposition. For citizenship, it looks for awareness of civic duty, openness to others and sensitivity to environmental protection and energy management.

The most recent instrument is the Ministerial Order of 5 May 2022, which sets the accreditation file currently in force for the BTS in biomedical equipment maintenance (ATFP, 2026, section I.2). The file comprises a general presentation of the training operator, a presentation of the diploma, the human and material resources required to deliver it, the methods for selecting candidates and assessing learners, and the

qualification sheets of the trainers involved. Its validity runs for a renewable period of five years, from 25 June 2022 to 24 June 2027.

Across these instruments the BTS is defined within a work-study model, with company placement written into the diploma's own reference framework, and accreditation by the responsible ministry is required of any public or private provider of a regulated specialty. The instruments reviewed contain no specific provisions on gender in access, enrolment or employment (ATFP, 2026, section I.2), a point taken up in the transversal reading of gender and inclusion. How the framework operates in practice, and the fact that the specialty is at present delivered by a single public provider, are examined in sections 2.3 and 2.6.

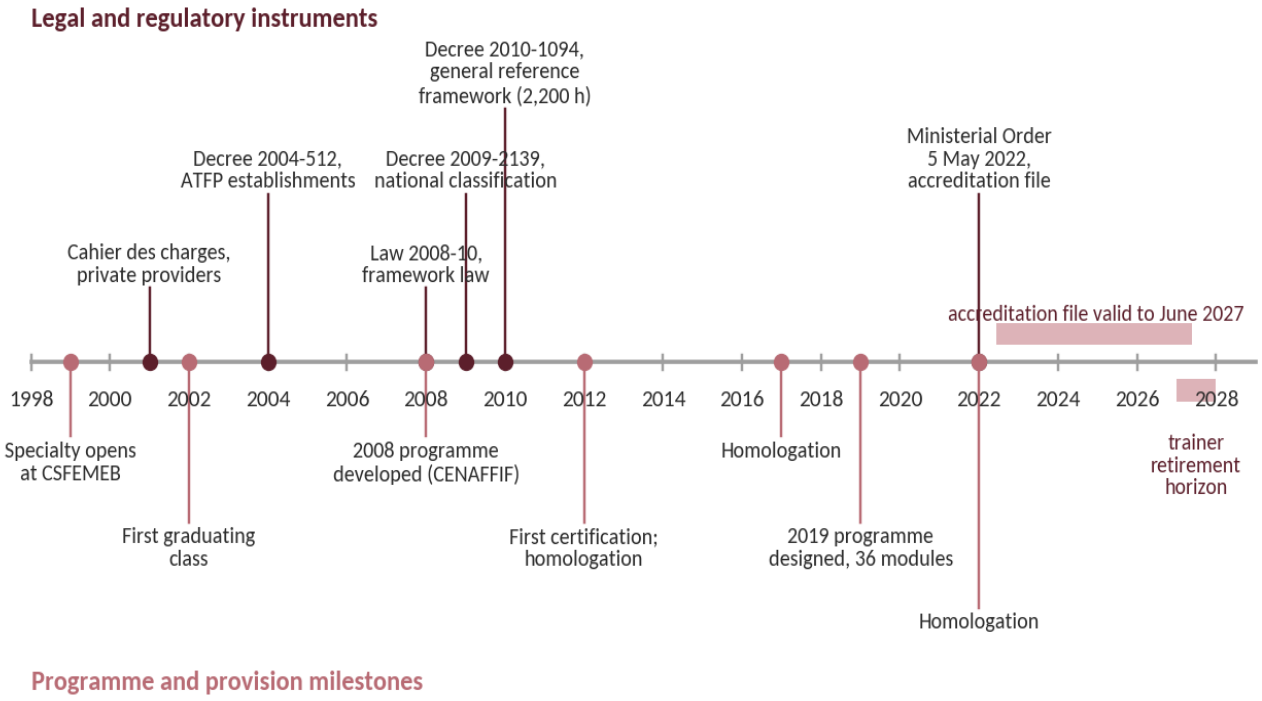


Figure 2.1. Legal and regulatory instruments governing the BTS in biomedical equipment maintenance (above the line) and the milestones of the programme and its provision (below the line), 1998 to 2028.

Source: National Report (ATFP, 2026, sections I.2 and III); Elemtiez (2026c) for the specifications of 12 September 2001.

2.2 The Tunisian NQF and EQF level 5

Tunisia places its qualifications within the national classification established by Decree 2009-2139 of 8 July 2009, which links diplomas to levels of skill expressed as learning outcomes across seven levels and requires public and private institutions to keep their qualifications consistent with the descriptors of the level concerned (ATFP, 2026, section I.2). The BTS in biomedical equipment maintenance sits at level 4 of this national framework (ATFP, 2026, section I.2). Its learning outcomes, as the classification defines them for level 4, cover the cognitive and practical skills needed to establish and apply procedures through a problem-solving approach, the capacity to communicate clearly and with reasoned judgement, the ability to lead a

team under one's own responsibility, and the ability to identify one's own training needs and build a learning path (ATFP, 2026, section I.2).

The comparison that matters for MeDCare is between this national level 4 and level 5 of the European Qualifications Framework, since the MeDCare qualification is itself defined at EQF level 5. These are two different frameworks, and the evidence keeps two findings apart. No official equivalence or formal referencing has been established between the Tunisian NQF and the EQF, a conclusion the National Report attributes to the European Training Foundation in its 2023 Tunisia report (ATFP, 2026, conclusions, citing an ETF country report of 2023). At the same time, the National Report states, on the basis of its own reading of the learning outcomes, that Tunisian NQF level 4, the BTS level, aligns strongly with the EQF level 5 descriptors, particularly in autonomy, problem-solving capacity and responsibility (ATFP, 2026, conclusions); the report does not set out the comparison itself, and no formal referencing exercise has been conducted. There is, in other words, an argued alignment of learning outcomes, but no formal act of referencing that would make the two levels officially equivalent.

The stakeholders interviewed treat this gap as a matter of recognition and institutional procedure rather than of technical content alone. Alignment with the EQF is sought by several actors, including the ETF and the European Union, to ease the recognition of Tunisian diplomas, but institutional obstacles remain, and a more formal framework together with stronger involvement of the relevant directorates and of CENAFFIF is considered necessary (INT-LA-01). The national classification is seen as clearly defining the competences and learning outcomes expected at each level, and so as a sound basis for comparing Tunisian qualifications with European standards, with alignment viewed as a way to ease recognition abroad once the outstanding administrative and institutional issues are resolved (INT-LA-03). One senior ministry official proposed developing a bilateral recognition framework between Tunisia and Italy for the biomedical qualification specifically (INT-LA-01).

Alongside international recognition, the interviews raise a question of domestic progression. Unlike holders of the BTP, BTS graduates are reported to be unable to progress to university, and legislative change is considered necessary to open that path (INT-LA-04). In the same respondent's view, BTS graduates already hold technical competences close to those of an EQF level 5 qualification, the differences lying in technological innovation, soft skills and languages (INT-LA-04). This is the judgement of one official on the centre's own graduates, not the result of a comparison against the EQF descriptors, and it is reported as such.

At the level of the framework, then, the BTS sits at NQF level 4, its learning outcomes are argued to align with EQF level 5 in autonomy, problem solving and responsibility, yet no formal referencing links the two frameworks and no domestic route carries BTS graduates into higher education. The institutional and regulatory dimension of this situation, including the basis for recognition and co-diplomation, is examined among the institutional barriers in chapter 4, section 4.2.

2.3 Governance of biomedical VET

The governance of the BTS in biomedical equipment maintenance brings together the vocational training authorities and the health sector, and the actors involved describe it as participatory (ATFP, 2026, section III; INT-LA-01, INT-LA-03). On the training side, the Ministry of Vocational Training and Employment (MEFP) sets the general reference frameworks and training standards and maintains the national and regional training map (section 2.1; ATFP, 2026, section I.2), the Tunisian Agency for Vocational Training (ATFP) orients, enrols and supports learners and operates the training centres (INT-LA-02), CENAFFIF develops the training programmes, as it did for the 2008 and 2019 versions (ATFP, 2026, sections III-2, III-3), and CSFEMEB, the sole public centre, delivers a specialty that has not been opened to private providers (ATFP, 2026, section III; INT-LA-03; section 2.6).

On the health side, several Ministry of Health structures take part. The Ministry itself acquires and supplies medical equipment to public hospitals and healthcare facilities (INT-HF-01). The *Centre des études techniques et de maintenance biomédicale hospitalière* (CETMBH), the Ministry of Health's centre for technical studies and hospital biomedical maintenance, covers hospital technical platforms across medical imaging, medico-surgical and operating-room equipment, respirators, dialysis and laboratory equipment, electromechanical and electrical services, sterilisation and the quality control of medical and radiology equipment (INT-HF-15). The National Agency for Medicines and Health Products carries a regulatory role and is developing digital registration systems for medical devices (INT-HF-06). The link between the training system and these health-sector bodies runs through joint committees: one between the vocational training ministry and the Ministry of Health covers initial paramedical and healthcare training, while a national committee handles continuing training, particularly for private healthcare institutions (INT-LA-03).

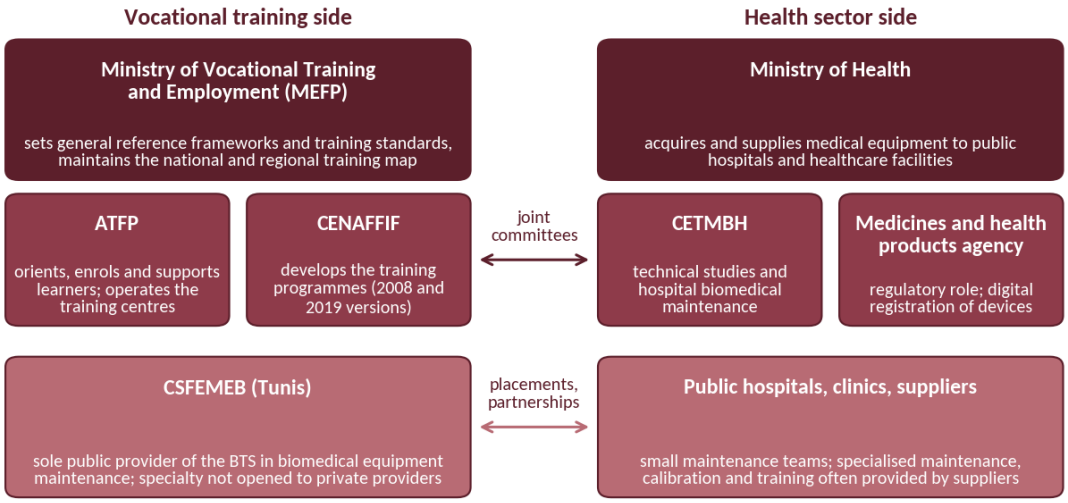


Figure 2.2. Governance of the BTS in biomedical equipment maintenance: the vocational training side, the health sector side and the links between them.

Source: National Report (ATFP, 2026, sections I.2 and III); interviews INT-LA-01 to INT-LA-04, INT-HF-01, INT-HF-06 and INT-HF-15 (ATAS, 2026).

The procedure for creating or revising a qualification is defined and runs through several stages. A new qualification requires an assessment of labour-market needs and consultation with the sector, an analysis of work situations, a programmed development of the qualification and official approval by the relevant authorities; existing qualifications are approved together with their study programmes, assessment guides and equipment requirements (INT-LA-02). What is most consistently reported as an obstacle is not the design of this procedure but its duration, since the time taken by administrative procedures and approvals is presented as the main brake on creating or updating a qualification (INT-LA-02; ATAS, 2026, section 12.1). Programme revision follows the same route, and the homologations of the 2008 programme and the still-pending accreditation of the 2019 programme pass through the same authorising channel (ATFP, 2026, sections III-2, III-3; section 2.6).

The regulation of private training providers is set separately from the public system. The specifications (*cahier des charges*) of 12 September 2001 on the creation and operation of private vocational training structures are a horizontal framework governing how a private training structure may legally operate: it fixes the conditions for establishing a private institution, requires prior authorisation, obliges providers to submit their training programmes and operational rules, requires qualified trainers and staff, and imposes transparency toward learners on the programme, its duration, certification and costs (Elemtiez, 2026c). It provides that certain training fields may be subject to additional sector-specific conditions set jointly with the competent ministry, which would apply to health-related or biomedical programmes. This remains contextual for the BTS in biomedical equipment maintenance, which is at present delivered only by the public centre and has not been opened to private providers (ATFP, 2026, section III; INT-LA-03).

2.4 The healthcare technology workforce

In the public sector the biomedical maintenance workforce is small but structured. At 30 June 2024 it numbered 234 biomedical technicians, with a marked female majority of about 65% women to 35% men (ATFP, 2026, section II.6). This runs against the male-majority trend seen in applications to the training, which suggests that women are more stably integrated into public employment once trained (ATFP, 2026, section II.6). This share concerns the employed workforce; it is kept separate from the applicant figures in section 2.5 and from learner-share estimates, which rest on different bases and are not combined.

The workforce is deployed across the country but unevenly. Greater Tunis (Tunis, Ariana, Ben Arous, Manouba) is the principal employment hub, through the major national hospitals, specialised centres and the central directorates of the Ministry of Health, with further concentrations in Sfax, Sousse, Monastir and Nabeul around regional hospitals and universities (ATFP, 2026, section II.6). There is also a significant presence in inland governorates such as Gafsa, Kasserine, Jendouba, Kebili and Tataouine, mostly in regional and local hospitals, reflecting an effort to cover biomedical maintenance nationwide (ATFP, 2026, section

II.6). The spread is not only quantitative: urban and reference hospitals concentrate the most qualified profiles, while inland regions hold more intermediate profiles and more thinly resourced structures, a pattern the National Report reads as a still hierarchical organisation of skills and equipment and a source of persistent territorial disparity (ATFP, 2026, section II.7).

At facility level the field accounts describe small teams stretched against large and varied equipment stocks. One hospital maintenance unit, made up of a service head, two senior biomedical technicians and a qualified worker, is presented as insufficient for a category B hospital given the amount and variety of equipment it must cover (INT-HF-09). A large establishment with thirty-seven services, twenty-seven operating rooms and about 2,400 staff reports too few technicians for its daily volume of requests (INT-HF-12), and a university hospital runs a four-technician biomedical team spread across radiology, laboratory analysis machines, ultrasound, anaesthesia respirators and water-treatment equipment, with gaps beyond each technician's own specialty (INT-HF-13). The obstacle reported most consistently is therefore not the competence of the technicians but their limited number relative to the volume and diversity of the equipment (ATAS, 2026, Part B; INT-HF-09, INT-HF-12).

Facilities also depend heavily on suppliers. Across the healthcare facilities interviewed, specialised maintenance, diagnosis, calibration, repair and equipment-specific training are frequently provided by suppliers and private companies rather than in-house (ATAS, 2026, Part B), and calibration in particular is generally carried out by the equipment manufacturer or supplier (INT-HF-09). This dependence carries a knowledge-concentration risk, because supplier training usually reaches only one or two technicians, so that the absence or departure of a trained technician can leave a facility without the capacity to operate or maintain the equipment effectively (INT-HF-13).

On gender within the workforce, the interviews describe teams that are genuinely mixed, with women present in technical roles and performing the same responsibilities, and with recruitment based on qualifications and technical competence rather than gender (INT-HF-12, INT-HF-13). Where barriers are mentioned they are linked to the conditions of the work, such as mobility, the handling of heavy equipment or field and night interventions, rather than to technical ability, and they are taken up in the transversal reading of gender and inclusion (INT-HF-12, INT-HF-13; ATAS, 2026, Part B).

The public-sector workforce thus offers a real and comparatively inclusive employment pathway, notably for women, but one centralised in the coastal and capital hubs, thinly staffed against the volume of equipment it maintains, and dependent on suppliers for the most specialised tasks. These conditions shape the competences that healthcare organisations expect of an EQF level 5 technician, examined in chapter 3.

2.5 Demand for training and access

The BTS admits a small and broadly stable number of trainees at each session, while the number of rejected applications rises markedly across the sessions and reaches its highest point in the second session of 2025 (ATFP, 2026, section II, figure 1). Together these two movements indicate a structural imbalance between the demand for the training and the places available, an unmet demand that the single public provider cannot absorb, examined further in section 2.6.

Applicants are predominantly male. The male share varies from one session to another rather than following a continuous trend, and it widens in the most recent session (ATFP, 2026, section II.1, figure 2). This tendency among applicants has to be read separately from the composition of the employed workforce in section 2.4, where women form the majority of public-sector biomedical technicians. The two shares rest on different bases, applicants to the training on one side and the employed workforce on the other, and are not combined into a single figure. The divergence between them, sometimes called a **gender paradox**, is examined among the gender-related barriers and enablers in section 4.6.

Applicants are drawn disproportionately from Greater Tunis, yet a substantial proportion come from outside the principal governorates, grouped by the report under an "other" category that it reads as a sign of diffuse national demand for the qualification (ATFP, 2026, section II.2, figure 3). This national demand meets a provision concentrated at a single site in Tunis (section 2.6), so applicants from other governorates face the mobility and accommodation costs taken up among the socio-economic barriers in section 4.5. The report also records regional contrasts in the gender of applicants, with some governorates, such as Gabes and Bizerte, more strongly male and others, such as Ariana, showing higher female participation (ATFP, 2026, section II.3, figure 4).

Read from the figures of the National Report, the intake is of about twenty admissions per session, while rejected applications rise to around seventy-five in the second session of 2025 (ATFP, 2026, figure 1); the male share of applicants is roughly 60% and rises to about 75% in that session (figure 2); and the "other" territorial category exceeds one third of applicants (figure 3). StatistiqueBTSMEB-12-04-2026)

The profile of recent graduates, drawn from the 2022 cohort, is young and mostly male, and comes mainly from the Tunis centre (ATFP, 2026, section II.5). Integration into the labour market is only partial, with varied delays before employment and a range of contract types, and some graduates consider migration as an alternative to the domestic market (ATFP, 2026, section II.5). This partial insertion sits against the employability of graduates reported by the provider and the centre's management, an enabler taken up in chapter 4, section 4.7.

These patterns describe a demand for the qualification that is national in origin and in structural excess of a centralised, single-site provision, whose capacity and content are examined in section 2.6.

2.6 Existing provision: the BTS in biomedical equipment maintenance

Within the vocational training system the BTS in biomedical equipment maintenance, whose diploma the National Report renders as Higher Technician in Biomedical Equipment Maintenance, is delivered at a single site. The Sectoral Training Centre for Electricity and Maintenance of Biomedical Equipment in Tunis (CSFEMEB) is the sole public provider, and the specialty has not been opened to private centres (ATFP, 2026, section III, III-1). The specialty began in September 1999 and produced its first graduating class in February 2002 (ATFP, 2026, section III-1). The centre delivers the biomedical specialty at two levels, the *Brevet de technicien professionnel* (BTP), which gives access to the BTS, and the BTS itself, with about five or six groups of some twenty trainees each (INT-VET-05, INT-VET-06).

Two programmes define the BTS provision, one in use and one awaiting implementation. The programme currently delivered was developed by CENAFFIF in 2008 and first certified in 2012 (ATFP, 2026, section III-2). It is organised in twenty-nine modules, each lasting between fifteen and 150 hours, grouped into technical foundations (analogue and digital electronics, electrical engineering, automation, microprocessors), biomedical applications (maintenance of imaging, laboratory, sterilisation, surgical and other medical equipment) and transversal skills (communication, languages, human-resource management, labour legislation). It has been homologated three times, in 2012, 2017 and 2022; these revisions mainly reduced the hours allocated to certain modules, generally the general and soft-skill teaching, under the combined pressure of the medical devices available in working order and a training year shortened by ministerial decision (ATFP, 2026, section III-2).

A new programme was developed by CENAFFIF in 2019 to carry out the updates requested by professionals and to align the qualification with the general reference framework and training standard model (ATFP, 2026, section III-3). It renames the diploma "Higher Biomedical Technician" in order to widen the technician's field of tasks, and it is structured in thirty-six modules, including three integration modules, for a total of 2,454 hours distributed between specific professional training (1,520 hours), transversal training (555 hours) and general training (379 hours), with modules of between thirty and 160 hours and two named work-based components. This programme has not yet been implemented; an application for its accreditation is to be scheduled before it can begin at the centre (ATFP, 2026, section III-3). Provision therefore continues to run on the 2008 programme while the 2019 revision remains on hold.

The biomedical teaching body is small and ageing. Of about eighty trainers at the centre, roughly ten work in the biomedical field (INT-VET-05, INT-VET-06). The specialised biomedical trainers are described as competent but close to retirement, several within one or two years, and the trainers expected to replace them are not yet sufficiently prepared, which the interviewees present as a significant capacity risk (INT-VET-01, INT-VET-03, INT-VET-07). The authority interviewed places the difficult horizon at 2027 to 2028, when many trainers are expected to retire, and reports that an external recruitment competition is planned to

address the shortage (INT-LA-04). Continuing professional development for these trainers is reported as insufficient or largely absent: it is not accessible to all, one trainer reports having received no specialised training from the centre for about twenty years, and none reports structured development in digital health, so trainers update knowledge individually (INT-VET-01, INT-VET-03, INT-VET-05, INT-VET-06, INT-VET-07).

The training equipment is largely that acquired when the centre and the programme were established around 2000, some of it about twenty-five years in service, with items that are obsolete, out of service or in rooms no longer functionally equipped (INT-VET-01, INT-VET-05, INT-VET-06). Some equipment was replaced or updated in 2023, 2024 and 2025, but the renewal is partial and, on the trainers' account, slower than the pace of technological change (INT-VET-03).

Work-based learning is built into the diploma. Decree 2010-1094 requires 320 hours of company placement (section 2.1), and the current programme is delivered with several internships in hospitals and companies, generally reported as three placements together with a technical internship linked to the final project (INT-VET-01, INT-VET-05, INT-VET-06, INT-VET-07). Their practical value is constrained by the availability of equipment during placement and, in the field accounts, by the absence of clearly targeted learning objectives; focus-group and narrative sources additionally report the placements as too short and insufficiently practical (INT-VET-07; Elemtiez, 2026a, section 3; ATAS, 2026, section 13). The reach of hospital partnerships is uneven, and at least one maintenance unit reports no established partnership with the training centre because of staff shortage and workload (INT-HF-09).

Provision therefore rests on a single public centre running a technically sound 2008 programme, with the 2019 revision designed but not yet accredited, a small biomedical teaching body close to retirement, equipment dating largely from the centre's foundation, and work-based learning that is required and present but uneven in practice. How far this baseline meets the competences that employers and the system now expect is taken up in section 2.8 and chapter 3.

2.7 Digital health adoption in the sector

Digital adoption among the healthcare organisations interviewed is uneven and concentrated in specific functions rather than system-wide. Electronic patient records are reported as implemented in at least one hospital, which describes itself as a pilot for digitalisation, with laboratory results automatically transferred into the record and the facility stated as open to extending telemedicine, which it does not yet use (INT-HF-09). Digital archiving and the transfer of laboratory results between services are reported as developing at a second hospital (INT-HF-13), and a computerised patient management system is in use at a private clinic (INT-HF-10). At the national level, the medicines and health products agency evaluates technical dossiers through processes it describes as increasingly connected to digital systems for registration and evaluation (INT-HF-06), and the Ministry of Health reports that digitalisation of patient records is being introduced and

expanding across several hospitals, alongside a wide range of biomedical and medical technologies supplied to facilities (INT-HF-01).

Maintenance-related digital systems are the most consistently reported form of adoption within the healthcare facilities. A hospital biomedical maintenance department uses a computerised maintenance management system (INT-HF-02). Remote reading in radiology and connected medical equipment are named at two further hospitals, one of which links connectivity explicitly to hospital data management systems (INT-HF-12, INT-HF-14). A university hospital maintenance department names telemedicine, telemaintenance, connected medical devices, data transfer, networks and health informatics together as an evolving requirement rather than as fully embedded practice (INT-HF-11). The national biomedical maintenance and hospital technical studies centre reports experience with connected biomedical equipment, interfacing, sensors and the remote communication of equipment information, alongside continuing work on quality control of imaging, laboratory and other critical equipment (INT-HF-15).

Two of the fifteen respondents recorded under the health facility guide are private laboratory-supply companies rather than healthcare providers as such: a diagnostics company working in molecular biology (INT-HF-07) and a laboratory equipment and technical services company (INT-HF-08). Both describe telemaintenance and remote technical support as an established part of the service they provide to their own clients, that is as supplier-side practice attached to laboratory instruments rather than as a clinical information system operated inside a care facility (INT-HF-07, INT-HF-08). Their evidence is reported here as a distinct sub-group so that supplier-side telemaintenance is not read as facility-level clinical adoption.

Telemedicine is reported as not yet in use by any of the facilities that discuss it directly, although one hospital states it is open to introducing it (INT-HF-09) and the market perspective focus group discusses telemedicine as part of the digital layer of the profession rather than as an established practice in the facilities represented (Elemtiez, 2026b, section 3). Read together, the evidence points to a sector where maintenance management, remote diagnostic support from suppliers and, in a smaller number of hospitals, digital patient records and result transfer are already in place, while telemedicine, full interoperability between connected equipment and hospital information systems, and structured cybersecurity practice remain at an early or aspirational stage.

Function	Status reported	Source
Computerised maintenance management	In place	INT-HF-02
Remote reading in radiology, connected equipment	In place	INT-HF-12, INT-HF-14
Electronic patient record, laboratory results into record	In place (pilot)	INT-HF-09
Computerised patient management (private clinic)	In place	INT-HF-10
Digital archiving, transfer of laboratory results	Developing	INT-HF-13
Digital registration and evaluation of devices (agency)	Developing	INT-HF-06
Connected equipment and remote data (national centre)	Experience reported	INT-HF-15
Telemaintenance and remote support (supplier side)	Established, supplier side	INT-HF-07, INT-HF-08
Telemedicine	Not yet in use	INT-HF-09; Elemtiez, 2026b
Interoperability of equipment and hospital systems	Early or aspirational	INT-HF-11
Structured cybersecurity practice	Early or aspirational	Elemtiez, 2026a, 2026b

in place | developing or supplier side | early or aspirational | not yet in use

Figure 2.3. Digital health functions reported by the organisations interviewed, by status of adoption.

Source: healthcare-sector interview sheets (ATAS, 2026); Focus Group 1 and Focus Group 2 Analytical Reports (Elemtiez, 2026a, 2026b).

2.8 Chapter summary: baseline for the competence analysis

This chapter sets the baseline against which chapter 3 measures competence gaps, and that baseline has clear strengths. The BTS is anchored in a structured body of legislation and in the national qualifications classification (sections 2.1, 2.2), and it follows a work-study model with company placement written into the diploma's own reference framework (sections 2.1, 2.6). Its 2008 programme gives a sound technical foundation (section 2.6; ATFP, 2026, conclusions), it feeds a public-sector workforce that offers a real and comparatively inclusive employment pathway, particularly for women (section 2.4), and demand for it exceeds the places available (section 2.5). Graduates are reported by the provider and the centre's management to find employment readily, while the National Report records only a partial insertion of the 2022 cohort (section 2.5); the two readings are set side by side in chapter 4, sections 4.7 and 4.8.

The baseline is thin in three areas that shape the competence analysis. The programmes give limited room to transversal skills and do not cover medical informatics or digital health, in the 2008 programme in use or in the 2019 revision that awaits accreditation (section 2.6; ATFP, 2026, conclusions); the sector's own digital adoption is examined in section 2.7. The biomedical teaching body is close to a retirement horizon of 2027 to 2028, its successors are not yet ready, and structured continuing development is largely absent (section 2.6). And the training equipment dates mostly from the centre's foundation around 2000 and is renewed

more slowly than the technology moves on (section 2.6). Digital content, trainer renewal and equipment are the gaps that chapter 3 measures against the competences that employers and the system now expect of an EQF level 5 technician.

Chapter 3. Competence mapping

This chapter answers the second research sub-question (SQ2): which technical, digital and transversal competences an EQF level 5 medical technology and digital health care technician needs in the Tunisian context. It starts from the competence perimeter fixed before the fieldwork, reports what the two focus groups and the interviews said about each competence, brings the results together in the competence mapping grid of annex C, and identifies the competences to prioritise and those on which the evidence disagrees. The evidence is the two focus group analytical reports (Elemtiez, 2026a, 2026b), the healthcare-sector and vocational-training interview sheets (ATAS, 2026) and the National Report (ATFP, 2026).

Two features of the fieldwork shape the reading throughout. The two focus groups gathered the opposite constituencies to those the design had planned: Focus Group 1 (FG1, hereafter the system actors' group) brought together the ministry, the standardisation directorates and trainers, while Focus Group 2 (FG2, hereafter the market actors' group) brought together companies, distribution, regulatory affairs and telemedicine. The groups are therefore named by what they were. In addition, one respondent took part in both strands, appearing in the market actors' group and again as a healthcare-sector interviewee (INT-HF-07), so that respondent is never counted twice as convergence between the interviews and the focus groups.

3.1 The competence perimeter

The competence perimeter for the study was fixed before the fieldwork and then tested against it. It was anchored to the ESCO occupation profile 2149.5 (bioengineer) and its narrower occupation 2149.5.1 (biomedical engineer), narrowed and downscaled to EQF level 5. The anchor has to be read with care, because the bioengineer profile as ESCO defines it is broader than, and in its core different from, medical technology. The essential skills and competences listed for the bioengineer profile concern adjusting and approving engineering designs, developing bioremediation techniques and performing scientific research, and the essential knowledge concerns the bioeconomy, biological chemistry, biotechnology, genetics, synthetic biology and life sciences. Medical technology sits in the profile's optional layer, not its essential one: biomedical engineering, medical devices materials, laboratory techniques, computer simulation and the interpretation of 2D and 3D plans all appear among the optional skills and knowledge. The perimeter was therefore drawn from that optional layer, from the essential and optional items of the biomedical engineer profile that concern medical devices, test procedures and professional practice, and from the project's own additions, and the areas outside the medical-technology scope, such as bioremediation, food science and pharmaceutical manufacturing, were excluded. The ESCO profiles are best understood as the point of departure that was deliberately narrowed, not as a close description of the target occupation.

The narrowed perimeter was expressed as twenty-seven competence cards, distributed across three domains:

1. The technical domain (cards N1 to N10) covers the engineering and maintenance foundation of the profession.
2. The digital health domain (cards N11 to N18) covers information systems, telemedicine, connected devices, data protection and the software and security that come with them.
3. The managerial and transversal domain (cards N19 to N27) covers documentation, quality, communication, problem-solving and the organisational competences of the role.

Of the twenty-seven cards, nineteen are drawn from the ESCO profiles 2149.5 and 2149.5.1 (annex A, Table A.3) and eight are additions made within the MeDCare project; all eight additions fall in the digital health domain, which is the part of the profile the ESCO anchor covers least. The competence descriptions were written at EQF level 5, that is, to the level of a technician who applies procedures, adapts methods to solve problems, plans the work of a small team and evaluates the quality of the work performed, rather than to the level of a design engineer or a researcher.

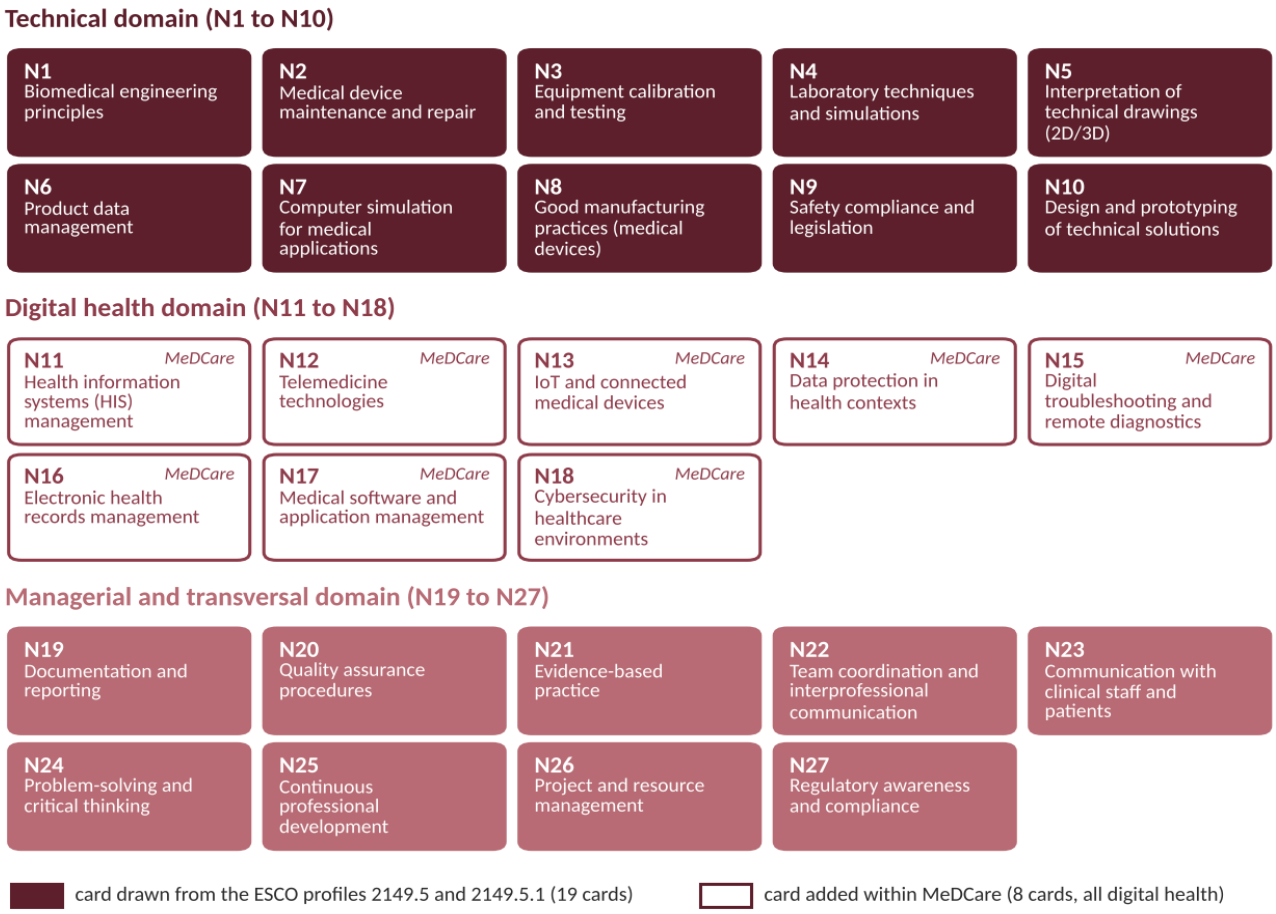


Figure 3.1. The twenty-seven competence cards by domain.

Note: Filled cards are drawn from the ESCO profiles 2149.5 and 2149.5.1; outlined cards were added within MeDCare. Source: annex A.

Each card was presented to the two focus groups for sorting, and the same twenty-seven competences were used as the reference against which the healthcare-sector and vocational-training interviews were read. The perimeter is thus common to every strand of the evidence, which is what allows the results to be consolidated into a single grid. The sections that follow report, in turn, the relevance the two groups attached to each card, the expectations employers expressed at recruitment, the coverage the current and planned training programmes provide, the consolidated reading by domain, the competences that emerged beyond the twenty-seven, the contested cards, the priority set, and the gender composition of the evidence.

3.2 Card-sorting results: relevance

In each focus group the participants sorted the twenty-seven cards into three levels of relevance for an EQF level 5 technician: essential, important but not critical, and not relevant. The system actors' group (FG1) classified the cards it discussed and left three cards without a relevance vote; the market actors' group (FG2) classified all twenty-seven. Because the two groups looked at the profession from opposite vantage points, the interest of the exercise lies less in any single vote than in where the two readings converge and where they diverge.

The system actors' group placed the biomedical technical core in the essential category, naming the principles of biomedical engineering (N1), maintenance and repair (N2), calibration and testing (N3), the reading of technical drawings (N5), product data management (N6), good manufacturing practices (N8) and safety compliance (N9). It treated the digital health block of information systems (N11), telemedicine (N12), connected devices (N13) and medical software (N17) as strategic and essential, and it placed documentation (N19), quality assurance (N20), continuous professional development (N25) and project and resource management (N26) among the essential transversal competences. It classified laboratory and simulation competences (N4, N7), design and prototyping (N10) and several digital cards (N14 data protection, N15 remote diagnostics, N16 electronic health records) and communication with clinical staff (N23) as important rather than essential, and it did not record a relevance vote for evidence-based practice (N21), team coordination (N22) or regulatory compliance (N27).

The market actors' group returned a broadly similar essential core but weighted the digital health domain more heavily. It classified as essential the technical foundation (N1 to N7 and N9), the digital health block except cybersecurity (N18), including data protection (N14), remote diagnostics (N15) and electronic health records (N16), and the professional competences of documentation (N19), team coordination (N22), communication with clinical staff (N23) and regulatory monitoring (N27). It placed good manufacturing practices (N8), design and prototyping (N10), cybersecurity (N18), quality assurance (N20), problem-solving (N24), continuous professional development (N25) and project management (N26) in the important category, and it classified evidence-based practice (N21) as not relevant to the core profile.

Table 3.1. Convergence of relevance ratings between the system actors' group (FG1) and the market actors' group (FG2).

Convergence pattern	Cards	Reading
Essential in both groups	N1 (biomedical engineering principles), N2 (medical device maintenance and repair), N3 (equipment calibration and testing), N5 (interpretation of technical drawings), N6 (product data management), N9 (safety compliance and legislation), N11 (health information systems), N12 (telemedicine technologies), N13 (IoT and connected medical devices), N17 (medical software and application management), N19 (documentation and reporting).	The shared core: the technical foundation, the first digital health competences and technical documentation are treated as indispensable by both constituencies.
Essential for the market, important for the system	N4 (laboratory techniques and simulations), N7 (computer simulation for medical applications), N14 (data protection in health contexts), N15 (digital troubleshooting and remote diagnostics), N16 (electronic health records management), N23 (communication with clinical staff and patients).	The market actors raise several digital and laboratory competences, and clinical communication, to essential, where the system actors see them as important.
Essential for the system, important for the market	N8 (good manufacturing practices), N20 (quality assurance procedures), N24 (problem-solving and critical thinking; contested within the system actors' group, see section 3.7), N25 (continuous professional development), N26 (project and resource management).	The system actors weight quality, manufacturing standards and the organisational competences higher than the market actors do.
Not classified by the system actors	N21 (evidence-based practice), N22 (team coordination and interprofessional communication), N27 (regulatory awareness and compliance).	The system actors recorded no relevance vote for these three; the market actors rated N22 and N27 essential and N21 not relevant.
Other readings	N10 (design and prototyping of technical solutions), important but not critical for both groups; N18 (cybersecurity in healthcare environments), not relevant as a specialisation for the system actors and important for the market actors (contested, see section 3.7).	The two cards outside the four patterns: one rated important by both groups, one contested in its scope rather than its importance.

Source: annex C consolidated competence mapping grid, relevance columns, from the Focus Group 1 and Focus Group 2 Analytical Reports (Elemtiez, 2026a, 2026b).

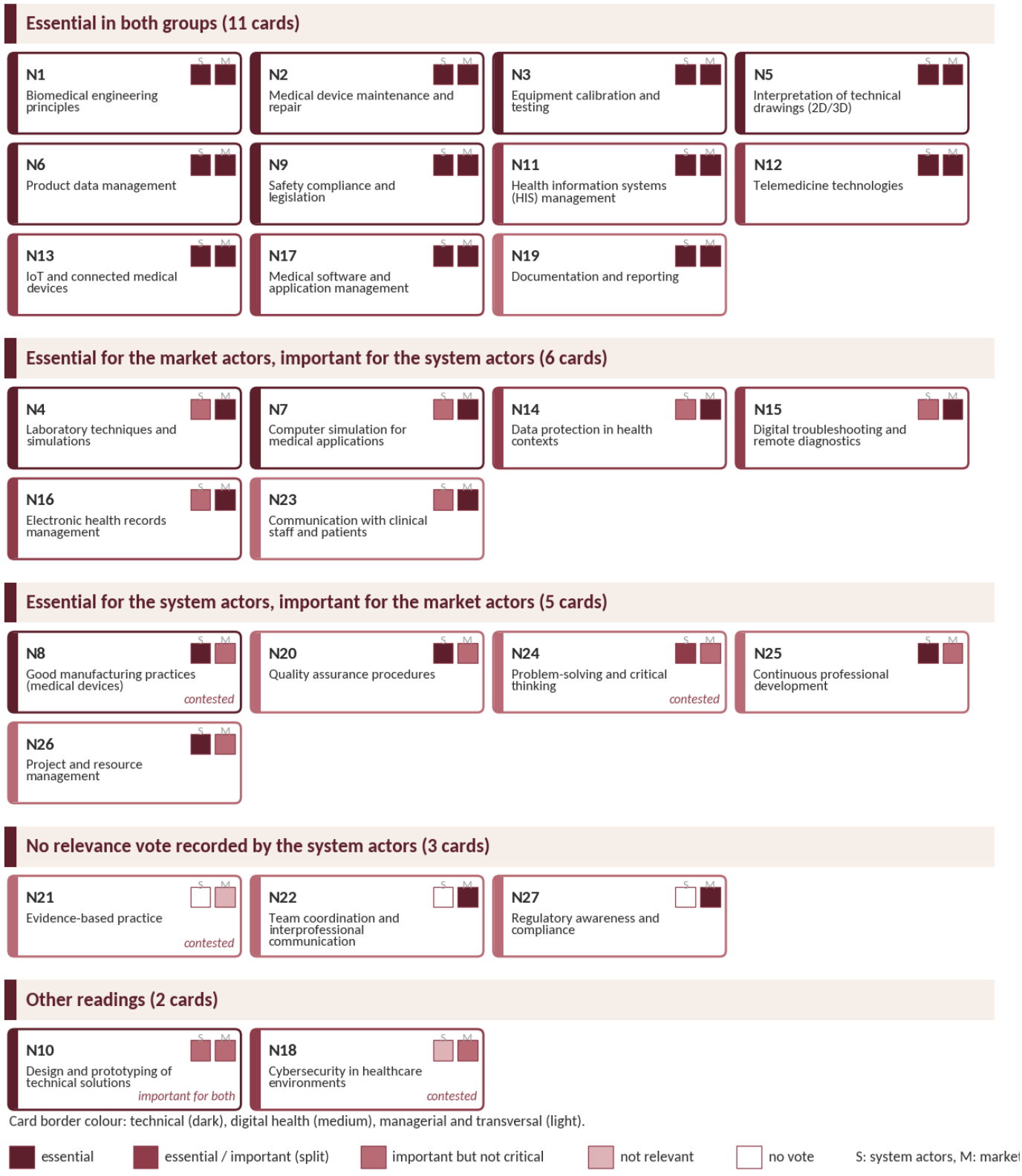


Figure 3.2. The twenty-seven cards grouped by convergence pattern of the relevance ratings (Table 3.1), with the two cards the table does not list under 'Other readings'.

Note: For each card, the square marked S shows the rating of the system actors (FG1) and the square marked M the rating of the market actors (FG2): dark for essential, medium for important but not critical, light for not relevant, white where no vote was recorded; the card border follows the domain. Source: annex C, relevance columns (Elemtiez, 2026a, 2026b).

Two disagreements arose within a single group rather than between the groups, and both are reported as disagreements.

In the system actors' group, problem-solving and critical thinking (N24) was classified as essential by some participants and as important but not critical by another; the report attributes the split to differing views on whether the ability to analyse a fault is a taught competence or one acquired through experience, and the card is therefore recorded in both categories. In the same group, digital troubleshooting and remote diagnostics (N15) drew a documented divergence, some participants regarding it as mainly learned in the workplace.

The market actors' group recorded its own internal disagreement on good manufacturing practices (N8), some participants holding it essential for quality and compliance and others important but not critical because it relates more to manufacturing than to hospital maintenance. These contested cards are taken up in section 3.7.

3.3 Employer expectations of an EQF level 5 technician

The fifteen healthcare-sector interviews (INT-HF-01 to INT-HF-15), which include the three Ministry of Health structures and the two laboratory-equipment companies kept distinct in section 1.5, record what these organisations look for when they recruit a biomedical technician, and what they consider a newly qualified EQF level 5 technician should already be able to do. The interviewees were heads of maintenance departments in public hospitals and private clinics, a senior Ministry of Health official, a national medicines agency evaluator, a senior manager of the national hospital biomedical maintenance centre, and two managers of laboratory-equipment supply companies. Their expectations are recorded in the grid as an employer count, that is, the number of the fifteen sheets that name a given competence. The count measures what organisations expect of a technician at recruitment; it is distinct from the adoption of digital systems in the same organisations, reported in section 2.7 from the same fifteen sheets, so a competence may be named by more organisations than currently operate the corresponding system. Three rules govern the count. It records only what the interviewees said in so many words. A blank cell means that no organisation named the competence when describing what it expects at recruitment; it does not mean that the competence carries no weight. Where the interviewees used a wording close to a card but not the card itself, the count is marked as a proxy: the thirteen mentions for the principles of biomedical engineering (N1), the largest count of the grid, are a proxy of this kind, because the interviewees spoke of a strong technical foundation and not of engineering principles as such. The interviews used no cards: the interviewees described their expectations in their own words, and the research team then read each sheet against the twenty-seven cards (section 1.4).

Read with that caution, the interviews describe a recruitment profile built first on a solid technical and diagnostic foundation and on the ability to communicate. The strongest explicit signal is documentation and

reporting (N19), named in eight sheets; communication with clinical staff and suppliers (N23, communication with clinical staff and patients) also stands at eight, as a proxy count for the recurring expectation of communication with doctors, nurses and suppliers; four of these organisations also report communication as the main gap in their current technicians (section 4.3). Connected medical devices (N13, IoT and connected medical devices) are named in eight sheets, the highest count in the digital health domain, and health information systems (N11) in six. Safety and regulatory competences (N9, safety compliance and legislation, and N27, regulatory awareness and compliance) are each named in four sheets, as are maintenance and repair (N2), quality assurance (N20), team coordination (N22) and continuous professional development (N25); telemedicine (N12) is named in three.

Beyond the twenty-seven cards, several employers named competences that the framework did not contain, and these are carried in the grid as emergent rows. One facility asked specifically for a module on medical gas systems (INT-HF-02). Two laboratory-equipment suppliers (INT-HF-07 and INT-HF-08) asked for medical biology and knowledge of the human body sufficient to understand laboratory results; one of these two, INT-HF-07, is the respondent who also took part in the market actors' focus group, and the overlap is noted so that the request is not read as independent convergence. A private clinic reports the same need from the recruitment side, in the difficulty of finding technicians who combine technical and clinical knowledge (section 4.5). Device regulation and conformity, including the ability to interpret a certificate of conformity, was named in four sheets (INT-HF-01, 02, 06 and 15). The ability to read manufacturer technical documentation was named in four sheets (INT-HF-05, 10, 11 and 14). Finally, several interviewees described the competence they most wanted in terms of autonomy: a technician able, in the words of one maintenance manager, to analyse a technical problem before calling the supplier (INT-HF-05), which the grid records under problem-solving (N24) and reading of manufacturer documentation.

Table 3.2. Competences most frequently named by healthcare-sector organisations (INT-HF-01 to 15), with the emergent employer requests.

Competence	Employer count / 15	Reading
N1 biomedical engineering principles	13 (proxy)	Stands for the general expectation of a strong technical foundation, not the card in its precise sense.
N13 IoT and connected medical devices	8	Highest count in the digital health domain.
N19 documentation and reporting	8	Documenting interventions and managing equipment records.
N23 communication with clinical staff and patients	8 (proxy)	Communication with doctors, nurses, suppliers and between departments.
N11 health information systems	6	Health informatics, networks and data management.
N2 maintenance and repair / N9 safety compliance / N20 quality assurance / N22 team coordination / N25 continuous	4 each	Maintenance, safety, quality, team coordination, regulatory and professional-development expectations recur across the sheets.

Competence	Employer count / 15	Reading
professional development / N27 regulatory compliance		
N12 telemedicine technologies	3	Named as a relevant and emerging competence.
Emergent: device regulation and conformity	4	INT-HF-01, 02, 06, 15; interpreting a certificate of conformity.
Emergent: reading of manufacturer documentation	4	INT-HF-05, 10, 11, 14; reading technical manuals and documentation.
Emergent: medical biology for laboratory equipment	2	INT-HF-07, 08 (laboratory-equipment suppliers).
Emergent: medical gas systems	1	INT-HF-02; a single but specific request for a dedicated module.

Source: annex C consolidated competence mapping grid, employer count column and emergent rows, from the healthcare-sector interviews. The table carries every card named in at least four of the fifteen sheets, telemedicine (N12, three sheets) because it enters the system actors' top five, and all emergent employer requests; N15, N17 and N24 also stand at three, and N3, N4, N18 and N26 at two. Counts are explicit mentions only; a blank in the grid means the competence was not named at recruitment; a proxy count groups wordings close to the card but not identical to it (for example, 'a strong technical foundation' for N1).

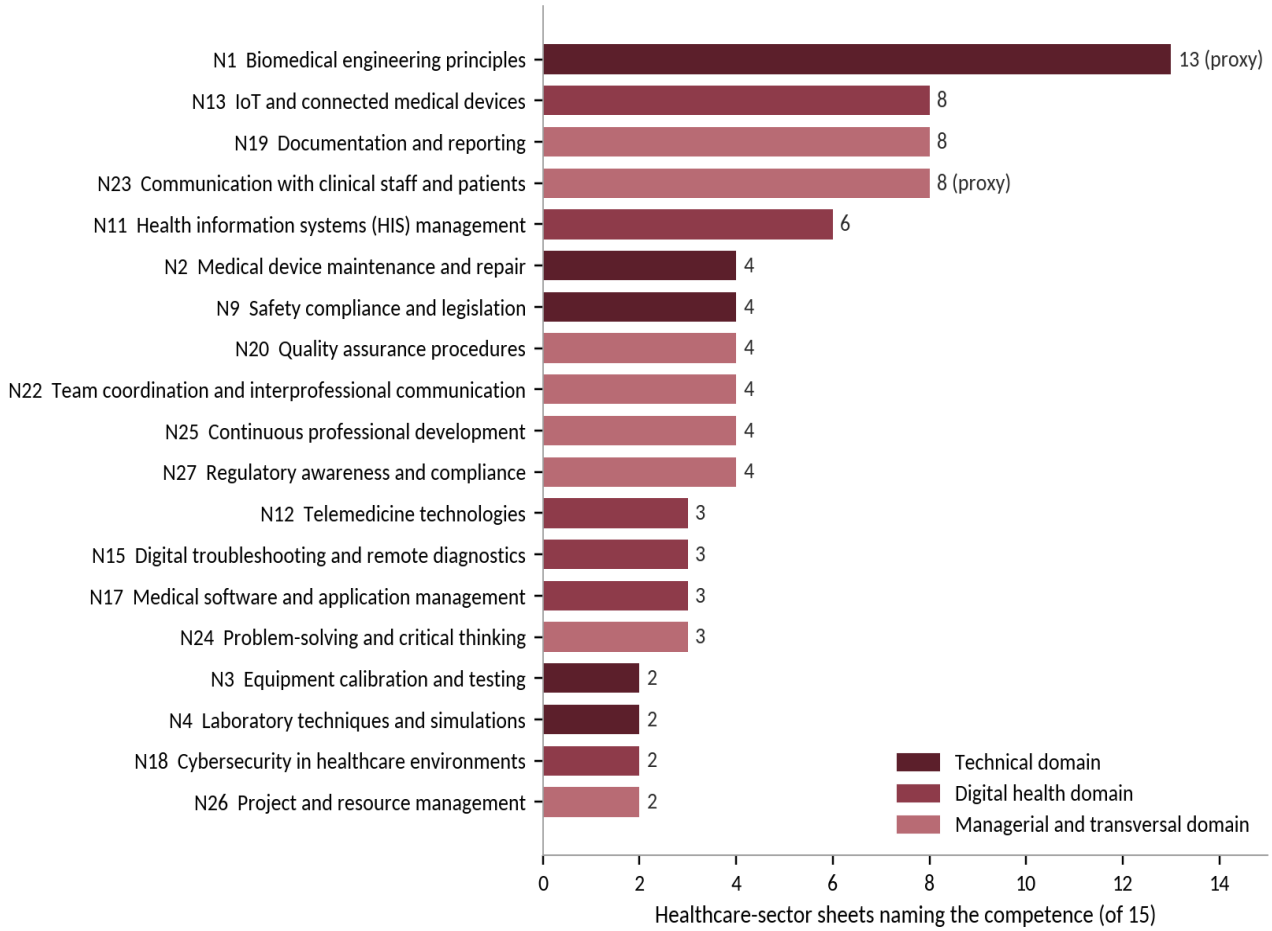


Figure 3.3. Competences named at recruitment by the healthcare-sector organisations interviewed, number of sheets out of fifteen, by domain.

Note: Counts marked proxy group wordings close to the card. Source: annex C, employer count column (ATAS, 2026).

3.4 Current VET coverage and gaps

Coverage was assessed from three sources: the two focus groups' own judgements of how well the current training provision covers each essential or important competence, the mapping of the twenty-seven cards onto the modules of the two training programmes described in the National Report, and the account the trainers themselves gave in the vocational-training interviews (INT-VET-01 to INT-VET-07, vocational-training provider interviews at the sectoral centre). All seven belong to CSFEMEB, at present the sole public provider of the specialty (sections 2.3 and 2.6), so the trainers' account describes one institution.

The two focus groups agreed that coverage is weakest in the digital health domain.

The system actors' group recorded no coverage for health information systems (N11), connected devices (N13), medical software (N17) and cybersecurity (N18), and partial coverage for maintenance (N2), safety (N9), data protection (N14), quality assurance (N20), continuous professional development (N25) and regulatory compliance (N27).

The market actors' group recorded no coverage for data protection (N14) and partial coverage for the technical core (N1), good manufacturing practices (N8), connected devices (N13), electronic health records (N16), problem-solving (N24) and project management (N26).

Quality assurance (N20) is one of the four cards on which the two groups' coverage ratings diverge (N13, N14, N20, N24): the system actors rated it partial and the market actors rated it good, and the disagreement is reported as such. The market actors also rated evidence-based practice (N21) well covered, a judgement the report itself flags as methodologically sensitive because the same group had classified the card as not relevant.

The mapping of the cards onto the modules of the two programmes described in the National Report makes the digital gap concrete. The programme currently in use is the 2008 programme, structured in twenty-nine modules; the programme awaiting accreditation is the 2019 programme, structured in thirty-six modules, which had not yet been implemented at the time of the study. The technical and transversal cards map onto modules of both programmes: maintenance and repair (N2) onto the preventive and corrective maintenance modules, safety (N9) onto the safety and quality-standards modules, documentation (N19) onto the workplace-communication and technical-file modules, quality assurance (N20) onto the quality-control modules, and so on. Every card of the digital health domain, by contrast, maps onto no module in either programme: health information systems (N11), telemedicine (N12), connected devices (N13), data protection (N14), remote diagnostics (N15), electronic health records (N16), medical software (N17) and cybersecurity (N18) are all recorded as having no module identified in the 2008 programme in use and none in the 2019 programme awaiting accreditation. This is consistent with the National Report's own conclusion

that the new programme, although closer to the ESCO modules than the old one, will still not cover digital health skills.

The trainers' own account, recorded in the vocational-training interviews, corroborates this. The trainers described digital competences as almost absent from the current programme (INT-VET-01, 03), and one estimated the current balance of the training at about 60% theory and 40% practice, attributing the imbalance to outdated or non-functional equipment, some of it in service since about 2000 (INT-VET-02). They described the technical foundation as solid but the equipment as ageing, continuous professional development for trainers as almost non-existent, and a cohort of experienced biomedical trainers approaching retirement without a prepared replacement (INT-VET-03, 05, 06, 07). Several trainers judged the centre close to ready to integrate digital health content provided the trainers were themselves trained and the equipment renewed (INT-VET-04, 07).

Table 3.3. Coverage of the twenty-seven cards by the two training programmes described in the National Report.

Domain	Coverage in the 2008 programme (in use) and the 2019 programme (awaiting accreditation)
Technical (N1 to N10)	Mostly covered: the engineering and maintenance foundation maps onto modules of both programmes. Calibration and testing (N3) maps to a quality-control module in the 2008 programme only; technical drawings (N5), computer simulation (N7), good manufacturing practices (N8) and design and prototyping (N10) map onto no module in either programme.
Digital health (N11 to N18)	None identified in either programme. All eight cards map onto no module of the 2008 programme in use and no module of the 2019 programme awaiting accreditation, consistent with the National Report's conclusion that digital health skills will not be covered.
Managerial and transversal (N19 to N27)	Partly covered: documentation (N19), quality assurance (N20), team coordination (N22), communication (N23), project management (N26) and regulatory compliance (N27) map onto communication, quality, procurement and technical-file modules. Evidence-based practice (N21), problem-solving (N24) and continuous professional development (N25) map onto no dedicated module in either programme.

Source: annex C consolidated competence mapping grid, columns '2008 programme modules' and '2019 BTS modules', from the National Report, part III (ATFP, 2026).

3.5 The consolidated competence mapping grid

The consolidated competence mapping grid brings the four readings together on one row per card: the relevance vote of each group, the coverage rating of each group, the two top-five selections, the employer count from the healthcare-sector interviews, the module mapping onto the two programmes, the trainers' account, and a reinforcement-priority label. The full grid is annex C; this section reads it by domain. The reinforcement-priority label is rule-based and uniform across all twenty-seven cards:

- a competence is high priority to reinforce when it is essential for at least one group and coverage is absent or partial in at least one group;

- medium when it is essential for one group with coverage unrated by either, or important for both with partial coverage;
- low when coverage is good in at least one group and no group rates it absent;
- not determined when there is no coverage rating and no vocational-training or interview evidence.

The label reads as a priority, not as a measure of deficit: a competence that is already taught can still be high priority to reinforce because one group rated its coverage only partial, as is the case for safety compliance (N9) and quality assurance (N20). The four contested cards (N8, N18, N21, N24) carry the label contested and are treated separately in section 3.7.

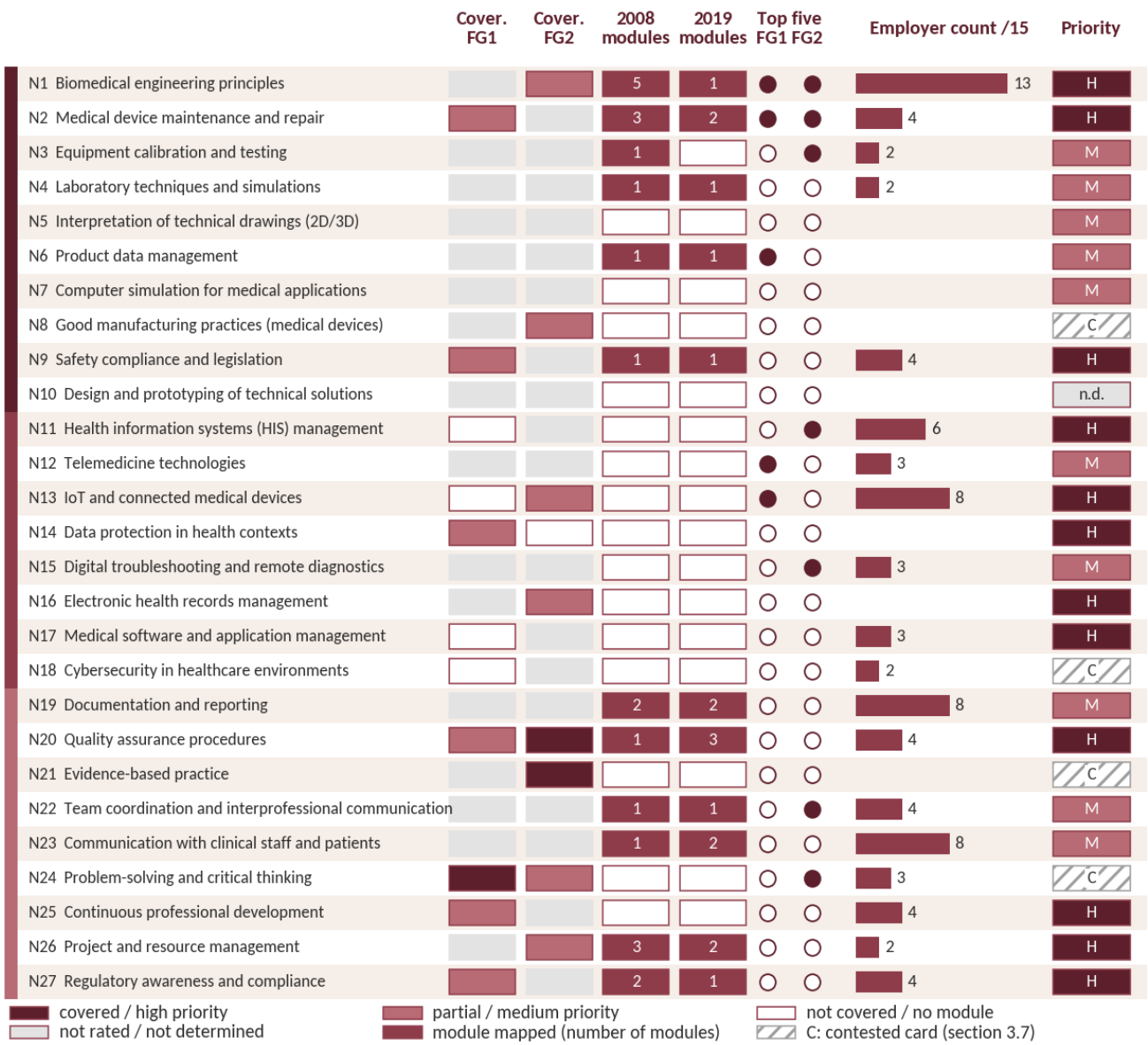


Figure 3.4. The consolidated grid at a glance: coverage rated by each focus group, modules of the 2008 and 2019 programmes onto which each card maps (number of modules), top-five selections, employer count and reinforcement priority.

Source: annex C.

3.5.1 The technical domain

The technical domain (N1 to N10) is the domain the two groups agree on most and the one the current training covers best. The principles of biomedical engineering (N1), maintenance and repair (N2) and calibration and testing (N3) are essential for both groups and are the technical spine of the profession; N1 and N2 map onto modules of both programmes, and N3 onto a module of the 2008 programme only, and the employer interviews point to them unevenly: N1 carries the highest count of the grid, thirteen, as a proxy for a strong technical foundation, while N2 is named in four sheets and N3 in two. The reinforcement priority is nonetheless high for N1 and N2, because coverage is rated only partial and the trainers describe the practical training as constrained by ageing equipment, so the reinforcement needed is practical and up to date, not a change of syllabus. Within the domain, laboratory and simulation competences (N4, N7), the reading of technical drawings (N5), product data management (N6), good manufacturing practices (N8) and design and prototyping (N10) are more weakly evidenced: they are rated important by at least one group, several map onto no module, and design and prototyping (N10) has no coverage rating and no employer or vocational-training evidence, so its priority is recorded as not determined.

3.5.2 The digital health domain

The digital health domain (N11 to N18) is where relevance is high and coverage is lowest, and it is the domain that most distinguishes the target profile from the existing one. Health information systems (N11), telemedicine (N12), connected devices (N13) and medical software (N17) are essential for both groups; data protection (N14), remote diagnostics (N15) and electronic health records (N16) are essential for the market actors and important for the system actors. Every card in the domain maps onto no module in either programme, and the trainers describe digital competences as almost absent. Connected devices (N13) carry the highest digital employer count, at eight, and health information systems (N11) the next, at six; telemedicine (N12), remote diagnostics (N15) and medical software (N17) are named in three sheets each and cybersecurity (N18) in two. Two cards carry an empty employer cell: data protection (N14) and electronic health records (N16). The blank does not mean the competences carry no weight, and their importance is carried by the relevance columns, where both are essential for the market actors; it means only that no employer named the competence in that precise sense at recruitment, electronic records appearing in the interviews as a system the facility runs rather than as a competence asked of the technician. Five of the eight cards (N11, N13, N14, N16, N17) are therefore high priority to reinforce, two are medium (N12 and N15, essential for at least one group but with coverage unrated by either) and one is contested (N18); the concentration of reinforcement priority in this domain is the central finding of the coverage analysis.

3.5.3 The managerial and transversal domain

The managerial and transversal domain (N19 to N27) is the domain of integration into the workplace, and it is partly covered. Documentation and reporting (N19) and communication with clinical staff (N23) carry the

joint-highest transversal employer counts, at eight each, and both map onto communication and technical-file modules of the two programmes. Quality assurance (N20), continuous professional development (N25), project management (N26) and regulatory compliance (N27) are all present in the employer interviews; N20, N26 and N27 map onto modules, while N25 maps onto none in either programme. One group rates their coverage only partial and they are high priority to reinforce for that reason; team coordination (N22), named in four sheets and in the market actors' top five, was not rated for coverage by either group and carries a medium priority. The domain also contains two of the four contested cards, problem-solving (N24) and evidence-based practice (N21), which are treated in section 3.7.

Read together, the three domains describe a profile whose technical foundation is broadly in place, whose transversal competences are present but under-reinforced, and whose digital health competences are largely absent from the current provision while being rated essential by the field.

The profile in three domains

- Technical domain (N1 to N10): the two groups agree most, the training covers it best, and employers signal it most strongly; priority is nonetheless high for N1, N2 and N9 because coverage is rated partial and the equipment is ageing.
- Digital health domain (N11 to N18): rated essential or important by both groups, named by employers at recruitment for six of its eight cards, covered by no module of either programme; five of its eight cards are high priority to reinforce.
- Managerial and transversal domain (N19 to N27): largely present in both programmes and in the employer interviews, but rated only partially covered; documentation, communication and quality are the cards to reinforce.

3.6 Emergent competences

Beyond the twenty-seven cards, the fieldwork produced competences that the framework did not contain. They are kept distinct by source, because the two groups and the employers proposed different things and only one proposal is common to both groups. Merging them would create a false appearance of consensus.

The two focus groups proposed six new competences between them, of which only one is shared:

Applied artificial intelligence (N28) was proposed by both the system actors' group and the market actors' group, in each case as an introductory competence covering the use of data, assisted maintenance and the diagnosis of equipment, together with its limitations and risks; it is the only emergent point of agreement between the two groups.

The system actors' group therefore made three proposals, one shared with the market actors and two of its own:

1. predictive maintenance (N29 in that group's numbering), the use of equipment data to anticipate failures and plan interventions;
2. the digital twin principle (N30 in that group's numbering), the simulation of the operation and ageing of medical equipment.

The market actors' group added two different proposals:

1. statistical process control (N29 in that group's numbering), for the analysis of the reliability and performance of maintenance processes, and
2. clinical and anatomical knowledge by equipment family (N30 in that group's numbering), to help the technician understand the clinical use of the equipment.

The two groups' proposals are recorded under their own group numbering and are not combined.

The employers added four further competences, each carried in the grid with its source:

1. Device regulation and conformity, including the interpretation of a certificate of conformity, was named in four healthcare-sector sheets (INT-HF-01, 02, 06 and 15).
2. The reading of manufacturer technical documentation was named in four sheets (INT-HF-05, 10, 11 and 14) and was also raised by the market actors' group as a language and openness factor.
3. Medical biology for laboratory equipment was named by the two laboratory-equipment suppliers (INT-HF-07 and 08).
4. Medical gas systems was a single but specific request for a dedicated module (INT-HF-02).

Distinct from the reading of documentation, the market actors' group also proposed **technical biomedical English**; this proposal came from that group alone and was not named in any healthcare-sector interview, so it carries no employer count.

All of these emergent competences are recorded for chapter 5 to weigh against the twenty-seven, and the chapter does not fold them into the framework; annex A, Table A.2, identifies them by name and source rather than by number, because both groups reused the numbers of the blank cards.

3.7 Contested competences

Four cards did not resolve into a single reading, and they are reported here as disagreements. They are kept open here because the two groups read them differently, and chapter 5 takes a position on each when it defines the draft competence profile (sections 5.3 and 5.4).

Problem-solving and critical thinking (N24) was contested within the system actors' group, some participants classifying it as essential and another as important but not critical. The report attributes the split to a difference over whether the ability to analyse a fault, identify its cause and choose a solution is a competence that can be taught or one that is mainly acquired through professional experience. The market actors' group classified it as important while describing it as, in effect, a core competency of the profession, and placed it

in its top five. The coverage ratings also differ between the groups. The card is therefore recorded with its disagreement intact.

Good manufacturing practices (N8) was contested within the market actors' group. Some participants held it essential for quality and compliance; others held it important but not critical because it relates more to the manufacture of devices than to their maintenance in a hospital, in a market that is, as the vocational-training interviews note, composed of service and after-sales companies rather than manufacturers. The system actors' group rated it essential. The final market classification of important but not critical is recorded, with the note that the principles of quality, traceability and compliance are expected to be secured through other cards.

Cybersecurity in healthcare environments (N18) was contested in its scope rather than its importance. The system actors' group classified it as not relevant when understood as an advanced specialisation belonging to information-technology professionals, but agreed that every technician should master a basic level of digital security. The market actors' group classified it as important and recommended a mandatory applied basic level covering access control, passwords, confidentiality, incident management and connected devices. The two readings converge on the substance, a basic transversal competence rather than a specialisation, and the card is recorded that way without resolving the difference in the relevance label.

Evidence-based practice (N21) is the most methodologically sensitive card. The market actors' group classified it as not relevant to the core profile, perceiving it as belonging to clinical professions or research, yet rated its coverage as good, a combination the report itself flags as sensitive because a card judged not relevant cannot easily be judged well covered. The system actors' group recorded no relevance vote. The market actors' report recommends reformulating the card, for an EQF level 5 technician, as technical decision-making based on data, protocols and test evidence, which it considers better suited to the level and free of clinical ambiguity. The card is recorded with both the not-relevant classification and the proposed reformulation, and chapter 5 adopts the reformulation (section 5.4).

3.8 Priority competences

At the end of the sorting exercise each group selected a top five.

The system actors' group selected:

1. the principles of biomedical engineering (N1),
2. maintenance and repair (N2),
3. product data management (N6),
4. telemedicine (N12) and

5. connected devices (N13).

The market actors' group selected:

1. a block of the three core technical competences together (N1, N2 and N3),
2. health information systems (N11),
3. digital troubleshooting and remote diagnostics (N15),
4. team coordination and interprofessional communication (N22) and
5. problem-solving and critical thinking (N24).

The two selections overlap on the technical spine and on the digital direction of travel. Both name the principles of biomedical engineering (N1) and maintenance and repair (N2), and calibration and testing (N3) is present in the market actors' core block, so the two groups agree on the core technical trio.

Both selections then reach into the digital health domain, the system actors through telemedicine (N12) and connected devices (N13) and the market actors through health information systems (N11) and remote diagnostics (N15). The market actors' selection adds the transversal competences of team coordination (N22) and problem-solving (N24), reflecting their emphasis on integration into the clinical and organisational environment.

Read against the employer expectations of section 3.3, the priority set is coherent. The technical core carries the highest employer counts as a proxy for a strong technical foundation; connected devices (N13) and health information systems (N11) carry the highest and second-highest digital employer counts; and communication and documentation, close to the market actors' N22, carry the highest transversal counts. The resulting priority set, on which the two groups and the employers converge, is the technical core (N1, N2, N3), the first digital health competences (N11, N13, and the telemedicine and remote-diagnostics pair N12 and N15), and the integration competences of communication, documentation and team coordination (N19, N22, N23).



Figure 3.5. The top-five selections of the two focus groups and the competences on which they meet.

Source: Focus Group 1 and Focus Group 2 Analytical Reports (Elemtiez, 2026a, 2026b).

Problem-solving (N24) belongs with this set in the market actors' reading but remains a contested card, as section 3.7 records.

The priority set

- Technical core: biomedical engineering principles (N1), maintenance and repair (N2), calibration and testing (N3), named by both groups and carrying the strongest employer signal.
- First digital health competences: health information systems (N11), connected devices (N13), with the telemedicine and remote-diagnostics pair (N12, N15).
- Integration competences: documentation (N19), team coordination (N22) and communication with clinical staff (N23).
- Problem-solving and critical thinking (N24) belongs to the set for the market actors and remains contested (section 3.7).

3.9 Gender and inclusion in the competence data

The two focus groups together comprised thirteen participants, of whom three were women: two of the five participants in the system actors' group and one of the eight in the market actors' group. Both reports provided by researchers at the end of each focus group state plainly that this composition is too small and too unbalanced, particularly in the market actors' group, for any gender-based analysis of the competence judgements to be drawn, and both recommend that future consultations include more women technicians, trainers and human-resource managers. No competence rating in this chapter is attributed to the gender composition of the groups.

The interviews add observations on women in technical roles that are reported without being generalised. Interviewees described their teams as mixed and reported no gender-based barrier to recruitment or progression (INT-HF-12, INT-HF-13; the full set of sheets is given in section 4.6), while noting that the practical demands of some field work, such as travel within the country, overnight assignments, emergency interventions and the handling of heavy equipment, can bear differently on individuals; these were consistently described as features of the nature of the work rather than of technical ability. One facility reported an entirely female biomedical team (INT-HF-13) and cited it as evidence that there is no gender-based discrimination in the workplace. Because these are individual observations and not a pattern, no inference is drawn from any single mention.

3.10 Chapter summary

The perimeter, narrowed from the ESCO profiles 2149.5 and 2149.5.1 and downscaled to EQF level 5, held: the twenty-seven cards were meaningful to both constituencies, and the exercise added competences at the margins rather than overturning the framework. The technical core of the profession, the principles of biomedical engineering, maintenance and repair, and calibration and testing, is essential to both the system actors and the market actors, is present in the current training and carries the strongest employer signals; its

priority for reinforcement is nonetheless high because coverage is partial in practice and the training equipment is ageing.

The digital health domain is the decisive finding. Health information systems, telemedicine, connected devices, remote diagnostics, data protection, electronic health records and medical software are rated essential or important by the field, are named by employers at recruitment with the exception of data protection and electronic health records, and are covered by no module of either the programme in use or the programme awaiting accreditation. Five of its eight cards are high priority to reinforce, and the domain is the principal distance between the existing profile and the target profile. The managerial and transversal domain sits between the two: documentation, communication and quality are present but under-reinforced.

Four cards remain contested and are settled in chapter 5: problem-solving and critical thinking, good manufacturing practices, cybersecurity as a basic competence rather than a specialisation, and evidence-based practice with its proposed reformulation as technical decision-making based on data, protocols and test evidence.

Six group proposals and four employer additions are recorded as emergent competences, kept distinct by source.

Taken together, the stakeholder-tested map defines an EQF level 5 profile built on a reinforced technical core, a new and largely uncovered digital health capability, and a strengthened set of transversal competences, and it is this map that chapter 5 turns into the draft competence profile for WP3.

What chapter 3 hands to chapter 5

- A perimeter that held: twenty-seven cards meaningful to both constituencies, added to at the margins rather than overturned.
- A technical core that is essential, taught and expected, but under-reinforced in practice.
- A digital health domain rated essential and covered by no module of either programme: the principal distance between the existing profile and the target profile.
- Four contested cards (N8, N18, N21, N24) and ten emergent competences, kept distinct by source, for chapter 5 to settle.

Chapter 4. Barriers and enablers

4.1 Analytical approach

This chapter answers the third research sub-question (SQ3): which skills deficits healthcare organisations identify in their biomedical technology staff, which constraints the vocational training provider faces in delivering industry-aligned training, and which regulatory and institutional barriers the authorities identify for establishing a new EQF level 5 qualification. It sets out the barriers that stand between current provision and that qualification, and the enablers on which work package 3 can build. The evidence is the twenty-six interview sheets and the Narrative Report (ATAS, 2026), the two focus group analytical reports (Elemtiez, 2026a, 2026b) and the National Report (ATFP, 2026). The interview and focus-group material was analysed by reflexive thematic analysis, coded at two levels: deductive codes taken from the barrier typology of the research design, which distinguishes institutional, pedagogical, technological and socio-economic barriers, and inductive codes generated from the data to capture what that framework did not anticipate. One inductive theme is reported here, the dependence on suppliers and the concentration of knowledge in a small number of technicians, presented in section 4.4 and carried into chapter 5.

The coding produced the barrier and enabler matrix from which this chapter is written. Each row is a barrier or an enabler; the columns hold the evidence of the three stakeholder categories, healthcare organisations, the vocational training provider and the authorities, with further columns for the obstacle tables of the two focus groups and for triangulation against the National Report. Every cell records its source codes, so that each statement below can be traced to its source, and the number of categories attesting an item is what section 4.8 reads as convergence. Gender items are held on a separate track and are reported in section 4.6. The analytical procedure is set out in section 1.6.

4.2 Institutional and regulatory barriers

Four institutional findings are reported here:

1. the length and rigidity of the procedures through which qualifications are created, revised and approved;
2. the uneven reach of coordination between institutions;
3. the referencing of the national framework and the progression gap that follows from it;
4. the structural fact that one centre provides this training. The five-yearly revision of the programme appears in this section because it is a procedure; what it does to the content of the curriculum is reported in section 4.3.

4.2.1 The length and rigidity of qualification procedures

The most widely shared institutional barrier is **the length and rigidity of qualification procedures**, attested by the authorities, the provider, healthcare organisations and focus group 1. A senior official of the ATFP responsible for guidance and support identified the time required for administrative procedures and approvals as the main obstacle, a new qualification having to pass through consultation with the sector, analysis of work situations, programme development and official approval (INT-LA-02). The two senior officials of the Ministry of Vocational Training and Employment interviewed in the joint session framed the same difficulty as inter-institutional process, holding that a new qualification cannot be decided by training centres alone, that institutions at a higher level must be involved, and that coordination between the ministries and institutions concerned is what avoids administrative difficulty (INT-LA-01, INT-LA-03). The centre's management described it from inside the centre, naming long administrative procedures and, specifically, the revision of the training programme and the legal changes co-diplomation would require, with outdated equipment as a further condition that can delay or prevent alignment with EQF level 5 (INT-LA-04).

At the provider the same weight is reported from below. The centre’s pedagogical coordination, which also develops the programmes, named administrative procedures, limited resources and outdated equipment as the main constraints on training quality, adding that they make it difficult to update programmes and adapt them quickly to technological developments (INT-VET-03). One trainer recounted that the team had requested an update of the programme and the renewal of equipment over several years and perceived some form of blockage, while declining to attribute a cause, and proposed that the views of trainers and professionals be taken into account when decisions are made about the programme and its resources (INT-VET-05). Another described administrative procedures as often lengthy, particularly when changes to the programme are needed, and working with the relevant authorities as making the process more difficult (INT-VET-07). In healthcare organisations the barrier appears in everyday form: a respondent at a public paediatric hospital reported that not all proposed improvements can be carried out, because of infrastructure limits and lengthy administrative procedures (INT-HF-03), and the head of the maintenance department of another public hospital listed administrative procedures, together with limited opportunities for continuing specialised training and the need to coordinate technical decisions across departments and with external suppliers, among the main institutional difficulties (INT-HF-14). Focus group 1 recorded the “administrative burden for revising qualifications” with the likely consequence of a “slowing down of pedagogical innovation” (Elemtiez, 2026a, section 8).

What those procedures cost is visible in the revised programme itself. A new training programme was developed in 2019 by CENAFFIF, the National Centre for the Training of Trainers and Training Engineering, to make the updates professionals had requested and to bring the qualification into line with the current programme model, renaming the diploma higher biomedical technician so as to widen the scope of the technician’s tasks. Its implementation has not yet taken place, and an application for accreditation is still to

be scheduled (ATFP, 2026, section III-3; see section 2.6). A programme developed in 2019 and still awaiting accreditation is the administrative burden measured in elapsed time. The ordinary cycle is slow in the same way: the curriculum is updated about every five years, following requests from trainers who identify the training needs, which are then passed through the institutions concerned (INT-VET-06). Two features of that arrangement are institutional rather than pedagogical, the length of the interval and the fact that the impulse for revision comes from the trainers rather than from a scheduled review tied to technological change.

4.2.2 The uneven reach of coordination between institutions

Coordination between institutions is uneven rather than absent, and the unevenness is specific. Both ministry officials described existing machinery: a joint committee between the Ministry of Vocational Training and Employment and the Ministry of Health, responsible mainly for initial training in the paramedical and healthcare fields, and a national committee for continuing training (INT-LA-01); and coordination between the two ministries which the second official judged could be improved when new occupations or technologies are introduced, adding that healthcare institutions should be involved because they hold the information on the competences the workplace requires (INT-LA-03). The gap is sharpest where that machinery does not reach: the centre's management reported having seen no coordination with the Ministry of Higher Education, and could say only that coordination with the Ministry of Health might exist at another level (INT-LA-04). On a different axis, the ATFP respondent described cooperation between the central administration and the centres as generally good, with significant autonomy for the centres (INT-LA-02). The existing committees are recorded as an enabler in section 4.7; what is reported here is the limit of their reach.

4.2.3 The referencing of the national framework and the progression gap that follows

Recognition and progression form the second authority-side finding. Both ministry officials describe the National Qualifications Framework as sound in itself, setting out the competences and learning outcomes expected at each level and providing a good basis for comparison with European standards (INT-LA-01, INT-LA-03). The difficulty lies in referencing. Alignment with the EQF is requested by several stakeholders, including the ETF and the European Union, to facilitate the recognition of diplomas, but institutional obstacles remain, so that a more formal framework and stronger involvement of the relevant departments and of CENAFFIF would be needed (INT-LA-01), and administrative and institutional issues still have to be addressed before alignment would make Tunisian qualifications easier to recognise abroad (INT-LA-03). At the level of the qualification itself, the centre's management set out the progression gap: the BTS is not treated as equivalent to a university licence and, unlike holders of the BTP, BTS graduates cannot proceed to university, which in that account calls for legislation (INT-LA-04).

4.2.4 The structural fact that one centre provides this training

The last institutional finding is structural. CSFEMEB is the only centre providing training in this field, which one senior ministry official stated directly, drawing from it the need for more specialised programmes and more institutions in both initial and continuing training (INT-LA-01). The National Report corroborates only indirectly, describing the 2022 graduating class as coming mainly from the Tunis training centre, which is consistent with a single-provider structure without stating it (ATFP, 2026, section II.5). One further limit belongs here: no respondent in the authorities category speaks for the Ministry of Health, whose perspective is reached through three Ministry of Health structures interviewed as healthcare organisations (INT-HF-01, INT-HF-06, INT-HF-15) and is reported as such.

4.3 Pedagogical barriers

This section reports the barriers internal to training:

1. the currency of the curriculum,
2. the place of digital and connected-device competences in it,
3. the balance between theory and practice,
4. the number and continuing development of the trainers,
5. the quality of work-based learning, and
6. the communication gap reported by employers.

All seven provider respondents belong to one institution, so the section is written as depth on a single centre.

4.3.1 The currency of the curriculum

The provider evidence that the curriculum lags behind fast-moving healthcare technology is close to unanimous. One trainer held that the traditional profile of a technician who mainly repairs equipment is no longer sufficient and that training must move towards the technologies now used in healthcare (INT-VET-04). Another explained that the programme is revised about every five years and that the lack of regular updating and insufficient follow-up of new biomedical technologies affect graduates when they move into employment (INT-VET-06). A third reported that training does not fully meet the needs of the sector, because of the pace of innovation and the state of the equipment, so that learners meet more advanced technologies mainly during their internships (INT-VET-02). The remaining sheets name digital health, regulations and standards as the missing content (INT-VET-01), place the gaps in managerial modules and soft skills (INT-VET-03), and describe a profession moving beyond maintenance towards the management of equipment (INT-VET-07). The authorities concur: the centre's management judged that the centre and the national agency were still working with approaches from the 2000s, close to two decades behind the technology (INT-LA-04), and a senior ministry official noted that programmes must adapt to new technologies and needs (INT-LA-03).

Focus group 1 named “outdated, highly theoretical and poorly flexible curricula”, with the consequence of “weak adaptation to emerging technologies and market needs” (Elemtiez, 2026a, section 8), and the National Report corroborates indirectly, reading the rising number of ineligible applicants as a signal of unmet skills needs (ATFP, 2026, section II.4).

4.3.2 The place of digital and connected-device competences

Digital and connected-device competences are weak or almost absent in the current training. Trainers described them as almost not covered (INT-VET-01, INT-VET-03), named the missing areas as information technology, networks, embedded systems and connected equipment, with the ability to communicate with equipment remotely and manage it across its life cycle (INT-VET-04), and argued that what is taught must evolve towards digital and information-technology skills, connected equipment, embedded systems and maintenance management (INT-VET-07). Healthcare organisations report the mirror gap in their own technicians, in digital skills, documentation and connected medical devices (INT-HF-10), in technical documentation, troubleshooting, digital skills and interoperability with hospital information systems (INT-HF-14), in patient-record digitalisation (INT-HF-01), and as a need to develop competences in new technologies, digitalisation and artificial intelligence (INT-HF-15). The focus groups give the sharpest evidence: focus group 1 rated health information systems, the internet of things and connected devices, medical software and cybersecurity as offering no coverage in the current training (Elemtiez, 2026a, section 5), and focus group 2 listed “insufficient digital skills”, with the risk of an “inability to manage data, software, connected systems, and digital risks” (Elemtiez, 2026b, section 8). The authorities place digitalisation and artificial intelligence among the national priorities (INT-LA-01, INT-LA-03), which belongs with the enablers and does not attest the gap.

4.3.3 The balance between theory and practice

Delivery is reported as more theoretical than the profession requires, and the cause given is the equipment. One trainer estimated the balance at about 60% theory and 40% practice, explaining that some modules lean on theory because the equipment needed is outdated or unavailable (INT-VET-02), and another described how the small number of functional devices and the difficulty of repeatedly installing large equipment reduce practical work (INT-VET-01). The evidence is not uniform: the centre’s pedagogical coordination put theory and practice at roughly equal proportions, while noting that advanced methods such as virtual reality are not provided (INT-VET-03). What the sheets agree on is the absence of substitutes. Simulation is not used, for want of equipment and computing resources (INT-VET-06); fault simulation is difficult when devices are unavailable (INT-VET-05); and one trainer proposed smaller representative equipment together with simulation and virtual training for technologies the centre cannot realistically own, arguing that teaching should start from the equipment and move down to components, circuits and principles (INT-VET-04).

4.3.4 The number and continuing development of the trainers

Distinct from the currency of trainers' skills is a question of their number and renewal. Specialist trainers are approaching retirement (INT-VET-01), most of the specialists have only one or two years left while those expected to replace them are not yet prepared, which the centre's pedagogical coordination described as a significant shortage of trainer capacity (INT-VET-03), and one trainer reported that several experienced colleagues are expected to retire soon with no arrangement for handover or transfer of knowledge (INT-VET-07). The scale is small to begin with: of about eighty trainers at the centre, about ten work in the biomedical field (INT-VET-05). The centre's management expected the shortage to worsen in 2027 and 2028, with an external recruitment competition awaited (INT-LA-04).

That the trainers who remain have limited access to continuing professional development is the most fully cross-cutting pedagogical barrier. At the provider it was described as insufficient and, in one account, disappointing, with the argument that it should be provided every year and across the biomedical fields (INT-VET-05); as practically non-existent beyond occasional seminars (INT-VET-03); as unavailable, so that trainers rely on self-learning and sometimes discover new equipment only through technical documentation while supervising placements (INT-VET-01); as blocked by workload and administrative constraints (INT-VET-02); as unevenly accessible (INT-VET-06); and as unstructured, no structured trainer training existing within the institutions (INT-VET-07). Healthcare organisations report the same limit on their technicians, where training tends to follow the acquisition of equipment and continuing development is constrained by time, work commitments and the absence of provision from the administration (INT-HF-02, INT-HF-06). The authorities confirm it: trainers in this field had received no continuing training since their initial training in 1999 (INT-LA-01), and more trainer development is needed to keep pace with new medical technologies (INT-LA-03). Both focus groups corroborate, naming "insufficiently updated technical and digital skills among trainers and some practicing technicians" and a "lack of continuous training" with the risk of a "rapid obsolescence of trainers' and technicians' skills" (Elemtiez, 2026a, 2026b, section 8).

4.3.5 The quality of work-based learning

Work-based learning is established but uneven in quality, and stands in tension with the enabler in section 4.7. The centre places learners in hospitals, military hospitals and private companies, with supervision shared between company staff and trainers (INT-VET-01, INT-VET-02, INT-VET-03, INT-VET-07). One trainer judged the partnership with healthcare establishments weaker than it should be, explaining that companies can regard a trainee as an additional responsibility and that supervision is extra work for the tutor, so motivating tutors matters as much as the agreements (INT-VET-04). A public hospital reported no established placement partnership at all, attributing this to its staff shortage and workload (INT-HF-09). Provision is also uneven between levels: the higher-technician programme includes three internships across three years, while the professional-technician programme includes one, which one trainer judged too little exposure to real

situations (INT-VET-02). Focus group 1 named the "*lack of structured linkage with hospitals and manufacturers*", with the consequence of "*opportunistic internships, poorly supervised and not aligned with expected competencies*" (Elemtiez, 2026a, section 8).

4.3.6 The communication gap reported by employers

The last pedagogical barrier is reported by employers, not by the provider. Communication and transversal competences are named as the principal gap by a public paediatric hospital, which placed them ahead of technical ones (INT-HF-03), by a private clinic, where technicians sometimes need better communication with nurses, doctors and suppliers to understand problems quickly (INT-HF-05), and by both laboratory-equipment companies, one naming communication and soft skills as the main gap (INT-HF-07) and the other communication and reporting (INT-HF-08). Focus group 2 listed "weak communication", with the risk of "poor coordination with medical staff, communication errors, and low recognition of the technician's role" (Elemtiez, 2026b, section 8). The gap is reported by the healthcare organisations and by focus group 2; the trainers describe the communication modules they teach and do not report a gap in them.

4.4 Technological and infrastructure barriers

This section reports the material conditions:

1. the age and adequacy of equipment in training and in facilities,
2. the infrastructure that has to be in place before technology can be adopted,
3. the cost of equipment,
4. connectivity,
5. the dependence on suppliers.

The healthcare sub-groups are kept visible, because the Ministry of Health structures and the laboratory-equipment companies do not speak as hospitals.

4.4.1 The age and adequacy of equipment in training and in facilities

Equipment that is outdated or insufficient is the most consistently attested barrier in the analysis. At the centre the evidence is dense and repeated: workshops are well equipped across the technical fields, but part of the equipment is only partially functional and has been in use since 2000 (INT-VET-01); many devices are outdated, faulty or no longer usable, which limits practical training and prevents some competences from being taught (INT-VET-02); most of the equipment has remained much as it was when the centre and the programme were established around 2000, with some items replaced or updated in 2023, 2024 and 2025 (INT-VET-03); some equipment has been in service for about twenty-five years, some is obsolete or withdrawn, and some rooms no longer have functional equipment (INT-VET-05); the equipment is ageing and

partly obsolete, and its maintenance is practically non-existent (INT-VET-06); and a limited shortfall remains relative to what hospitals expect (INT-VET-07). The authorities concur, describing the centre's equipment as acceptable but in need of regular updating (INT-LA-03) and reporting a significant lack of innovative equipment (INT-LA-04). On the healthcare side a Ministry of Health structure reported a small shortfall relative to hospitals' needs and requests (INT-HF-15). The focus groups place equipment first among their obstacles, naming the "lack of up-to-date equipment for practical training", with training becoming disconnected from hospital reality, and the "lack of modern equipment", with training disconnected from the technological reality of hospitals and companies (Elemtiez, 2026a, 2026b, section 8).

4.4.2 The infrastructure that has to be in place before technology can be adopted

In facilities the constraint is stated as a prerequisite rather than as a shortage. A national institute reported that new equipment is acquired only once the necessary infrastructure is confirmed to be in place, including space, electrical supply and information-technology systems (INT-HF-02). A public paediatric hospital put the point the other way round, naming the building itself as the main obstacle, since its architecture is not always suitable for installing and using the equipment required (INT-HF-03). A second public hospital named limited infrastructure among the barriers to adopting new equipment, alongside the financial and training conditions reported below (INT-HF-14). This is a healthcare-specific finding: the provider sheets report the opposite, describing the centre's premises as adequate and close to ready for new equipment and for digital health content (INT-VET-02, INT-VET-03, INT-VET-04, INT-VET-07).

4.4.3 The cost of equipment

Cost is reported by facilities as one condition among several rather than as the decisive one. A private clinic named the cost of equipment as an important issue, while insisting that installation requirements, after-sales service, the availability of spare parts and the ability to train staff weigh alongside it (INT-HF-05). Another clinic named cost, staff training and infrastructure requirements together (INT-HF-10), and a public hospital named financial constraints, staff training needs and the compatibility of new technologies with existing hospital systems, alongside the infrastructure limit reported above (INT-HF-14). The cost of training and certification, which is a different matter, is reported in section 4.5.

4.4.4 Connectivity

Connectivity is reported at the centre as the one material limit on digital content. Two trainers who otherwise judged the premises suitable named the quality of the internet connection as the exception, one describing it as an occasional difficulty (INT-VET-02) and the other as the main limitation on integrating certain digital technologies (INT-VET-07).

4.4.5 The dependence on suppliers

The last finding in this section was not anticipated by the barrier typology and was coded inductively from the data. Facilities depend on suppliers and manufacturers for the training, calibration and repair of their equipment, and that training reaches very few people. A university hospital reported that only one or two technicians can usually attend the training that comes with newly acquired equipment, so that if one of them is absent or leaves the post the facility may no longer hold the knowledge (INT-HF-13). A laboratory-equipment company described training provided by suppliers, including training abroad, after which the technician is expected to transfer the knowledge to the rest of the team (INT-HF-07). A Ministry of Health structure reported that training is often provided when equipment is acquired under contract, and stressed the importance of having the latest versions and appropriate training in order to follow technological developments (INT-HF-15). The dependence extends beyond training to a regulated technical act: a second Ministry of Health structure reported that calibration cannot be carried out independently for want of staff able to perform it, so that external suppliers are often required (INT-HF-06). The same arrangement is an asset and a vulnerability: it is reported as an enabler in section 4.7, and here as the concentration of critical knowledge in one or two people, with no mechanism for its transfer. The theme is named and carried to chapter 5 as a question of resilience; it does not add a fifth barrier type.

4.5 Organisational and socio-economic barriers

This section reports the barriers that arise from how work and training are organised and from what they cost:

1. staffing levels and the administrative load they carry,
2. the time the work leaves for developing skills,
3. the mobility and accommodation costs borne by learners from other regions,
4. the cost of training and certification,
5. the motivation of younger technicians (reported by two suppliers).

Gender-linked aspects of access are cross-referred to section 4.6 and are not restated here.

4.5.1 Staffing levels and the administrative load they carry

Staffing is reported as the binding constraint in public hospitals. One hospital described two biomedical technicians and one qualified worker as insufficient for a Category B establishment given the quantity and variety of its equipment, and added that the maintenance service has no dedicated administrative support, so that technicians carry both the technical interventions and the administrative work (INT-HF-09). Another reported the same imbalance in a larger establishment, with the number of technicians limited relative to the volume of requests and activities across thirty-seven services and twenty-seven operating rooms (INT-

HF-12). The consequence is reported by the same hospital that has no established placement partnership: the shortage of staff and the workload of the maintenance service are what make such collaboration difficult to develop (INT-HF-09), which is where this barrier meets the work-based-learning finding in section 4.3.

4.5.2 The time the work leaves for developing skills

A second organisational constraint is reported by private clinics, and its mechanism is different. The manager of the maintenance department of one clinic named the lack of time for the technical team to develop new skills and explore new technologies as the main institutional obstacle, daily maintenance requests and urgent interventions taking priority and leaving limited time for innovation, training and the testing of new solutions (INT-HF-05). The manager of the maintenance department of a second clinic reported the same difficulty in finding time for continuous training, particularly when the clinic is busy, alongside the difficulty of recruiting technicians who combine technical and clinical knowledge (INT-HF-10). What is reported here is not the size of the establishment's complement, which is the public-hospital finding above, but the absence of room in the working week for development, so that the barrier bears directly on the currency of technicians' skills reported in section 4.3, where the same constraint is described from the side of what is on offer; here it is described from the side of the time available.

4.5.3 The mobility and accommodation costs borne by learners from other regions

Access to training carries costs that fall on the learner. The centre provides neither financial support nor scholarships, so that accommodation and travel between regions are, in one trainer's account, the main barrier to entering the training (INT-VET-02). Another described the same difficulty in terms of living conditions for those who come from regions far from the capital, where accommodation, rent, food and daily expenses accumulate (INT-VET-03). The authorities report the policy side of the same problem, the ministry working to improve access to accommodation for trainees from different regions (INT-LA-01) and noting that geographical and financial difficulties affect access to training for young people from some regions (INT-LA-03). The National Report triangulates this from its applicant data: registrations concentrate in Greater Tunis, while more than a third of applicants fall outside the named governorates, which it reads as a centralisation of access alongside a demand distributed across the territory (ATFP, 2026, section II.2); and it describes a health system in which urban areas and reference hospitals concentrate the most qualified profiles while inland regions hold intermediate profiles and less equipped structures (ATFP, 2026, section II.7). Where these factors bear differently on women, they are reported in section 4.6.

4.5.4 The cost of training and certification

The cost of qualifying is reported separately from the cost of equipment. While judging the resources available to the sector generally sufficient, the national training agency identified international certification

and specialised training for trainers as expensive (INT-LA-02). This is the socio-economic counterpart of the trainer-development barrier in section 4.3: what is missing is not only the provision but the means to buy it.

4.5.5 The motivation of younger technicians

The last finding in this section is reported by suppliers and is written as such. Both private laboratory-equipment companies described a question of motivation and career horizon among younger technicians. One framed it as a generational difference, with some younger technicians seen as ambitious while others seek mainly a stable position and show less interest in professional advancement (INT-HF-07). The other described the same pattern, with some technicians focused on salary and job stability rather than progression, and stressed the importance of encouraging longer-term professional development (INT-HF-08). No hospital and no Ministry of Health structure reported this, and the two companies are the two private suppliers in the sample, so the finding is recorded as a supplier-side observation about the technicians they employ and recruit, and not as a sector-wide statement about retention.

One socio-economic finding reaches this chapter only through the desk study. The National Report's analysis of the 2022 graduating class describes a partial integration into the labour market, with varying delays in access to employment and a diversity of types of contract, and records that some graduates continue to look for work, sometimes considering emigration as an alternative (ATFP, 2026, section II.5). That reading stands against the near-total insertion reported by the provider and the centre's management, and the two are set out together as the chapter's principal divergence in sections 4.7 and 4.8.

4.6 Gender-related barriers and enablers

Gender items were held on a separate analytical track, so that a predominant finding, a cluster of recurring indirect factors and a single direct report each keep their proper weight. This section follows that order and presents the available figures on their different bases without reconciling them.

The predominant finding is that **no formal barrier was reported**. Healthcare organisations stated that no gender-specific barrier was identified in access to or progression in these roles (INT-HF-02, INT-HF-04, INT-HF-08, INT-HF-09, INT-HF-11, INT-HF-14).

The provider reported no gender-based restriction on admission (INT-VET-01), no criterion of gender in registration or admission (INT-VET-03, INT-VET-07) and no discrimination in recruitment (INT-VET-04).

The authorities reported the same in law and policy: equal access and opportunity under the vocational training laws (INT-LA-01), equal access with women increasingly entering technical fields traditionally dominated by men (INT-LA-03), no discriminatory criterion of gender or region at the centre, the only criterion of preference being the baccalaureate score (INT-LA-04), and no major gender discrimination in biomedical training or recruitment (INT-LA-02).

Alongside that absence, the sheets report a recurring cluster of indirect factors, which is the substantive gender finding of this chapter.

4.6.1 Travelling and shift hours

The most frequently named concerns mobility: biomedical maintenance can require travel within the country and nights away from home, and some employers therefore prefer to recruit men, although the respondent stressed that both men and women can do the work technically (INT-HF-15). The provider reports the same mechanism at the point of placement, where some companies prefer male trainees for tasks involving heavy equipment or travel to remote areas over several days, for practical and accommodation reasons (INT-VET-01), and some employers or partners hold reservations about assigning women to equipment handling, field work and travel, which two trainers were careful to describe as not generalised (INT-VET-04, INT-VET-07).

4.6.2 The work conditions

A second group concerns the conditions of the work: emergency interventions, night work and handling heavy equipment (INT-HF-05), cultural perceptions associating field and physically demanding work with men together with night shifts that can be harder to combine with family responsibilities (INT-HF-10), field interventions, physical handling and irregular hours (INT-HF-14), and geographical factors or displacement (INT-HF-13). An authority describes the same perception at national level, no official restriction applying to women while cultural perceptions still influence the choice of occupation, so that technical work involving maintenance and equipment is sometimes considered more suitable for men, a pattern the respondent judged to be changing gradually (INT-LA-03).

4.6.3 Cost and distance

A third concerns cost and distance, where accommodation, rent and daily expenses weigh on learners from regions far from the capital and may be harder for women (INT-VET-02, INT-VET-03), reported as a general access barrier in section 4.5. One trainer also reported a pattern after training, maintenance roles being more often assigned to men while women move into administrative, technical support, commercial or marketing positions (INT-VET-02).

4.6.4 Socio behaviours at the workplace

One report concerns direct behaviour in the workplace. A public paediatric hospital reported that gender-related challenges exist within the team, male staff being in some cases reluctant to collaborate effectively with female colleagues, seeing the field as traditionally male-dominated and perceiving women as competitors (INT-HF-03). This is the only direct in-workplace account of its kind in the twenty-six sheets. It is recorded because it was said, and it is not generalised, because a single mention cannot establish a pattern.

The figures rest on three different bases and are presented separately.

Among applicants, the National Report describes a configuration generally dominated by men, a male majority of about 60% in the first sessions, a phase in which the proportions move closer, and a marked increase to 75% in the second session of 2025, a variability it reads as evidence that the pattern is not on a trajectory of continuous improvement (ATFP, 2026, section II.1).

Among learners at the centre, the national training agency estimated women at around 70% to 80% (INT-LA-02), while a trainer described enrolment as male-dominated when the programme began in 1999 and almost balanced today (INT-VET-01).

Among the public-sector workforce, the National Report records 234 biomedical agents at 30 June 2024, about 65% of them women, and reads this against the male majority among applicants as a sign that women are more durably integrated once trained (ATFP, 2026, section II.6).

The three are not converted into one another, because they count different populations at different moments. The learner picture is not uniform even within the centre: three other trainers describe the groups as balanced or as varying between intakes (INT-VET-02, INT-VET-03, INT-VET-07), while two respondents report male trainees usually more numerous (INT-VET-05, INT-HF-15). These are impressions of successive intakes, not counts, so the divergence is recorded as it stands; the National Report adds that gender imbalances depend strongly on local context (ATFP, 2026, section II.3).

On the enabler side, women are already established in the occupation. A national institute reported a biomedical team composed entirely of four women, which the respondent attributed to circumstance rather than policy (INT-HF-02); a hospital reported two women among its senior biomedical technicians (INT-HF-09); another reported a team composed of women (INT-HF-13); and the centre's management reported an employment rate of around 100% irrespective of gender, with women also among the trainers (INT-LA-04). Gender equality has been part of the national vocational training and employment strategy since the 2000s, with social support in rural and disadvantaged areas, and the ministry works to encourage women into traditionally male-dominated fields and to improve access to accommodation for trainees from other regions (INT-LA-01, INT-LA-03).

Two limits apply:

1. Women were under-represented in the focus groups, three of thirteen participants, and both analytical reports state that no general conclusion on gender can be drawn from sessions of that composition, so that material carries little weight here and none is drawn from it (Elemtiez, 2026a, 2026b, section 9); this is reported again in section 1.8.
2. Several sheets record that no gender issue was raised in the interview, which is not the same as a respondent stating that no barrier exists; the two are distinguished in the matrix and the first is not counted as an attestation.

4.7 Enablers

The same evidence that documents the barriers also names a set of assets. Several of them are the reverse face of a barrier reported above, and chapter 5 builds on them.

4.7.1 The technical foundation of graduates and technicians

The first asset is the technical foundation of the graduates and of the technicians already in post. Healthcare organisations report no major technical skills gap: a national institute identified no significant gap (INT-HF-02), a hospital saw no major training gap among its technicians (INT-HF-09), another described its technicians as technically competent and able to manage equipment tasks in difficult conditions (INT-HF-11), a clinic reported a good practical level in routine maintenance and first-level troubleshooting (INT-HF-05), and a Ministry of Health structure described its team as holding the required technical skills, particularly in maintenance and quality control (INT-HF-15). The provider reports the same from the training side, with graduates holding strong technical abilities that let them develop further relatively easily (INT-VET-03) and trainers judged qualified and holding a basic technical foundation (INT-VET-05). The centre's management put it in framework terms: the centre sits at level 4, but its graduates already hold almost the technical qualifications of level 5, the difference lying in technological innovation, soft skills and languages (INT-LA-04). Both focus groups found the same in their coverage assessment, focus group 1 rating problem-solving and critical thinking as well covered and focus group 2 rating quality assurance as relatively well covered (Elemtiez, 2026a, 2026b, section 5).

4.7.2 Employability and qualification

The second asset is employability, and it has to be stated together with its qualification. The provider reports a very high employment rate among graduates, which the centre's pedagogical coordination reads as evidence that the qualification meets labour-market needs (INT-VET-03), a view shared by a trainer (INT-VET-02), and the centre's management reported an employment rate of around 100% irrespective of gender (INT-LA-04). The National Report describes the same cohort differently, as a partial integration with varying delays, a diversity of contract types and a still fragile insertion (ATFP, 2026, section II.5). Both are reported here; the divergence is taken up in section 4.8.

4.7.3 The network of placements and partnerships

The third asset is the network of placements and partnerships already in place. The centre holds agreements with public hospitals, military hospitals and private companies, and with the Ministry of Health and the Ministry of Defence (INT-VET-01, INT-VET-02, INT-VET-03, INT-VET-05, INT-VET-07). Healthcare organisations confirm it from their side, hosting trainees for practical training (INT-HF-02), receiving students for placements and work-based training (INT-HF-12), and, in one company, having recruited most of its technicians from the sectoral centre after they completed final-year projects there, a collaboration the

respondent described as very positive (INT-HF-08). A Ministry of Health structure reported effective partnerships with the sectoral centre and other institutions for assistance, expertise and repair (INT-HF-15).

4.7.4 The supplier and manufacturer training on newly acquired equipment

The fourth asset is supplier and manufacturer training on newly acquired equipment, which reaches technicians where the formal system does not (INT-HF-07, INT-HF-08, INT-HF-09, INT-HF-13, INT-HF-15). It is the direct mirror of the emergent theme in section 4.4: the same arrangement that transfers current knowledge also concentrates it. Alongside it, digitalisation is already under way in facilities. One hospital has implemented an electronic medical record and describes itself as a pilot for digitalisation, with laboratory results transferred automatically into the record (INT-HF-09); another is developing digital archiving, electronic records and the transfer of results between services (INT-HF-13); and the Ministry of Health reports the digitalisation of patient records in several hospitals, still being expanded (INT-HF-01). These give the qualification a real setting in which its digital competences would be used.

4.7.5 The adequacy of the centre's premises and workshops

The fifth asset is on the provider side. The centre's premises and workshops are reported as adequate, covering electronics, mechanics, automation, radiology, laboratory, sterilisation and medico-surgical devices (INT-VET-01, INT-VET-02, INT-VET-03), and a Ministry of Health structure reported its own technical platform across the same range (INT-HF-15). Three respondents judged the centre close to ready to integrate digital health content, needing trainer preparation and appropriate tools rather than new premises (INT-VET-03, INT-VET-04, INT-VET-07). Readiness here is a question of people and programmes, not of buildings.

4.7.6 Participatory governance

The last assets are institutional. Participatory governance exists in practice, through a joint committee between the Ministry of Vocational Training and Employment and the Ministry of Health for initial training in the paramedical and healthcare fields, and a national committee for continuing training (INT-LA-01, INT-LA-03), with cooperation between the central administration and the centres described as generally good and the centres holding significant autonomy (INT-LA-02). The National Qualifications Framework is in place and is judged a sound basis for comparison with European standards (INT-LA-01, INT-LA-03), and national priorities already point where the profile points, to digitalisation, artificial intelligence, advanced technologies and language and soft skills (INT-LA-01, INT-LA-02, INT-LA-03). One senior ministry official went further and proposed a bilateral recognition framework between Tunisia and Italy for the biomedical qualification (INT-LA-01), which is the most concrete institutional opening the interviews produced.

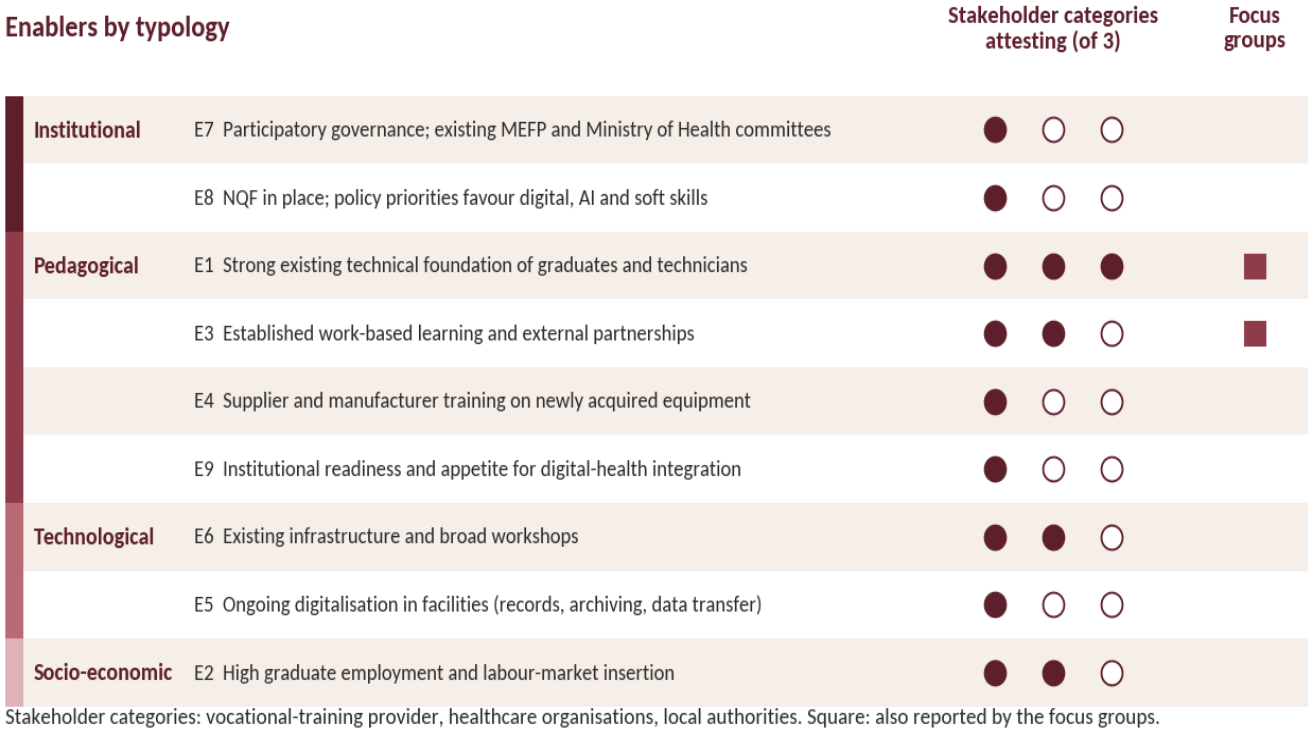


Figure 4.1. Enablers by typology, with the number of stakeholder categories attesting each one (vocational-training provider, healthcare organisations, local authorities) and the enablers also named by the focus groups.

Source: Table 4.1.

4.8 Convergence and divergence across stakeholders

This section reads across the columns of the matrix and adds no new evidence. Convergence is taken as the number of stakeholder categories attesting an item, with the focus-group obstacle tables as a separate check.

Four barriers form the structural core of the chapter: two are attested by all three categories and by both focus groups (B4, B5), one by the provider and the healthcare organisations and by both focus groups (B2), and one by all three categories and by focus group 1 (B8):

1. weak digital and connected-device competences (B2),
2. insufficient continuing development for trainers (B4),
3. outdated or insufficient equipment (B5) and
4. the length of administrative and qualification-approval procedures (B8).

Both focus groups name the first three among their obstacles; the fourth is named by focus group 1.

Barriers by typology		Stakeholder categories attesting (of 3)	Focus groups
Institutional	B8 Lengthy administrative and qualification-approval procedures	● ● ●	■
	B9 Weak inter-institutional and inter-ministerial coordination	● ○ ○	
	B10 EQF and NQF recognition and progression gaps	● ○ ○	
	B12 Single-provider concentration (CSFEMEB the only centre)	● ○ ○	
Pedagogical	B4 Trainer continuing professional development insufficient or inaccessible	● ● ●	■
	B1 Curriculum lags behind fast-moving healthcare technology	● ● ○	■
	B2 Digital and connected-device competences weak or absent in training	● ● ○	■
	B3 Trainer shortage, ageing workforce, no succession or handover	● ● ○	
	B13 Weak or under-developed work-based-learning partnerships	● ● ○	■
	B17 Communication and soft-skills gap among technicians	● ○ ○	■
Technological	B5 Outdated or insufficient equipment (training and facilities)	● ● ●	■
	B6 Facility infrastructure not ready for new equipment	● ○ ○	
	B7 Cost of equipment	● ○ ○	
	B14 Dependence on suppliers; knowledge concentration in few technicians	● ○ ○	
Socio-economic	B15 Learner mobility, accommodation, geographic and financial access	● ● ○	
	B11 Staffing shortages and administrative overload in facilities	● ○ ○	
	B16 Cost of training and certification	● ○ ○	
	B18 Career-motivation and retention issues among technicians	● ○ ○	
	B19 Limited time for skills development in facilities	● ○ ○	

Stakeholder categories: vocational-training provider, healthcare organisations, local authorities. Square: also reported by the focus groups.

Figure 4.2. Barriers by typology, with the number of stakeholder categories attesting each one and the barriers also named by the focus groups.

Source: Table 4.1.

Curriculum lag (B1) sits immediately alongside them, attested by the provider, by the authorities and by both focus groups; the healthcare voice on this theme is recorded under B2, because facilities describe the competences their technicians lack, not the state of the curriculum. The two groups look at the same problem from two sides, and read together the five items describe one mechanism: technology moves faster than the programme, the equipment and the trainers can follow.

One mechanism behind five barriers

- Technology in healthcare facilities moves faster than the programme (B1), the equipment used for training (B5) and the competences of the trainers (B4) can follow.
- The gap shows first in the digital and connected-device competences that facilities find missing in their technicians (B2).
- The procedures through which a qualification is revised and approved (B8) lengthen every correction, so the programme falls further behind while the revision waits.

Two qualifications apply to this reading:

1. The trainer shortage and succession problem (B3) is attested by the provider and the authorities but not by the focus groups, whose obstacle tables address the currency of trainers' skills and not their number; it is therefore reported as a provider and authority finding that completes the picture of the trainers.
2. One healthcare respondent also took part in focus group 2 (INT-HF-07), so where that sheet and the focus-group tables attest the same item the two are not independent sources; the matrix marks this and no convergence claim in this chapter rests on that pair alone.

Several findings are specific to one category:

1. Healthcare organisations alone report facility infrastructure as a precondition for adoption (B6), staffing shortages and administrative overload (B11), the absence of time for skills development in two private clinics (B19), the cost of equipment (B7), and the supplier-dependence theme (B14). Career motivation among younger technicians (B18) is narrower still, resting on the two private laboratory-equipment companies, and is reported as a supplier-side observation.
2. The authorities alone report weak inter-institutional coordination (B9), the recognition and progression gap (B10), single-provider concentration (B12) and the cost of certification (B16). The provider evidence throughout concerns one institution.

Two divergences are reported:

1. The first concerns employability: the provider and the centre's management report near-total insertion, while the National Report describes partial and fragile integration with delays, varied contracts and some graduates considering emigration (INT-VET-02, INT-VET-03, INT-LA-04 against ATFP, 2026, section II.5). The two rest on different evidence, self-report from the institution against a tracer study of one cohort, and the chapter states both.
2. The second concerns the adequacy of resources at the centre: a senior ministry official described the resources available there as average, within a policy of fair distribution across centres (INT-LA-01), while the centre's management reported a significant lack of innovative equipment (INT-LA-04). Distance from the object appears to shape the judgement.

Gender is held on its own track and is not scored for convergence in the same way. Its predominant finding, an absence of formal barriers, is uniform across all three categories, while the indirect factors recur across categories without any single one being universal, and the one direct report stands alone. Section 4.6 sets out why those are not treated as equivalent.

4.9 Chapter summary

The barriers that this chapter reports are not independent. A single provider trains for a fast-moving field with equipment largely unchanged since about 2000, revises its programme about every five years through procedures that all three stakeholder categories describe as long, and does so with about ten specialist trainers, most close to retirement and with almost no continuing development since their initial training. Each of those conditions makes the others harder to correct, and the digital and connected-device competences that the profile requires fall into the space between them. Against that, the technical foundation of the graduates is sound, placements and supplier training already reach the workplace, digitalisation is under way in the facilities that will employ these technicians, and the qualifications framework and the national priorities already point in the direction of the profile.

Two boundaries limit how far these findings reach. The provider evidence describes one institution in depth, which is not a limitation of the sample alone but a feature of the system, since that centre is currently the only one providing this training. And all fifteen healthcare respondents are located in Greater Tunis, so the facility evidence describes that setting and not the territorial variation that the desk study documents. Section 1.5 states both.

Table 4.1. Barrier and enabler matrix, summary.

Code	Barrier or enabler	Typology	Section	Categories attesting	Focus groups
B1	Curriculum lags behind fast-moving healthcare technology (outdated, theoretical, insufficiently updated)	Pedagogical	4.3	2	Yes
B2	Digital and connected-device competences weak or absent in training	Pedagogical	4.3	2	Yes
B3	Trainer shortage, ageing workforce, no succession or handover	Pedagogical	4.3	2	No
B4	Trainer continuing professional development insufficient or inaccessible	Pedagogical	4.3	3	Yes
B5	Outdated or insufficient equipment (training and facilities)	Technological	4.4	3	Yes
B6	Facility infrastructure not ready for new equipment	Technological	4.4	1	No
B7	Cost of equipment	Technological	4.4	1	No
B8	Lengthy administrative and qualification-approval procedures	Institutional	4.2	3	Yes
B9	Weak inter-institutional and inter-ministerial coordination	Institutional	4.2	1	No

B10	EQF and NQF recognition and progression gaps	Institutional	4.2	1	No
B11	Staffing shortages and administrative overload in facilities	Socio-economic	4.5	1	No
B12	Single-provider concentration (CSFEMEB the only centre)	Institutional	4.2	1	No
B13	Weak or under-developed work-based-learning partnerships	Pedagogical	4.3	2	Yes
B14	Dependence on suppliers; knowledge concentration in few technicians	Technological	4.4	1	No
B15	Learner mobility, accommodation and geographic and financial access	Socio-economic	4.5	2	No
B16	Cost of training and certification	Socio-economic	4.5	1	No
B17	Communication and soft-skills gap among technicians	Pedagogical	4.3	1	Yes
B18	Career-motivation and retention issues among technicians	Socio-economic	4.5	1	No
B19	Limited time for skills development in facilities	Socio-economic	4.5	1	No
E1	Strong existing technical foundation of graduates and technicians	Pedagogical	4.7	3	Yes
E2	High graduate employment and labour-market insertion	Socio-economic	4.7	2	No
E3	Established work-based learning and external partnerships	Pedagogical	4.7	2	Yes
E4	Supplier and manufacturer training on newly acquired equipment	Pedagogical	4.7	1	No
E5	Ongoing digitalisation in facilities (electronic records, archiving, data transfer)	Technological	4.7	1	No
E6	Existing infrastructure and broad workshops	Technological	4.7	2	No
E7	Participatory governance and existing MEFP and Ministry of Health committees	Institutional	4.7	1	No
E8	NQF in place; policy priorities favour digital, AI and soft skills	Institutional	4.7	1	No
E9	Institutional readiness and appetite for digital-health integration	Pedagogical	4.7	1	No

Source: barrier and enabler matrix built from the 26 interview sheets, the Focus Group 1 and 2 analytical reports, the Narrative Report and the National Report. Categories attesting counts the stakeholder categories, of three, holding evidence for the item.

Chapter 5. Synthesis, recommendations and draft competence profile

This chapter serves the three analytical synthesis objectives of the study: the alignment of the field findings with the recommendations of the European Training Foundation for Tunisia (SO-A), the identification of priority competence clusters for the draft competence profile (SO-B), and the formulation of implementation conditions and recommendations for curriculum development in work package 3 (SO-C). It draws on the context analysis of chapter 2, the competence mapping of chapter 3 and the barrier and enabler analysis of chapter 4, and it is written to be used by the curriculum developers without returning to the field material. Section 5.1 sets out the triangulated findings; section 5.2 reads them against the ETF Key Competence Lighthouse (ETF, 2023a) and the two Torino Process documents on Tunisia (ETF, 2021, 2023b); sections 5.3 and 5.4 define the clusters and the draft profile; sections 5.5 to 5.7 state the conditions and recommendations for work package 3, for policy and for providers and healthcare organisations; section 5.8 closes with the hand-over to work package 3.

5.1 Triangulated findings

Reading the three strands of evidence together produces eight findings on which the desk study, the focus groups and the interviews converge, three points on which they diverge, and two silences. Table 5.1 summarises them with the sections that carry the evidence.

Table 5.1. Triangulated findings: convergence across the desk study, the focus groups and the interviews.

Finding	Desk study (chapter 2)	Focus groups (chapter 3)	Interviews (chapters 3 and 4)	Reading
1. The technical foundation of the BTS is sound (E1)	2008 programme technically sound; 2019 revision closer to the ESCO modules (2.6)	Technical core essential for both groups; coverage rated partial, reinforcement priority high (3.2, 3.4, 3.5.1)	No major technical gap reported by healthcare organisations; strong foundation expected by 13 of 15 (3.3, 4.7, E1)	Convergent: the profile builds on the existing base, it does not replace it
2. Digital health and connected-device competences are absent from provision and demanded by the market	Neither programme covers medical informatics or digital health (2.6); digital adoption under way in facilities (2.7)	Digital domain rated essential or important, except cybersecurity (N18), not relevant as a specialisation for the system actors and important for the market actors (contested, 3.7); no coverage; five of eight cards high priority (3.4, 3.5.2)	Named by employers (N13 in 8 sheets, N11 in 6); gap in current technicians (4.3, B2)	Convergent: the decisive distance between the existing and the target profile
3. Trainers: a small body near retirement, with little continuing development	About ten biomedical trainers of eighty; retirement horizon 2027 to 2028 (2.6)	Trainers' skills insufficiently updated; structured CPD recommended (3.4; Elemtiez, 2026a, 2026b, section 8)	B3 and B4 attested by provider and authorities; B4 by all three categories (4.3)	Convergent: trainer development is a precondition, not a complement

Finding	Desk study (chapter 2)	Focus groups (chapter 3)	Interviews (chapters 3 and 4)	Reading
4. Equipment and infrastructure	Training equipment from around 2000, partial renewal 2023 to 2025 (2.6)	Lack of up-to-date equipment first among obstacles in both groups	B5 attested by all three categories; facility infrastructure as prerequisite (B6); connectivity (4.4)	Convergent: practice-based training needs equipment, partnerships or simulation
5. Procedures, recognition and progression	No formal NQF to EQF referencing; BTS at NQF level 4; no progression to university (2.2)	Administrative burden for revising qualifications (Elemtiez, 2026a, section 8)	B8 attested by all three categories; B9, B10, B12 by the authorities (4.2)	Convergent: the qualification needs an institutional route as much as a curriculum
6. Work-based learning and partnerships	320 hours of placement required; three placements on the BTS (2.1, 2.6)	Opportunistic, poorly supervised internships; long-term agreements and shared tutoring recommended	B13 provider and focus groups; E3 partnerships in place; one hospital without partnership (4.3, 4.7)	Convergent: the framework exists; its objectives, tutoring and assessment do not
7. Communication, documentation and teamwork	Transversal hours reduced by successive homologations (2.6)	N19, N22, N23 essential or important; communication a critical rather than secondary skill (Elemtiez, 2026b, section 10)	N19 and N23 named by 8 organisations; communication the main gap for 4 (3.3, 4.3, B17)	Convergent: present in the programmes, under-reinforced in practice
8. Gender: no formal barrier, indirect factors	Male majority among applicants, female majority in the public workforce (2.4, 2.5)	Composition too small for conclusions; balanced representation recommended (3.9)	No formal barrier across all categories; mobility, night work, accommodation as indirect factors; one direct report (4.6)	Convergent: the profile raises no gender barrier of its own; access conditions do

The convergent findings describe one mechanism. The existing BTS gives a sound technical foundation that employers recognise, and the system around it, a single provider, a programme revised about every five years through long procedures, about ten specialist trainers close to retirement, training equipment largely unchanged since about 2000, cannot follow the pace of healthcare technology. The competences that the market and the system now rate as essential, in digital health, connected devices and health information systems, fall into that gap: they are covered by no module of the programme in use or of the programme awaiting accreditation, and the facilities that would employ the graduates report the same gap in their current technicians. Communication, documentation and teamwork are present in the programmes but under-reinforced, and are the competences that employers name most often after the technical base.

Three divergences are carried into the recommendations:

1. The provider and the centre's management report near-total employment of graduates, while the National Report records a partial and fragile insertion of the 2022 cohort (sections 2.5, 4.7 and 4.8); the two rest on different evidence and together argue for a tracer system rather than for either reading.

2. A ministry official judged the centre's resources average within a policy of fair distribution, while the centre's management reported a significant lack of innovative equipment (section 4.8).
3. The share of women among learners is estimated at 70% to 80% by an authority and at near parity by a trainer, against a male majority among applicants and a female majority of about 65% in the public workforce (sections 2.4, 2.5 and 4.6); the three series count different populations and are presented separately.

Two silences shape what the profile can claim:

1. No official of the Ministry of Health was interviewed as an authority, so the health-sector view of the qualification is that of the three Ministry of Health structures interviewed as healthcare organisations, and the question of how the profile would be positioned in the public health workforce classification remains open.
2. No learner or recent graduate took part in the study, so the demand for the qualification and the learners' own view of their competences are known only from application figures and from the accounts of trainers and employers.

5.2 Alignment with the ETF recommendations (SO-A)

The reference frameworks for this objective are the three ETF documents named in the research design. The first and most specific is the Key Competence Lighthouse (ETF, 2023a), the ETF's account of how Tunisia has used EntreComp, the European entrepreneurship competence framework, to reform its vocational training and to build a national framework and label for entrepreneurial VET centres. Two of its instruments bear on this study. The first is EntreComp itself, a framework of fifteen competences in three areas, ideas and opportunities, resources, and into action, which the Lighthouse presents as the key competence approach adopted by the Tunisian VET system. The second is the Tunisian Framework for Entrepreneurial VET Centres, a self-assessment and recognition tool in nine dimensions, each with progress descriptors from a starting to a transformational level (ETF, 2023a, annex 3). Table 5.2 reads the findings of chapters 2 to 4 against the dimensions of that framework that the evidence touches, and against EntreComp. The two Torino Process documents, the assessment of policies for human capital development (ETF, 2021) and the system monitoring report (ETF, 2023b), describe the Tunisian VET system as a whole and are read after the table.

Table 5.2. Alignment of the findings with the Key Competence Lighthouse (ETF, 2023a).

Lighthouse element	What the framework describes	What the study found	Implication for the qualification
Dimension 3. Partner in the skills development ecosystem	The centre engages with the organisations and businesses that develop skills in its locality or region	Agreements with hospitals, military hospitals, companies and two ministries exist (E3); reach uneven; one hospital without partnership (B13)	Formalise the ecosystem around the qualification: hospitals, suppliers, Ministry of Health structures, as partners in design and delivery (W6, O1)

Lighthouse element	What the framework describes	What the study found	Implication for the qualification
Dimension 4. Active participation of stakeholders in training and learning	Stakeholders take part in the design, delivery and evaluation of training	Programme revision triggered by trainers and passed through institutions; healthcare organisations not involved (4.2, B8, B9)	Involve employers in the definition of learning outcomes and in assessment (W7, P3)
Dimension 5. Entrepreneurial training (active and experiential pedagogy)	Learning methods are active and experiential across the programme	Delivery about 60% theory; practice constrained by equipment; no simulation (4.3, B1, B5)	Practice-first pedagogy starting from the equipment, with simulation where equipment is unattainable (W2, W4)
Dimension 6. Support for staff and trainers	Trainers are trained in the competences and the pedagogies the programme requires	Continuing development insufficient or absent; succession not prepared (B3, B4)	Trainer development as a precondition of the curriculum (W5, P5)
Dimension 7. Learners' competences through learning and assessment	Key competences are developed and assessed across the curriculum	Transversal competences present but under-reinforced; no assessment of them reported (3.5.3, B17)	Transversal learning outcomes with authentic assessment (unit U6, W8)
Dimension 8. Career development support	Recognition of competences for employability and career guidance	High employability reported by the provider; partial insertion in the tracer data; no progression to university (E2, B10)	Progression routes and recognition built into the qualification (P1, P4)
Dimension 9. Inclusion and sustainable development	The centre develops inclusion and sustainability awareness	No formal gender barrier; indirect factors in mobility, accommodation and work conditions (4.6)	Access measures for learners from other regions and monitoring of indirect barriers (P7, P8)
EntreComp as key competence approach	Fifteen competences in ideas and opportunities, resources, into action	Communication, teamwork, problem solving, planning and continuous learning rated essential or under-reinforced (3.5.3, 3.7, 3.8)	Transversal unit of the profile written in EntreComp terms (C6)
ETF conclusion on NQF to EQF referencing (ATFP, 2026, conclusions)	No formal equivalence between the national framework and the EQF	Confirmed by the authorities; alignment sought, institutional obstacles remain (2.2, B10)	Referencing and bilateral recognition as policy recommendations (P1, P2)

Three conclusions follow. First, the findings and the Lighthouse point in the same direction: the conditions the framework describes for an entrepreneurial VET centre, partnerships in the skills ecosystem, stakeholders in the design and delivery of training, experiential pedagogy, support for trainers, career support and inclusion, are the enablers that chapter 4 found in place in embryo and the barriers it found in their absence. The MeDCare qualification can therefore be designed as a contribution to the path the Tunisian system has already chosen, and the sole provider can use the framework's descriptors to position itself. Second, the transversal competences that the field rated essential or under-reinforced, communication, teamwork, problem solving, initiative, planning and continuous learning, are EntreComp competences; carrying them into the profile as learning outcomes, and assessing them, is the alignment the Lighthouse asks for, and it is the ground on which cluster C6 of section 5.3 stands. Third, on the referencing of qualifications, the ETF conclusion reported in the National Report, that no formal equivalence exists between the national

framework and the EQF, is confirmed by the authorities interviewed and is the institutional condition that section 5.6 addresses.

The two Torino Process documents corroborate this reading at system level. The ETF assessment of policies for human capital development (ETF, 2021) identifies two key issues, the partial lack of alignment of the VET system with economic and social needs and its lack of internal consistency, and addresses them with six recommendations: better skills anticipation and career guidance (R.1); multi-level and multi-stakeholder governance, with sector skills councils and common national frameworks for qualifications and quality assurance (R.2); a monitoring and evaluation system (R.3); stronger capacity and autonomy for VET providers, including in the development of curricula and the signing of agreements with companies (R.4); a continuing professional development strategy for VET teachers and trainers, with a renewal of CENAFFIF programmes and methods (R.5); and the extension and improvement of work-based learning, with company training periods planned as an integral part of the curriculum and trained tutors (R.6). Four of the six recommendations describe conditions that this study found wanting in the biomedical specialty: the governance and qualification procedures of section 4.2 (R.2), the autonomy of the sole provider over its programme and partnerships (R.4), the continuing development of its trainers (R.5) and the quality of its placements (R.6). The recommendations of sections 5.5 to 5.7 that answer them, W3, W5, W7, P3, P5, O1 and O3, are therefore consistent with the direction the ETF set for the system in 2021.

The system monitoring report (ETF, 2023b) adds the measure of where the system stood in 2023. It finds vocational pathways rigid, with difficult transitions from VET to academic education, which is the progression gap of section 2.2 and barrier B10 and the ground of recommendation P4; a deficit of language and communication skills among young learners, which the field confirmed for technical English and clinical communication and which W6 and unit U5 address; a long tradition of work-based learning whose alignment with labour market demand is nonetheless only average, so that graduates find employment but their skills may not correspond to their jobs, which is the pattern of enabler E2 read against the digital gap of chapter 3; a low score on pedagogy and the professional development of teachers and trainers, attributed to outdated practices and the lack of continuing development opportunities, which is barrier B4 and the premise of W5 and P5; and weaknesses in participatory governance, public accountability and quality assurance, which section 4.2 recorded as barrier B9 and section 4.7 as the embryonic enabler E7. On one point the monitoring report is more favourable than the field evidence: it rates the incorporation of the digital transition into Tunisian VET content slightly above the international average, whereas in the biomedical specialty neither programme covers digital health (section 3.4). The difference is one of scale, a system-wide indicator against one specialty, and it confirms that the digital domain of the profile is the specific contribution the qualification has to make.

5.3 Priority competence clusters (SO-B)

The twenty-seven competences of the perimeter and the emergent competences of section 3.6 were grouped into seven clusters on three criteria: the relevance the two focus groups attached to the cards, the frequency with which healthcare-sector organisations named them, and the reinforcement priority of the grid (annex C). Each cluster is given a weight in the profile, core, major, supporting or orientation, which indicates the share of the specialised training it should receive and the depth of the learning outcomes expected; the weight is a judgement on the evidence, not a measure drawn from it. Table 5.3 defines the clusters and figure 5.1 shows them; figure 5.2 shows how the reinforcement priorities of the grid distribute across them.

Table 5.3. The seven competence clusters, their composition, weight and evidence base.

Cluster	Competences of the perimeter	Emergent additions	Weight	Evidence base
C1 Biomedical maintenance and diagnosis	N1 engineering principles, N2 maintenance and repair, N3 calibration and testing, N5 technical drawings, N6 product data; N4, N7 laboratory techniques and simulation as support	Reading of manufacturer technical documentation; first-level fault diagnosis before recourse to the supplier; options by equipment family (laboratory equipment, medical gas systems)	Core	Essential for both groups; N1 and N2 in both top fives, N3 in the market actors' top five; N1 named by 13 of 15 organisations; priority high for N1 and N2 because coverage is practical rather than complete
C2 Connected devices, health information systems and remote support	N11 health information systems, N13 connected devices, N16 electronic health records, N17 medical software, N12 telemedicine, N15 remote diagnostics	None	Core	Essential for the market, essential or important for the system; N13 named by 8 and N11 by 6 organisations; no module in either programme; four of six cards high priority
C3 Data protection and basic cybersecurity	N14 data protection, N18 cybersecurity (basic applied level)	None	Supporting	N14 essential for the market, high priority; N18 contested in scope, converging on a basic transversal level; no module in either programme
C4 Quality, safety, regulation and documentation	N9 safety compliance, N20 quality assurance, N27 regulatory compliance, N19 documentation and reporting; principles of N8	Device regulation and conformity, including the reading of a certificate of conformity	Major	N9, N20, N27 high priority; N19 named by 8 organisations; regulation named by 4; modules exist in both programmes but coverage rated partial
C5 Clinical context, communication and teamwork	N22 team coordination, N23 communication with clinical staff	Clinical and anatomical knowledge by equipment family; option: medical biology for laboratory equipment	Major	N23 named by 8 organisations and the main gap for 4; N22 in the market top five; communication a critical skill for the market actors; clinical knowledge asked by suppliers and a clinic
C6 Professional autonomy, project	N24 problem solving, N26 project and resource	Initiative, planning and adaptability as	Major	N24 in the market top five and the employers'

Cluster	Competences of the perimeter	Emergent additions	Weight	Evidence base
and resource management, continuous development	management, N25 continuous professional development, N21 as technical decision making on data, protocols and test evidence	EntreComp key competences		description of autonomy; N26 and N25 high priority; soft skills and management named as gaps by the provider and the authorities
C7 Emerging technologies and orientation to the future	None of the twenty-seven	Applied artificial intelligence and predictive maintenance (introductory); digital twin principle and statistical process control (orientation)	Orientation	AI proposed by both groups and named in two interviews; predictive maintenance by the system actors; the other two by one group each; innovation culture named as a barrier by the market actors

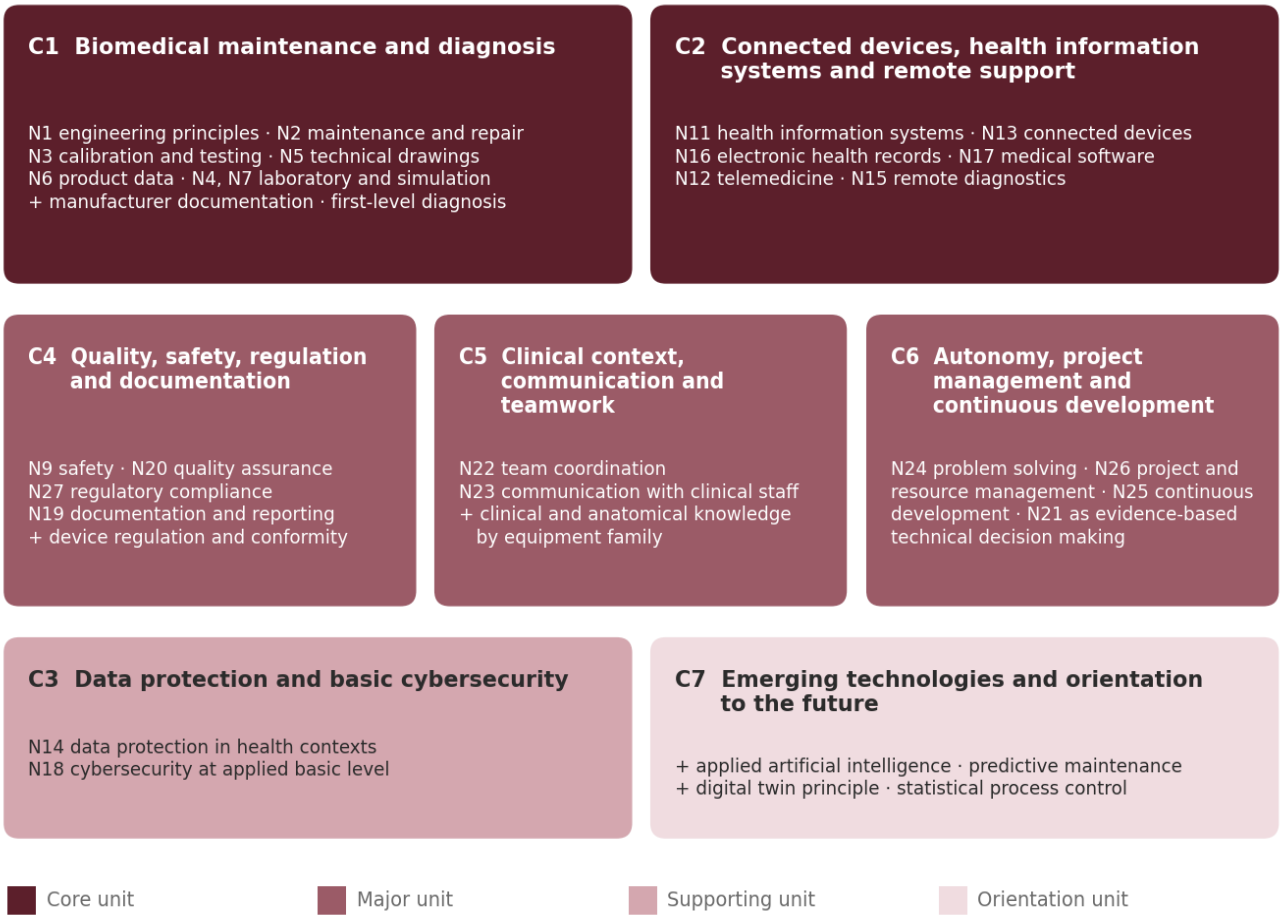


Figure 5.1. The seven competence clusters of the draft profile, by weight in the profile.

Source: Table 5.3 and annex C.

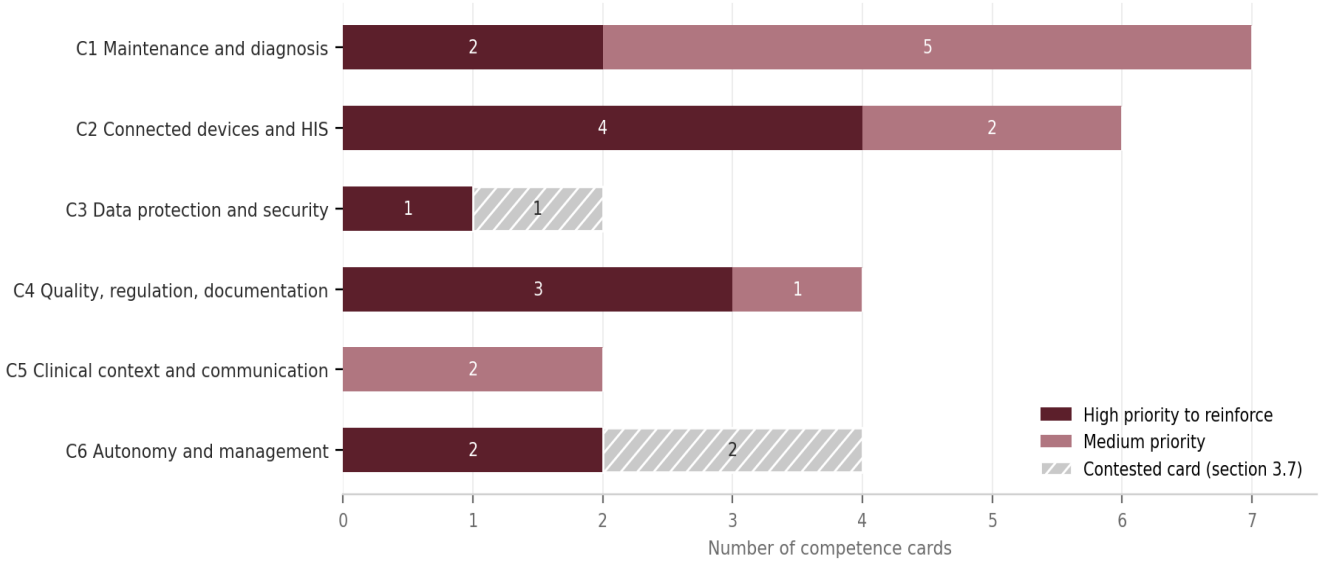


Figure 5.2. Reinforcement priority of the competence cards by cluster (annex C).

Note: C7 consists of emergent competences and carries no grid priority; N8 and N10 are not in the chart. Source: annex C, reinforcement priority column.

Four rulings on the contested cards of section 3.7 are built into the clusters. Problem solving and critical thinking (N24) enters cluster C6 as a priority competence: the market actors placed it in their top five, the employers' most frequent description of the technician they want is one who analyses a fault before calling the supplier, and the disagreement within the system actors' group concerned how it is learned, not whether it is needed. Good manufacturing practices (N8) is not a unit of the profile: the market is one of service and after-sales companies rather than manufacturers, and the principles of quality, traceability and conformity that the card carries are secured in cluster C4. Cybersecurity (N18) enters cluster C3 at the applied basic level on which both groups converged, access control, passwords, confidentiality, incident reporting and the security of connected devices, and not as a specialisation. Evidence-based practice (N21) enters cluster C6 in the reformulation proposed by the market actors, technical decision making based on data, protocols and test evidence, which removes the clinical ambiguity of the original card.

The emergent competences are treated by their weight of evidence. Applied artificial intelligence, proposed by both groups and named in two interviews, and predictive maintenance, proposed by the system actors, form the core of cluster C7 at an introductory level; the digital twin principle and statistical process control, each proposed by one group, are included in the same cluster as orientation content, so that the profile names the direction of the technology without claiming a demand the field did not express. Device regulation and conformity, named in four interviews, enters cluster C4. The reading of manufacturer documentation, named in four interviews and by the market actors, enters cluster C1. Clinical and anatomical knowledge by equipment family, proposed by the market actors and asked for by the two laboratory-equipment companies

and by a clinic, enters cluster C5. Medical gas systems, a single request, and medical biology for laboratory equipment are recorded as options for specialisation by equipment family within clusters C1 and C5. Technical English, proposed by the market actors, is carried as an enabling condition in section 5.5 rather than as a unit. Design and prototyping of technical solutions (N10), which received no coverage rating and no evidence from the interviews or the trainers, is not carried into the profile.

5.4 Draft competence profile: Medical Technology and Digital Health Care Technician, EQF level 5

Occupational definition: The Medical Technology and Digital Health Care Technician installs, maintains, calibrates and repairs medical and biomedical equipment in healthcare facilities and in the companies that supply them; manages the connected and software-dependent dimension of that equipment, including its integration with health information systems and its remote support; documents interventions and keeps the equipment compliant with safety, quality and regulatory requirements; communicates with clinical staff and suppliers; and organises the work of a small team or of a maintenance service within the resources available, taking responsibility for the quality and safety of the work and for keeping their own competences current.

The profile is written at EQF level 5 in the terms of section 1.3.1: comprehensive, specialised knowledge of the field with an awareness of its boundaries; a comprehensive range of cognitive and practical skills required to develop creative solutions to abstract problems; and the exercise of management and supervision in contexts of unpredictable change, with the review and development of one's own performance and that of others. Table 5.4 gives one unit of competence per cluster with its learning outcomes in the three categories of the EQF, and states what each unit adds to the 2019 programme. Work-based learning is not a unit: it is the setting in which every unit is practised and assessed, under the conditions set in section 5.5.

Table 5.4. Draft competence profile: units, learning outcomes at EQF level 5 and what each unit adds to the 2019 programme.

Unit (cluster)	Knowledge	Skills	Responsibility and autonomy	What it adds to the 2019 programme
U1 Biomedical maintenance and diagnosis (C1, core)	Comprehensive knowledge of the operating principles, architecture and failure modes of the main families of medical equipment (imaging, laboratory, operating theatre, intensive care, sterilisation); of calibration and testing standards; of manufacturer documentation and its conventions	Carry out preventive and corrective maintenance, calibration and functional testing; diagnose a fault to board or module level before recourse to the supplier; read and apply manufacturer technical documentation in French and English; keep product and traceability data	Plan and carry out interventions autonomously; decide when to escalate to the supplier; supervise the routine work of junior technicians; review the quality of own work against procedures	Practice on current equipment; first-level diagnosis as an explicit outcome; systematic use of manufacturer documentation; options by equipment family (laboratory equipment, medical gas systems)

Unit (cluster)	Knowledge	Skills	Responsibility and autonomy	What it adds to the 2019 programme
U2 Connected devices, health information systems and remote support (C2, core)	Specialised knowledge of networks and interfaces used by connected medical devices, of the architecture of health information systems and electronic records, of medical device software and its life cycle, of telemedicine platforms and remote diagnostics	Connect, configure and monitor networked devices; support the integration of equipment with the hospital information system; install, update and troubleshoot medical device software; carry out and document remote diagnostics and remote maintenance sessions with suppliers	Take responsibility for the availability and integrity of connected equipment in the service; coordinate with the information technology function and with suppliers; recognise the limits of own competence in information technology and escalate	Entirely new: no module in either programme covers this unit
U3 Data protection and basic cybersecurity (C3, supporting)	Knowledge of the rules on the protection of personal health data applicable in Tunisia and of the basic principles of information security in connected environments	Apply access control, password and confidentiality rules; recognise and report security incidents; apply the security settings of connected devices; handle patient data encountered during interventions correctly	Act within the facility's data protection and security policies and contribute to their application in the maintenance service	New: no module in either programme
U4 Quality, safety, regulation and documentation (C4, major)	Comprehensive knowledge of the safety standards and regulations applicable to medical devices in Tunisia, of quality assurance and quality control procedures, of the regulatory status of devices and the meaning of a certificate of conformity	Apply safety and quality procedures; verify the conformity and regulatory status of a device; document interventions in reports and equipment records that others can rely on; prepare the technical elements of acquisition and acceptance files	Take responsibility for the compliance of the equipment under own charge; keep the equipment record of the service; contribute to internal audits and to the quality system	Device regulation and conformity as an explicit outcome; documentation to a standard others rely on; quality already taught, reinforced in practice
U5 Clinical context, communication and teamwork (C5, major)	Knowledge of the clinical use of each equipment family and of the risks of its malfunction for patients; of the organisation of a healthcare facility and the roles of its staff; option: medical biology sufficient to understand laboratory results	Communicate with doctors, nurses and suppliers about the technical state of equipment; translate a clinical complaint into a technical question; train users in correct use; work within multidisciplinary teams and in interprofessional meetings	Represent the maintenance function in dealings with clinical departments and suppliers; take responsibility for the information given to clinical staff	Clinical knowledge by equipment family is new; communication and teamwork already taught, reinforced and assessed in authentic situations
U6 Professional autonomy, project and resource management, continuous	Knowledge of problem-solving methods applied to technical faults; of the planning and management of maintenance activities and resources; of the sources through which	Analyse complex situations, identify root causes and choose solutions on the basis of data, protocols and test evidence; plan, organise and monitor the activities and resources of a	Exercise management and supervision of a small team or service in contexts of unpredictable change; review and develop own performance and that of others; take	Project and resource management already present, reinforced; technical decision making on evidence and self-directed

Unit (cluster)	Knowledge	Skills	Responsibility and autonomy	What it adds to the 2019 programme
development (C6, major)	the field keeps its knowledge current	maintenance service or project; identify own training needs and build a learning path; show initiative and adapt to change	responsibility for decisions within own remit	development are new outcomes
U7 Emerging technologies and orientation to the future (C7, orientation)	Introductory knowledge of the uses of artificial intelligence in equipment diagnosis and maintenance and of their limits; of predictive maintenance on equipment data; awareness of the digital twin principle and of statistical process control applied to maintenance reliability	Use equipment data and simple indicators to anticipate failures and plan interventions; use assisted diagnosis tools critically; follow the evolution of the technology in the field	Judge the reliability of automated or assisted outputs before acting on them; contribute to innovation projects in the service	Entirely new; designed as an updatable module

Two features of the profile are deliberate. The units are not of equal size: C1 and C2 are the core and together define the occupation; C4, C5 and C6 are major units that distinguish the EQF level 5 technician from the current BTS graduate in autonomy, responsibility and breadth; C3 is a supporting unit and C7 an orientation unit. And the profile keeps the three-cycle logic of the Tunisian system in view: most of C1 and of C4 is already taught at BTS level, with the exception of technical drawings (N5) and computer simulation (N7), which no module of either programme covers, and the profile builds on it rather than repeating it, so that a route from the existing BTS to the new qualification, through recognition of prior learning, is possible and should be designed in work package 3. For the double degree, the profile will also be read against its European EQF level 5 counterparts, the Italian ITS Academy profile in the biomedical field and the Spanish Técnico Superior en Electromedicina Clínica (Real Decreto 838/2015), a comparison that work package 3 will document (W9).

5.5 Implementation conditions and recommendations for work package 3 (SO-C)

The draft profile can be taught only if the conditions that chapter 4 identified as barriers are addressed in the design of the curriculum itself. Figure 5.3 groups them in four pillars; the recommendations below, numbered W1 to W10, state what work package 3 should build into the curriculum, the barrier or enabler each responds to, and the task report that proposed it where one did. Work package 3 is also expected to take into account the cross-cutting themes to which the MeDCare project is committed, namely sustainability and energy efficiency, the One Health approach and the DigComp, LifeComp and GreenComp frameworks, which the fieldwork did not raise.

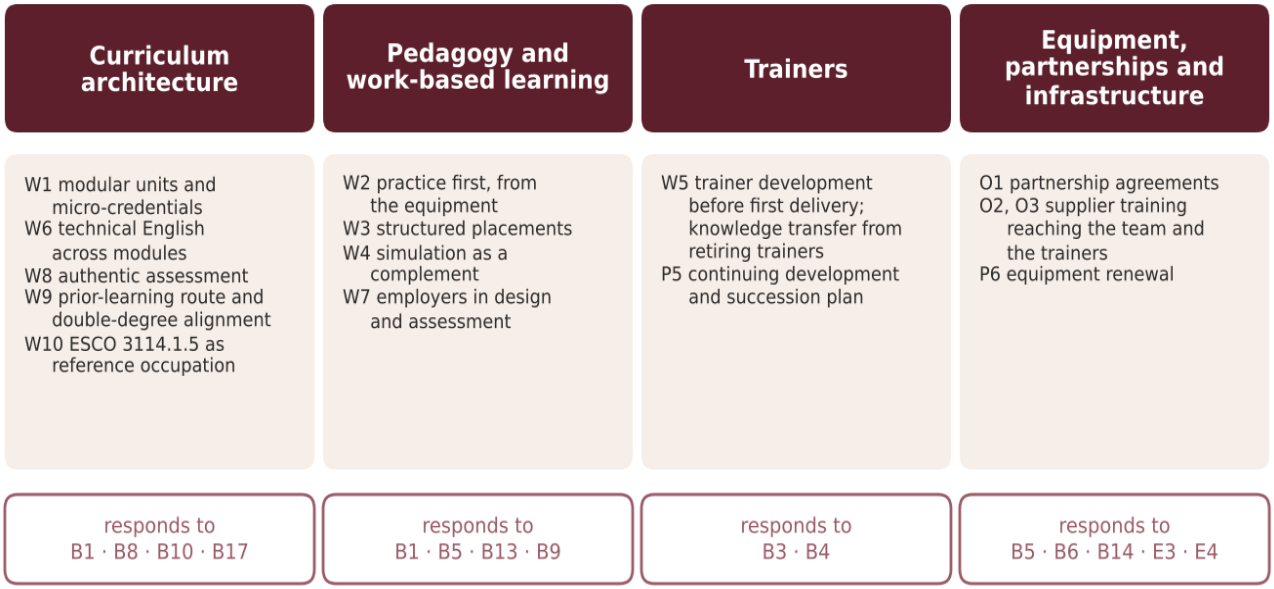


Figure 5.3. Implementation conditions for work package 3 in four pillars, with the recommendations and the barriers and enablers they respond to.

Source: Table 5.5 and the barrier and enabler codes of Table 4.1.

Table 5.5. Recommendations for curriculum development in work package 3.

No.	Recommendation	Responds to	Proposed by
W1	Design the curriculum as a modular architecture in which the seven units of section 5.4 are delivered as modules with their own learning outcomes and assessment, and in which the digital units (U2, U3, U7) can also be certified as micro-credentials and offered to technicians already in post; this allows the content most exposed to technological change to be updated without reopening the whole qualification	B1, B8 (five-yearly revision through long procedures)	Elemtiez, 2026a, section 8; Elemtiez, 2026b, section 11; ATAS, 2026, recommendation 1
W2	Adopt a practice-first pedagogy that starts from the equipment and moves to components, circuits and principles, with the balance between theory and practice set in favour of practice in every technical module	B1, B5 (about 60% theory; equipment limiting practice)	INT-VET-04; ATAS, 2026, recommendation 3
W3	Structure work-based learning with learning objectives per placement linked to the units, a tutor in the host organisation and a trainer sharing supervision, and an assessment of the outcomes achieved; use long-term agreements with hospitals, Ministry of Health structures and suppliers rather than placements negotiated case by case	B13, E3 (placements present but without objectives, tutoring or assessment)	Elemtiez, 2026a, section 8; ATAS, 2026, recommendation 8
W4	Use simulation, including virtual environments, for the equipment and situations the centre cannot own or reproduce, as a complement to practice on real equipment and never as a substitute for it	B5, B6 (equipment unattainable; infrastructure prerequisites)	Elemtiez, 2026a, section 8; ATAS, 2026, recommendation 4
W5	Treat trainer development as a precondition: before the first delivery, train the biomedical trainers in the content of U2, U3 and U7 and in the pedagogy of W2 and W3, and	B3, B4 (succession and continuing development)	Elemtiez, 2026a, 2026b, section 8; ATAS, 2026,

No.	Recommendation	Responds to	Proposed by
	plan the transfer of knowledge from the trainers close to retirement to their successors		recommendations 5 and 6
W6	Integrate technical English, with French, as an enabling competence across the technical modules, through the reading of manufacturer documentation, standards and software interfaces, rather than as a separate language module	INT-LA-04; market actors' proposal	Elemtiez, 2026b, sections 3 and 10
W7	Define the learning outcomes and the assessment of U4, U5 and U6 with healthcare organisations and suppliers, and involve them in the assessment of work-based learning	B9, dimension 4 of the Lighthouse framework (stakeholders in design and delivery)	ETF, 2023a; ATAS, 2026, recommendation 7
W8	Assess competences in authentic situations: fault diagnosis on real or simulated equipment, documentation of an intervention, communication with a clinical interlocutor, management of a maintenance plan, with the transversal outcomes of U5 and U6 assessed and not only taught	B17, dimension 7 of the Lighthouse framework	ETF, 2023a, annex 8; Elemtiez, 2026b, section 8
W9	Design a recognition of prior learning route for holders of the BTS and for technicians in post, linked to the micro-credentials of W1, and align the units of the profile with their European EQF level 5 counterparts for the double degree, the Italian ITS Academy profile in the biomedical field and the Spanish Técnico Superior en Electromedicina Clínica (Real Decreto 838/2015), with the workload of each unit expressed in hours or credits	B10, E2; section 5.4	VBI; INT-LA-04
W10	Adopt the ESCO occupation 3114.1.5, medical device engineering technician, as the reference occupation for the curriculum, and complement it with the digital health competences of units U2, U3 and U7, which no ESCO profile of this family covers	Section 1.3.3; annex A, Table A.3	ITS; this report, sections 1.3.3 and 3.1

5.6 Recommendations for policy enhancement

The qualification will not be adopted by curriculum design alone. The institutional barriers of section 4.2 and the socio-economic barriers of section 4.5 are matters for the Ministry of Vocational Training and Employment, the ATFP, CENAFFIF and the Ministry of Health, and the recommendations below, numbered P1 to P8, are addressed to them. They draw on what the authorities themselves proposed in the interviews and on the recommendations of the stakeholder consultation.

Table 5.6. Recommendations for policy enhancement.

No.	Recommendation	Responds to	Proposed by
P1	Pursue the referencing of the national classification of qualifications to the EQF, starting from the qualifications where the learning-outcome analysis already argues an alignment, and position the new qualification explicitly at EQF level 5 and at the corresponding national level from its creation	B10; ETF conclusion on referencing (2.2)	INT-LA-01, INT-LA-03; ATAS, 2026, recommendation 11
P2	Develop a bilateral recognition framework between Tunisia and Italy for the biomedical qualification, as proposed by the ministry, and use the double degree of the MeDCare project as its first case	B10; E8	INT-LA-01

No.	Recommendation	Responds to	Proposed by
P3	Shorten the cycle of qualification revision for fields exposed to rapid technological change, by allowing certified modules and micro-credentials to be added to a qualification between two full revisions through a lighter procedure that involves employers, and use the validity of the current accreditation file of the BTS, which runs to 24 June 2027, as the window for accrediting the 2019 programme and positioning the new qualification	B8, B1	Elemtiez, 2026a, section 8; INT-VET-05
P4	Open a progression route from the BTS and the new qualification to higher education, which today exists for BTP holders and not for BTS graduates	B10	INT-LA-04
P5	Adopt a structured continuing professional development and succession plan for the biomedical trainers of the public system, with the external recruitment competition planned for 2027 to 2028 brought forward and linked to the new qualification	B3, B4	INT-LA-04; ATAS, 2026, recommendations 5 and 6
P6	Programme the renewal of training equipment at the sole provider, and prepare the opening of the specialty to a second site or to accredited private providers once the qualification exists, so that national demand is not met by a single centre in Tunis	B5, B12, B15	ATAS, 2026, recommendation 9; INT-LA-01
P7	Provide accommodation and mobility support for learners from governorates other than Tunis, as the ministry has begun to do, and monitor its take-up by women	B15; 4.6 indirect factors	INT-LA-01, INT-VET-02, INT-VET-03; ATAS, 2026, recommendation 12
P8	Establish a tracer system for graduates of the biomedical qualifications, so that employment outcomes rest on data and not on the divergent accounts recorded in this study	Divergence on employability (4.8)	This report, section 5.1

5.7 Recommendations for VET providers and healthcare organisations

The enablers of section 4.7 are in the hands of the training centre and of the hospitals, clinics, Ministry of Health structures and suppliers that employ its graduates. The recommendations below, numbered O1 to O6, state what each can do within its own remit while the curriculum is developed.

Table 5.7. Recommendations for the training provider and for healthcare organisations.

No.	Recommendation	Addressed to	Responds to
O1	Convert the existing placement arrangements into partnership agreements that cover placements with objectives and tutoring, access of trainers to current equipment, participation of practitioners in teaching and assessment, and the loan or shared use of equipment for training	Training centre with hospitals, Ministry of Health structures and suppliers	B13, E3; Elemtiez, 2026a, section 8
O2	Make supplier training on newly acquired equipment reach more than one or two technicians, by requiring in acquisition contracts the training of the whole team or the production of training material, and by organising internal transfer sessions after each supplier training	Healthcare organisations	B14, E4 (knowledge concentrated in one or two technicians)
O3	Open supplier and manufacturer training sessions held in facilities to the centre's trainers, so that the trainers meet current equipment where it is installed	Healthcare organisations and suppliers with the training centre	B4, B5
O4	Organise the maintenance service by equipment family with a named technician responsible for each, and use the new qualification's options by equipment family to build that specialisation	Healthcare organisations	B11, B14; 3.6 emergent requests

No.	Recommendation	Addressed to	Responds to
O5	Give biomedical technicians protected time for continuing development, and recognise the micro-credentials of the new qualification in internal career progression, so that the development of competences sustains the employability on which the sector already relies	Healthcare organisations, in particular private clinics	B19, B18; E2
O6	Use the Tunisian Framework for Entrepreneurial VET Centres as a self-assessment tool to position the centre on the dimensions that this study found decisive, partnerships, stakeholder participation, experiential pedagogy and trainer support, and to plan its progression	Training centre	ETF, 2023a, annex 3; section 5.2

5.8 Conclusions and hand-over to work package 3

Work package 3 receives from this report a stakeholder-tested competence perimeter of twenty-seven competences and ten emergent ones, mapped against the judgements of the system and the market and against the existing programmes (chapter 3 and annex C); a barrier and enabler analysis with the conditions under which the qualification can be delivered (chapter 4); seven competence clusters and a draft profile of seven units with learning outcomes at EQF level 5 (sections 5.3 and 5.4); and three sets of recommendations addressed respectively to the curriculum developers, to the authorities and to the provider and the healthcare organisations (sections 5.5 to 5.7). The profile is a draft: its units, learning outcomes and weights are indicative, and it falls to work package 3 to complete the matrix, to write the final learning outcomes with action verbs and assessment criteria (Cedefop, 2017), and to build the modules, the assessment framework and the certification process from it.

Three points deserve the attention of the curriculum developers before anything else:

1. The digital units are the reason for the qualification and the part of it that no existing programme teaches, and they can be taught only if the trainers are trained first and the equipment, the partnerships or the simulation that give access to connected devices are in place.
2. The technical foundation is the asset on which the qualification stands, and the field asks that it be preserved and brought up to date, not reduced to make room for the new content.
3. The institutional route of the qualification, its level in the national classification, its referencing to the EQF, its progression and its recognition, is as much a condition of its success as the curriculum, and has to be pursued in parallel with the design.

The evidence behind these conclusions has the limits stated in section 1.8: one provider, one governorate, the vocational training side of governance more fully than the health side, the absence of learners and recent graduates among the participants (section 5.1), and the small number of women among the focus group participants, which limits what the evidence can support on gender. Within those limits, the three strands of evidence agree on what the qualification should contain and on what stands in the way of teaching it, and that agreement is the basis on which work package 3 can proceed.

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Annex A. Competence card set

This annex records the competence card set used in the two focus groups (T2.3) and the competences that participants proposed beyond it. The set is the instrument behind the card-sorting exercise described in section 1.4 and behind the competence mapping in chapter 3, and it is reproduced here so that the map can be read against the perimeter it started from (competence card set; Research Design v1.0, section 2.5).

Twenty-seven predefined cards were used, in three domains: ten technical competences, eight digital health competences and nine managerial and transversal competences. Nineteen of the twenty-seven were taken from the ESCO occupation profiles 2149.5 (bioengineer) and 2149.5.1 (biomedical engineer); Table A.3 gives the ESCO skill or knowledge item from which each of them was drawn. The other eight, which make up the digital health domain, were added by MeDCare to cover the digitalisation of medical technology that neither ESCO profile addresses (competence card set; source register, row I3). Every card was printed in French and Arabic and colour-coded by domain, and four further blank cards let participants propose competences of their own (competence card set; focus group protocol v1). The perimeter itself rests on the two profiles narrowed and downscaled to EQF 5; how it was arrived at is set out in sections 1.4 and 3.1 and is not repeated here.

Table A.1. The twenty-seven predefined competence cards.

No.	Domain	Competence	Definition	Source
N1	Technical	Biomedical Engineering Principles	Understand the fundamentals of engineering applied to biological systems and medical technologies.	ESCO 2149.5; 2149.5.1
N2	Technical	Medical Device Maintenance and Repair	Perform preventive and corrective maintenance of biomedical equipment in healthcare facilities.	ESCO 2149.5; 2149.5.1
N3	Technical	Equipment Calibration and Testing	Execute calibration, verification and testing procedures for medical devices according to applicable standards.	ESCO 2149.5; 2149.5.1
N4	Technical	Laboratory Techniques and Simulations	Master laboratory techniques and use simulation tools to test and validate medical equipment.	ESCO 2149.5; 2149.5.1
N5	Technical	Interpretation of Technical Drawings (2D/3D)	Read and interpret technical plans and schematics related to biomedical devices and installations.	ESCO 2149.5
N6	Technical	Product Data Management	Manage technical documentation, product sheets and traceability data for medical devices.	ESCO 2149.5; 2149.5.1
N7	Technical	Computer Simulation for Medical Applications	Use simulation software to model, test and optimise biomedical solutions.	ESCO 2149.5
N8	Technical	Good Manufacturing Practices (Medical Devices)	Apply manufacturing and quality control standards specific to medical devices.	ESCO 2149.5
N9	Technical	Safety Compliance and Legislation	Ensure compliance with safety standards and regulations applicable to medical technologies.	ESCO 2149.5
N10	Technical	Design and Prototyping of Technical Solutions	Contribute to the design and prototyping of solutions adapted to local clinical needs.	ESCO 2149.5; 2149.5.1
N11	Digital health	Health Information Systems (HIS) Management	Configure, use and maintain health information systems deployed in healthcare facilities.	MeDCare
N12	Digital health	Telemedicine Technologies	Install, configure and provide technical support for telemedicine platforms and tools.	MeDCare

No.	Domain	Competence	Definition	Source
N13	Digital health	IoT and Connected Medical Devices	Manage networks of connected medical devices, including configuration, monitoring and troubleshooting.	MeDCare
N14	Digital health	Data Protection in Health Contexts	Apply rules for the protection of personal health data and patient confidentiality.	MeDCare
N15	Digital health	Digital Troubleshooting and Remote Diagnostics	Diagnose and resolve technical problems in digital medical equipment remotely.	MeDCare
N16	Digital health	Electronic Health Records Management	Administer and maintain electronic health record (EHR) systems in healthcare facilities.	MeDCare
N17	Digital health	Medical Software and Application Management	Install, configure, update and troubleshoot software used in clinical environments.	MeDCare
N18	Digital health	Cybersecurity in Healthcare Environments	Identify cybersecurity risks and apply protective measures in digital health systems.	MeDCare
N19	Managerial and transversal	Documentation and Reporting	Write technical reports, document interventions and ensure traceability of activities.	ESCO 2149.5; 2149.5.1
N20	Managerial and transversal	Quality Assurance Procedures	Implement and follow quality control and assurance procedures in the biomedical context.	ESCO 2149.5
N21	Managerial and transversal	Evidence-Based Practice	Use data and scientific literature to guide technical and professional decisions.	ESCO 2149.5; 2149.5.1
N22	Managerial and transversal	Team Coordination and Interprofessional Communication	Work effectively within multidisciplinary teams in hospital and technical environments.	ESCO 2149.5.1
N23	Managerial and transversal	Communication with Clinical Staff and Patients	Communicate clearly with doctors, nurses and patients about the technical aspects of equipment.	ESCO 2149.5.1
N24	Managerial and transversal	Problem-Solving and Critical Thinking	Analyse complex situations, identify root causes and propose appropriate solutions.	ESCO 2149.5.1
N25	Managerial and transversal	Continuous Professional Development	Commit to lifelong learning to keep competences up to date.	ESCO 2149.5.1
N26	Managerial and transversal	Project and Resource Management	Plan, organise and monitor activities and resources within biomedical projects.	ESCO 2149.5.1
N27	Managerial and transversal	Regulatory Awareness and Compliance	Monitor evolving standards and regulations applicable to the biomedical sector and ensure compliance.	ESCO 2149.5

Nineteen cards are drawn from the ESCO profiles 2149.5 and 2149.5.1 (the ten technical and the nine managerial and transversal competences) and eight from MeDCare (the digital health competences).

Table A.2 lists the competences proposed beyond the twenty-seven cards. The reconciliation follows the consolidated competence mapping grid prepared for annex C. Each proposal keeps the source that raised it; competences that the two groups did not themselves reconcile are kept distinct; and none is folded into the twenty-seven cards. Whether any enters the draft competence profile is taken up in chapter 5. On the instrument the four blank cards were numbered 28 to 31, and both groups reused these numbers for different proposals, so the emergent competences are identified here

by name and source rather than by card number (emergent rows, annex C mapping grid; Focus Group 1 and Focus Group 2 Analytical Reports, section 6; healthcare-sector interview sheets).

Table A.2. Emergent competences proposed beyond the card set, reconciled by source.

Emergent competence	Source	Notes
Applied artificial intelligence	Both focus groups	The only emergent proposal common to both groups (Elemtiez, 2026a, section 6; Elemtiez, 2026b, section 6). Introductory competence on the use of data, assisted maintenance and equipment diagnosis, with its limitations and risks.
Predictive maintenance	System actors' group (FG1)	Elemtiez, 2026a, section 6. Using equipment data to anticipate failures, plan interventions and reduce downtime.
Digital twin principle	System actors' group (FG1)	Elemtiez, 2026a, section 6. Understanding the digital twin principle to simulate the operation and ageing of medical equipment.
Statistical process control	Market actors' group (FG2)	Elemtiez, 2026b, section 6. Analysis of the quality, reliability and performance of maintenance processes.
Clinical and anatomical knowledge by equipment family	Market actors' group (FG2)	Elemtiez, 2026b, section 6. Understanding the clinical use of equipment and its risks, by equipment family. Compare 2019 programme module M02 (anatomy and physiology).
Device regulation and conformity (certificate of conformity)	Employer interviews	Named in four sheets (INT-HF-01, 02, 06, 15). Interpreting a certificate of conformity and regulatory requirements. Overlaps cards N9 and N27; kept distinct as a recurring employer request.
Reading of manufacturer technical documentation	Employer interviews and FG2	Named in four sheets (INT-HF-05, 10, 11, 14) and by the market actors' group (Elemtiez, 2026b, section 3) as a language and openness factor. Reading technical manuals and manufacturer documentation.
Medical biology for laboratory equipment	Employer interviews	Named by the two laboratory-equipment suppliers (INT-HF-07, 08). Enough medical biology and knowledge of the human body to interpret laboratory results. INT-HF-07 also joined the market focus group, so not independent interview and focus-group convergence.
Medical gas systems	Employer interview	A single but specific request for a dedicated module (INT-HF-02).
Technical biomedical English	Market actors' group (FG2)	Elemtiez, 2026b, section 3. Proposed alongside the reading of manufacturer documentation but kept distinct. Not named in any interview. The 2008 programme has module M13 (apply technical English); in the 2019 programme English sits within the soft-skills block.

The competences are listed in the order used in the annex C grid, the two focus groups' proposals first and the employer additions after. Where a proposal overlaps an existing card, that is stated so that no competence is counted twice.

Table A.3 records, for each of the nineteen ESCO-derived cards, the skill or knowledge items of the two anchor profiles from which it was drawn, and the corresponding items of the ESCO occupation 3114.1.5, medical device engineering technician, to which section 1.3.3 relates the narrowed perimeter. Items are quoted as ESCO lists them; E marks an essential and O an optional item, S a skill or competence and K a knowledge item. A dash means that the profile lists no item corresponding to the card.

Table A.3. ESCO items of origin of the nineteen ESCO-derived cards, and the corresponding items of ESCO occupation 3114.1.5.

No.	Card	ESCO 2149.5 bioengineer	ESCO 2149.5.1 biomedical engineer	ESCO 3114.1.5 medical device engineering technician
N1	Biomedical engineering principles	engineering principles (E-K); biomedical engineering (O-K)	biomedical engineering, engineering principles (E-K)	biomedical engineering (E-K)
N2	Medical device maintenance and repair	medical devices materials (O-K)	medical devices materials (E-K)	maintain medical devices, repair medical devices, perform maintenance on installed equipment (E-S)
N3	Equipment calibration and testing	develop test procedures (O-S); test procedures (O-K)	develop test procedures (E-S); test procedures (E-K)	test medical devices, use measurement instruments, use testing equipment (E-S); medical device test procedures (E-K)
N4	Laboratory techniques and simulations	perform laboratory tests, run laboratory simulations (O-S); laboratory techniques (O-K)	perform laboratory tests (O-S); laboratory techniques (O-K)	–
N5	Interpretation of technical drawings (2D/3D)	interpret 2D plans, interpret 3D plans, use technical drawing software (O-S)	–	read engineering drawings (E-S); design drawings (E-K)
N6	Product data management	product data management (O-K)	product data management (O-K)	–
N7	Computer simulation for medical applications	computer simulation (O-K)	–	–
N8	Good manufacturing practices (medical devices)	advise on manufacturing problems (O-S); pharmaceutical manufacturing quality systems, statistical process control (O-K)	–	manufacture medical devices, inspect quality of products (E-S); quality standards (O-K)
N9	Safety compliance and legislation	ensure compliance with safety legislation (O-S)	–	medical device regulations (E-K); advise on safety improvements, prepare compliance documents (O-S)
N10	Design and prototyping of technical solutions	design prototypes, develop product design, draft design specifications (O-S)	design prototypes, develop product design, draft design specifications (O-S)	prepare production prototypes (E-S)

No.	Card	ESCO 2149.5 bioengineer	ESCO 2149.5.1 biomedical engineer	ESCO 3114.1.5 medical device engineering technician
N19	Documentation and reporting	document analysis results (O-S)	draft scientific or academic papers and technical documentation (O-S)	record test data (E-S); write technical reports, write inspection reports, write records for repairs (O-S)
N20	Quality assurance procedures	statistical process control, pharmaceutical manufacturing quality systems (O-K)	–	inspect quality of products (E-S); quality standards (O-K)
N21	Evidence-based practice	apply scientific methods (O-S); scientific literature, scientific research methodology (O-K)	apply scientific methods, synthesise information (E-S); scientific research methodology (E-K)	consult technical resources, assist scientific research (E-S)
N22	Team coordination and interprofessional communication	–	interact professionally in research and professional environments (E-S)	liaise with engineers (E-S)
N23	Communication with clinical staff and patients	–	communicate with a non-scientific audience (O-S)	apply technical communication skills, advise on medical device features (O-S)
N24	Problem-solving and critical thinking	–	think abstractly, synthesise information (E-S)	resolve equipment malfunctions (E-S); perform ICT troubleshooting (O-S)
N25	Continuous professional development	–	manage personal professional development (E-S)	–
N26	Project and resource management	–	perform project management (E-S)	order supplies, estimate restoration costs (O-S)
N27	Regulatory awareness and compliance	ensure compliance with safety legislation, ensure compliance with environmental legislation (O-S)	–	medical device regulations (E-K); prepare compliance documents, provide legal information on medical devices (O-S)

Source: ESCO occupation pages for bioengineer (2149.5), biomedical engineer (2149.5.1) and medical device engineering technician (3114.1.5), ESCO v1.2 (European Commission, n.d.-a, n.d.-b, n.d.-c). The 3114.1.5 column covers ten of the nineteen cards in its essential layer (N1, N2, N3, N5, N8, N9, N10, N19, N20, N27) and lists no item for N4, N6, N7 and N25.

Annex B. Participant profiles

This annex lists the twenty-six interview respondents and the thirteen focus group participants by code. Public institutions are named; hospitals, clinics and private companies are given by organisation type; individuals are never identifiable. Codes correspond to the interview sheets and to the focus group analytical reports. INT-LA-01 and INT-LA-03 were two officials interviewed in a single joint session and are counted as two respondents in one session. Within the healthcare category, three respondents are Ministry of Health structures and two are private laboratory-equipment companies; these sub-groups are kept visible throughout the analysis. One interview respondent, INT-HF-07, also took part in focus group 2, where he appears as MC006, so the two records are not independent sources and the barrier matrix marks this. Blocks not covered in an interview are treated as absent data (section 1.5.3).

Table B.1. Interview respondents: category, institution, role, gender, governorate, date, duration, guide, mode and recording.

Code	Category	Institution or organisation type	Role or title	Gender	Governorate	Date	Duration	Guide	Mode	Recorded
INT-HF-01	Healthcare	Ministry of Health	Senior official, maintenance function	M	Tunis	10/07/2026	27 min	A	In person	Yes
INT-HF-02	Healthcare	Public hospital	Biomedical engineering technician	F	Tunis	11/07/2026	25 min	A	In person	Yes
INT-HF-03	Healthcare	Public hospital	Head of maintenance department	F	Tunis	11/07/2026	38 min	A	In person	Yes
INT-HF-04	Healthcare	Private clinic	Head of equipment maintenance department	M	Tunis	09/07/2026	Not recorded	A	In person	No
INT-HF-05	Healthcare	Private clinic	Maintenance department manager	M	Tunis	14/07/2026	Not recorded	A	In person	No
INT-HF-06	Healthcare	National Agency for Medicines and Health Products	Technical dossier evaluator, importation	M	Tunis	14/05/2026	22 min	A	In person	Yes
INT-HF-07	Healthcare	Private laboratory-equipment company	General manager and biomedical technician	M	Tunis	14/07/2026	22 min	A	In person	Yes
INT-HF-08	Healthcare	Private laboratory-equipment company	Company manager	M	Tunis	14/05/2026	10 min	A	In person	Yes
INT-HF-09	Healthcare	Public hospital	Head of maintenance department	F	Tunis	08/07/2026	22 min	A	In person	Yes
INT-HF-10	Healthcare	Private clinic	Manager of maintenance department	F	Tunis	17/06/2026	25 min	A	In person	Yes
INT-HF-11	Healthcare	Public hospital	Head of maintenance department	F	Tunis	07/07/2026	43 min	A	In person	Yes
INT-HF-12	Healthcare	Public hospital	Head of maintenance department	M	Tunis	10/07/2026	26 min	A	In person	Yes
INT-HF-13	Healthcare	Public hospital	Head of maintenance departments	M	Tunis	09/07/2026	42 min	A	In person	Yes
INT-HF-14	Healthcare	Public hospital	Head of maintenance department	M	Tunis	08/07/2026	25 min	A	In person	Yes
INT-HF-15	Healthcare	Centre for Technical Studies and Hospital Biomedical Maintenance (*Centre des études*	Senior management	M	Tunis	03/07/2026	37 min	A	In person	Yes

		techniques et de maintenance biomédicale hospitalière), Ministry of Health								
INT-VET-01	VET provider	CSFEMEB (ATFP)	Trainer	F	Tunis	03/06/2026	26 min	B	In person	Yes
INT-VET-02	VET provider	CSFEMEB (ATFP)	Trainer	F	Tunis	14/06/2026	41 min	B	Online	Yes
INT-VET-03	VET provider	CSFEMEB (ATFP)	Pedagogical coordination and programme development	M	Tunis	15/07/2026	35 min	B	Online	Yes
INT-VET-04	VET provider	CSFEMEB (ATFP)	Trainer	F	Tunis	15/07/2026	45 min	B	Online	Yes
INT-VET-05	VET provider	CSFEMEB (ATFP)	Retired trainer	F	Tunis	14/07/2026	37 min	B	Online	Yes
INT-VET-06	VET provider	CSFEMEB (ATFP)	Trainer, electronics specialisation	M	Tunis	03/06/2026	18 min	B	In person	Yes
INT-VET-07	VET provider	CSFEMEB (ATFP)	Trainer	M	Tunis	03/06/2026	42 min	B	In person	Yes
INT-LA-01	Authority	Ministry of Vocational Training and Employment	Senior official, directorate-general level	M	Tunis	31/07/2026	1 h 13 min	C	Online, joint session with INT-LA-03	Yes
INT-LA-02	Authority	ATFP	Senior official, guidance and support	M	Tunis	10/06/2026	18 min	C	In person	Yes
INT-LA-03	Authority	Ministry of Vocational Training and Employment	Senior official, directorate-general level	M	Tunis	31/07/2026	1 h 13 min	C	Online, joint session with INT-LA-01	Yes
INT-LA-04	Authority	CSFEMEB (ATFP)	Senior management	M	Tunis	17/06/2026	31 min	C	In person	Yes

Source: the 26 interview sheets (INT-HF-01 to 15, INT-VET-01 to 07, INT-LA-01 to 04), header forms. Guide A = healthcare facilities; Guide B = VET providers; Guide C = authorities. "Not recorded" indicates that the sheet states no duration was recorded. For the six interviews conducted online, the governorate shown is that of the respondent's institution. The date on the INT-LA-01 sheet is written 31/072026 and is read as 31/07/2026, consistent with INT-LA-03, which records the same joint session

Table B.2. Focus group participants: group, code, profile and gender.

Code	Group	Profile	Gender
Mc01	Focus group 1	Director of systems and standardisation	M
Mc02	Focus group 1	Director of standardisation systems	F
Mc03	Focus group 1	Deputy director, Ministry of Vocational Training and Employment	F
Mc04	Focus group 1	Biomedical trainer	M
Mc05	Focus group 1	Biomedical trainer	M
MC001	Focus group 2	Sales and distribution manager	M
MC002	Focus group 2	Regulatory affairs manager	M
MC003	Focus group 2	Executive director	M
MC004	Focus group 2	Representative of a national employers' organisation, telemedicine and e-health division	M
MC005	Focus group 2	Company manager	M
MC006	Focus group 2	Managing director, private laboratory-equipment company (also interviewed as INT-HF-07)	M
MC007	Focus group 2	General manager	M
MC008	Focus group 2	Biomedical technician	F

Source: Focus Group 1 and Focus Group 2 Analytical Reports, section 1. Both sessions were held on 14 May 2026, 11.00 to 13.00, at CSFEMEB in Tunis. Focus group 1 had five participants, three men and two women; focus group 2 had eight, seven men and one woman. Women are therefore three of the thirteen participants, below the 40% target of the research design, a limitation reported in sections 1.5 and 1.8. The gender of MC001 is recorded as "H" on the source table and is read as male.

Annex C. Consolidated competence mapping grid

This annex reproduces the consolidated competence mapping grid on which chapter 3 is based. Table C.1 gives, for each of the twenty-seven cards and for the emergent competences, the relevance and coverage ratings of the two focus groups, their top-five selections, the employer count from the fifteen healthcare-sector interviews and the reinforcement priority, assigned with the rule stated in section 3.5. Table C.2 maps each card onto the modules of the 2008 programme in use and the 2019 programme awaiting accreditation, and records what the trainers report as taught or absent. Table C.3 states, for each employer count, the counting criterion and the sheets that mention the competence, so that every count used in chapter 3 can be checked against its source.

Three conventions apply throughout. 'Not rated' means that the group gave no coverage rating for that card, since each group rated only a subset of cards; it is not a claim that the competence is uncovered. 'Not classified' means that the group gave no relevance vote. In the employer count, PROXY marks a count for a closely related wording and not for the card in its exact sense, and an empty cell means that no sheet named the competence under a defensible criterion. Four cards (N13, N14, N20, N24) are those on which both groups rated coverage and their ratings differ; they are reported as disagreements. Contested cards (N8, N18, N21, N24) are treated in section 3.7.

Table C.1. Consolidated competence mapping grid: relevance, coverage, top-five selections, employer count and reinforcement priority.

No.	Competence	Domain	Source	Relevance, system actors (FG1)	Relevance, market actors (FG2)	Coverage FG1	Coverage FG2	Top five FG1	Top five FG2	Employer count /15	Reinforcement priority
N1	Biomedical engineering principles	Technical	ESCO 2149.5; 2149.5.1	Essential	Essential	Not rated	Partial	Yes	Yes (block N1-N3)	13	High
N2	Medical device maintenance and repair	Technical	ESCO 2149.5; 2149.5.1	Essential	Essential	Partial	Not rated	Yes	Yes (block)	4	High
N3	Equipment calibration and testing	Technical	ESCO 2149.5; 2149.5.1	Essential	Essential	Not rated	Not rated	No	Yes (block)	2	Medium
N4	Laboratory techniques and simulations	Technical	ESCO 2149.5; 2149.5.1	Important	Essential	Not rated	Not rated	No	No	2	Medium
N5	Interpretation of technical drawings (2D/3D)	Technical	ESCO 2149.5	Essential	Essential	Not rated	Not rated	No	No		Medium
N6	Product data management	Technical	ESCO 2149.5; 2149.5.1	Essential	Essential	Not rated	Not rated	Yes	No		Medium
N7	Computer simulation for medical applications	Technical	ESCO 2149.5	Important	Essential	Not rated	Not rated	No	No		Medium

No.	Competence	Domain	Source	Relevance, system actors (FG1)	Relevance, market actors (FG2)	Coverage FG1	Coverage FG2	Top five FG1	Top five FG2	Employer count /15	Reinforcement priority
N8	Good manufacturing practices (medical devices)	Technical	ESCO 2149.5	Essential	Important	Not rated	Partial	No	No		Contested (3.7)
N9	Safety compliance and legislation	Technical	ESCO 2149.5	Essential	Essential	Partial	Not rated	No	No	4	High
N10	Design and prototyping of technical solutions	Technical	ESCO 2149.5; 2149.5.1	Important	Important	Not rated	Not rated	No	No		Not determined
N11	Health information systems (HIS) management	Digital health	MeDCare	Essential	Essential	Not covered	Not rated	No	Yes	6	High
N12	Telemedicine technologies	Digital health	MeDCare	Essential	Essential	Not rated	Not rated	Yes	No	3	Medium
N13	IoT and connected medical devices	Digital health	MeDCare	Essential	Essential	Not covered	Partial	Yes	No	8	High
N14	Data protection in health contexts	Digital health	MeDCare	Important	Essential	Partial	Not covered	No	No		High
N15	Digital troubleshooting and remote diagnostics	Digital health	MeDCare	Important	Essential	Not rated	Not rated	No	Yes	3	Medium
N16	Electronic health records management	Digital health	MeDCare	Important	Essential	Not rated	Partial	No	No		High
N17	Medical software and application management	Digital health	MeDCare	Essential	Essential	Not covered	Not rated	No	No	3	High
N18	Cybersecurity in healthcare environments	Digital health	MeDCare	Not relevant (as specialisation)	Important	Not covered	Not rated	No	No	2	Contested (3.7)
N19	Documentation and reporting	Managerial & transversal	ESCO 2149.5; 2149.5.1	Essential	Essential	Not rated	Not rated	No	No	8	Medium
N20	Quality assurance procedures	Managerial & transversal	ESCO 2149.5	Essential	Important	Partial	Covered	No	No	4	High
N21	Evidence-based practice	Managerial & transversal	ESCO 2149.5; 2149.5.1	Not classified	Not relevant	Not rated	Covered	No	No		Contested (3.7)

No.	Competence	Domain	Source	Relevance, system actors (FG1)	Relevance, market actors (FG2)	Coverage FG1	Coverage FG2	Top five FG1	Top five FG2	Employer count /15	Reinforcement priority
N22	Team coordination and interprofessional communication	Managerial & transversal	ESCO 2149.5.1	Not classified	Essential	Not rated	Not rated	No	Yes	4	Medium
N23	Communication with clinical staff and patients	Managerial & transversal	ESCO 2149.5.1	Important	Essential	Not rated	Not rated	No	No	8	Medium
N24	Problem-solving and critical thinking	Managerial & transversal	ESCO 2149.5.1	Essential / Important (disagreement)	Important	Covered	Partial	No	Yes	3	Contested (3.7)
N25	Continuous professional development	Managerial & transversal	ESCO 2149.5.1	Essential	Important	Partial	Not rated	No	No	4	High
N26	Project and resource management	Managerial & transversal	ESCO 2149.5.1	Essential	Important	Not rated	Partial	No	No	2	High
N27	Regulatory awareness and compliance	Managerial & transversal	ESCO 2149.5	Not classified	Essential	Partial	Not rated	No	No	4	High
	Emergent competences (not card-sorted: relevance, coverage and top five do not apply)										
N28	Applied artificial intelligence	Emergent	Both FG1 and FG2	Proposed	Proposed	-	-	-	-		-
N29 (FG1)	Predictive maintenance	Emergent	FG1	Proposed	-	-	-	-	-		-
N30 (FG1)	Digital twin principle	Emergent	FG1	Proposed	-	-	-	-	-		-
N29 (FG2)	Statistical process control	Emergent	FG2	-	Proposed	-	-	-	-		-
N30 (FG2)	Clinical and anatomical knowledge by equipment family	Emergent	FG2	-	Proposed	-	-	-	-		-
INT-a	Medical gas systems	Emergent	Employer interview	-	-	-	-	-	-	1	-

No.	Competence	Domain	Source	Relevance, system actors (FG1)	Relevance, market actors (FG2)	Coverage FG1	Coverage FG2	Top five FG1	Top five FG2	Employer count /15	Reinforcement priority
INT-b	Medical biology for laboratory equipment	Emergent	Employer interviews	-	-	-	-	-	-	2	-
INT-c	Device regulation and conformity (certificate of conformity)	Emergent	Employer interviews	-	-	-	-	-	-	4	-
INT-d1	Reading of manufacturer technical documentation	Emergent	Employer interviews (and Elemtiez, 2026b, section 3)	-	-	-	-	-	-	4	-
INT-d2	Technical biomedical English	Emergent	Elemtiez, 2026b, section 3 only	-	Raised (Elemtiez, 2026b, section 3)	-	-	-	-		-

Source: Focus Group 1 and Focus Group 2 Analytical Reports (Elemtiez, 2026a, 2026b), sections 4, 5 and 7; healthcare-sector interview sheets INT-HF-01 to 15 (ATAS, 2026). Reinforcement priority as defined in section 3.5.

Table C.2. Mapping of the cards onto the modules of the 2019 and 2008 programmes, trainers' account and notes.

No.	Competence	2019 programme modules	2008 programme modules	Trainers' account (INT-VET)	Notes
N1	Biomedical engineering principles	M07	M03, M04, M07, M08, M09	Basic technical foundations (electronics, electrical engineering, automation, mechanics) taught and considered solid (INT-VET-01,03,05,06,07).	Employer count is a PROXY (near-universal expectation of 'a strong technical foundation'), not a specific gap. Strongest employer count of the grid. VET module exists but training equipment dates around 2000, so coverage is nominal (INT-VET-02,03,05).
N2	Medical device maintenance and repair	M11, M12	M18, M19, M22	Maintenance and repair taught; but professionals note advanced electronics could be reduced in favour of fault diagnosis, as repair now often means replacing electronic boards (INT-VET-01).	Practised across the BTS but on outdated equipment; INT-VET-01: repair now often means replacing electronic boards.
N3	Equipment calibration and testing	none identified	M27	Not singled out; practical calibration limited by outdated equipment (INT-VET-02,05).	Employer count is a gap signal only (INT-HF-06,13): shortage of staff able to calibrate independently.

No.	Competence	2019 programme modules	2008 programme modules	Trainers' account (INT-VET)	Notes
N4	Laboratory techniques and simulations	M04	M24	Laboratory equipment covered in specialised workshops, on ageing equipment (INT-VET-04,05).	Dedicated module exists (NR III). Groups differ: FG1 important, FG2 essential.
N5	Interpretation of technical drawings (2D/3D)	none identified	none identified	Reading technical diagrams stressed as central to maintenance logic (INT-VET-05).	No interview or VET confirmation of coverage; gap intensity not determinable.
N6	Product data management	M23	M29	Not specifically named by trainers.	FG1 top-5, FG2 not; no dedicated module beyond technical-file modules; employer signal overlaps N19.
N7	Computer simulation for medical applications	none identified	none identified	Simulation/virtual training proposed but not yet provided; no VR (INT-VET-03,04,06).	Groups differ (FG1 important, FG2 essential); no VET module identified.
N8	Good manufacturing practices (medical devices)	none identified	none identified	Not taught; no device-manufacturing content (market is service/after-sales, INT-VET-05).	Contested: FG1 essential; FG2 important with an internal split (manufacturing vs hospital maintenance).
N9	Safety compliance and legislation	M17	M16	Safety and hygiene taught; regulations/standards noted as partly missing/needing update (INT-VET-01,03).	Module exists (quality norms/standards). Count = regulations/standards + electrical safety.
N10	Design and prototyping of technical solutions	none identified	none identified	Not taught.	No VET or employer confirmation; lowest-evidenced technical card.
N11	Health information systems (HIS) management	none identified	none identified	Digital/health-informatics competences 'almost absent' from the current programme (INT-VET-01,03); trainers not prepared (INT-VET-05).	No 2019 BTS module; NR states digital health will not be covered. Count = health informatics/IT networks.
N12	Telemedicine technologies	none identified	none identified	Not covered; no digital-health content yet integrated (INT-VET-01,03,05).	Asymmetry: FG1 essential and top-5 yet gives no coverage rating; no module identified.
N13	IoT and connected medical devices	none identified	none identified	Connected equipment/embedded systems identified as missing or insufficiently developed (INT-VET-04,07).	Highest digital employer count. Coverage DISAGREEMENT: FG1 not covered vs FG2 partial.
N14	Data protection in health contexts	none identified	none identified	Not covered (digital competences almost absent, INT-VET-01,03).	Coverage DISAGREEMENT: FG1 partial vs FG2 not covered. Count is a PROXY (data management/interpretation), not data protection specifically. Employer cell now empty: no sheet names data protection specifically (see Employer trace).

No.	Competence	2019 programme modules	2008 programme modules	Trainers' account (INT-VET)	Notes
N15	Digital troubleshooting and remote diagnostics	none identified	none identified	Remote communication with equipment named as a needed but under-developed competence (INT-VET-04,07).	FG2 essential and top-5; FG1 important with a noted divergence (some see it as learned through experience). Count = tele-maintenance/remote support, incl. lab companies INT-HF-07,08. INT-HF-07 (also FG2 participant) and INT-HF-08 are laboratory-supply respondents; count reflects a strict telemaintenance/remote-diagnostics criterion (3, not 5).
N16	Electronic health records management	none identified	none identified	Not covered (INT-VET-01,03).	More often present as facility infrastructure than named as a competence (see 2.7). Count = stated competence only. Employer cell now empty: EHR appears as facility infrastructure, not a stated competence (see Employer trace).
N17	Medical software and application management	none identified	none identified	Applications/software for maintenance monitoring named as a growing need, not yet taught (INT-VET-04,07).	No module; FG1 records a coverage gap.
N18	Cybersecurity in healthcare environments	none identified	none identified	Not covered; trainers not specialists in cybersecurity (INT-VET-06).	Contested: FG1 not relevant as a specialisation but a basic level agreed for all technicians; FG2 important, mandatory applied basic level.
N19	Documentation and reporting	M13, M23	M15, M29	Documentation/technical-file and workplace communication taught (INT-VET-01,02,03).	Second-highest employer count. Module exists (technical-file management); delivery depth not confirmed.
N20	Quality assurance procedures	M16, M24, M26	M27	Quality control taught and considered a strength; no major gap in QC reported (INT-VET-07).	Coverage DISAGREEMENT: FG1 partial vs FG2 good. FG2 votes important but calls it essential in a regulated environment.
N21	Evidence-based practice	none identified	none identified	Not taught as such.	Contested. FG1 does not classify it; FG2 votes not relevant yet rates good coverage - the report itself flags this as methodologically sensitive and recommends reformulation.
N22	Team coordination and interprofessional communication	M13	M15	Workplace communication taught as a transversal module (INT-VET-01,02,03).	FG1 silent on the vote; FG2 essential and top-5. Count is a PROXY (teamwork).
N23	Communication with clinical staff and patients	M13, M14	M15	Workplace communication taught; French and English language skills included (INT-VET-01,02,03).	Highest transversal employer count. Count is a PROXY (communication). Communication modules exist.
N24	Problem-solving and critical thinking	none identified	none identified	Not a distinct module; developed through practical work and internships (INT-VET-04,05).	Contested: coverage DISAGREEMENT (FG1 covered vs FG2 partial); FG1 internal split on the vote; FG2 important but core competency and in top-5. Count is a PROXY (autonomy).

No.	Competence	2019 programme modules	2008 programme modules	Trainers' account (INT-VET)	Notes
N25	Continuous professional development	none identified	none identified	Concerns trainers more than students: continuous professional development for trainers is 'almost non-existent' (INT-VET-02,03,05,06,07).	Interview evidence concerns trainers more than students. Count is a PROXY (motivation/willingness to learn).
N26	Project and resource management	M16, M18	M20, M22, M23	Managerial modules and soft skills named among the main gaps (INT-VET-03).	INT-VET-03 names managerial modules among the main gaps; low employer count.
N27	Regulatory awareness and compliance	M17	M16, M28	Regulations/standards partly missing or in need of update (INT-VET-01,03).	Asymmetry: FG1 rates coverage but gives no relevance vote. Overlaps N9. Count = regulations/standards.
	Emergent competences				
N28	Applied artificial intelligence	-	-	-	Only emergent point of agreement between the two groups (Elemtiez, 2026a, section 6, Elemtiez, 2026b, section 6). Suggested integration: introductory module on simple maintenance-data cases. Also raised in interviews (INT-HF-13,15 name artificial intelligence).
N29 (FG1)	Predictive maintenance	-	-	-	Elemtiez, 2026a, section 6 only; kept separate from FG2's proposals. Workshops on failure histories and performance indicators.
N30 (FG1)	Digital twin principle	-	-	-	Elemtiez, 2026a, section 6 only. Advanced module or pilot with a supplier or hospital.
N29 (FG2)	Statistical process control	-	-	-	Elemtiez, 2026b, section 6 only; kept separate from FG1's proposals.
N30 (FG2)	Clinical and anatomical knowledge by equipment family	-	-	-	Elemtiez, 2026b, section 6 only. Module contextualised by equipment family. Compare 2019 programme M02 (anatomy and physiology).
INT-a	Medical gas systems	-	-	-	Single employer request (INT-HF-02): stressed a dedicated module on medical gas systems.
INT-b	Medical biology for laboratory equipment	-	-	-	INT-HF-07 and INT-HF-08 (both laboratory-supply companies). INT-HF-07 (a diagnostics company) is also FG2 participant MC006: do not read as independent focus-group / interview convergence.
INT-c	Device regulation and conformity (certificate of conformity)	-	-	-	INT-HF-01,02,06,15. Overlaps N9 and N27; kept distinct as a recurring employer request.

No.	Competence	2019 programme modules	2008 programme modules	Trainers' account (INT-VET)	Notes
INT-d1	Reading of manufacturer technical documentation	-	-	-	Split from former INT-d. INT-HF-05,10,11,14 (read technical manuals / documentation). Also raised in Elemtiez, 2026b, section 3 (training in reading manufacturers' documentation).
INT-d2	Technical biomedical English	-	-	-	Split from former INT-d. Elemtiez, 2026b, section 3 only ('Introduce technical biomedical English'). No INT-HF sheet mentions English or languages, so the employer cell is empty by design. 2008 programme module M13 (Apply Technical English) exists; 2019 English is within the soft-skills block.

Source: module codes from the National Report, part III (ATFP, 2026); trainers' account from the vocational-training interview sheets INT-VET-01 to 07 (ATAS, 2026), blocks 'Competences currently taught' and 'Curriculum content and relevance'.

Table C.3. Employer count: counting criterion and sheets mentioning each competence.

Card	Competence	Counting criterion (wordings that count as a mention)	Sheets that mention it (INT-HF-)	Count /15
N1	Biomedical engineering principles	Mentions of biomedical/technical engineering fundamentals, 'strong technical basics/foundation', 'good technical basics', 'solid technical foundation' as an expected competence. [PROXY]	INT-HF-01, INT-HF-02, INT-HF-04, INT-HF-05, INT-HF-06, INT-HF-07, INT-HF-08, INT-HF-10, INT-HF-11, INT-HF-12, INT-HF-13, INT-HF-14, INT-HF-15	13
N2	Medical device maintenance and repair	Explicit mention of preventive and/or corrective maintenance and repair of medical devices as a task or expected competence.	INT-HF-08, INT-HF-09, INT-HF-10, INT-HF-14	4
N3	Equipment calibration and testing	Explicit mention of calibration/testing/verification as a needed competence or an identified gap.	INT-HF-06, INT-HF-13	2
N4	Laboratory techniques and simulations	Mention of laboratory techniques/technologies as an expected competence of the technician (not merely lab equipment present in the facility).	INT-HF-07, INT-HF-08	2
N5	Interpretation of technical drawings (2D/3D)	Explicit mention of reading/interpreting technical drawings, plans, schematics (2D/3D).	: (none; cell left empty)	
N6	Product data management	Mention of managing product data / product sheets / traceability data (distinct from writing reports = N19).	: (none; cell left empty)	
N7	Computer simulation for medical applications	Mention of computer simulation software for medical applications.	: (none; cell left empty)	
N8	Good manufacturing practices (medical devices)	Contested card (3.7). Mention of good manufacturing practice / manufacturing quality-control standards for device manufacture.	: (none; cell left empty)	

Card	Competence	Counting criterion (wordings that count as a mention)	Sheets that mention it (INT-HF-)	Count /15
N9	Safety compliance and legislation	Mention of safety compliance/standards/regulations or electrical safety of biomedical equipment as an expected competence.	INT-HF-02, INT-HF-03, INT-HF-04, INT-HF-05	4
N10	Design and prototyping of technical solutions	Mention of design/prototyping of technical solutions.	: (none; cell left empty)	
N11	Health information systems (HIS) management	Mention of health information systems / health informatics / IT networks as a needed digital competence.	INT-HF-06, INT-HF-10, INT-HF-11, INT-HF-13, INT-HF-14, INT-HF-15	6
N12	Telemedicine technologies	Explicit mention of telemedicine as a needed/relevant competence or technology (distinct from telemaintenance = N15).	INT-HF-08, INT-HF-09, INT-HF-11	3
N13	IoT and connected medical devices	Mention of connected/IoT medical devices, interfacing, connected equipment as a needed competence.	INT-HF-04, INT-HF-05, INT-HF-10, INT-HF-11, INT-HF-12, INT-HF-13, INT-HF-14, INT-HF-15	8
N14	Data protection in health contexts	Explicit mention of health-data protection / patient confidentiality / data protection. PROXY where only generic 'data management' is named.	: (none; cell left empty)	
N15	Digital troubleshooting and remote diagnostics	Explicit mention of telemaintenance / remote diagnostics / remote technical support of equipment.	INT-HF-07, INT-HF-08, INT-HF-11	3
N16	Electronic health records management	Mention of electronic health/medical records management as a stated technician competence (not merely EHR present as facility infrastructure).	: (none; cell left empty)	
N17	Medical software and application management	Mention of medical/device software or applications management as a needed competence.	INT-HF-04, INT-HF-05, INT-HF-15	3
N18	Cybersecurity in healthcare environments	Contested card (3.7). Explicit mention of cybersecurity / digital security.	INT-HF-11, INT-HF-14	2
N19	Documentation and reporting	Mention of documentation/reporting, documenting interventions, equipment records, technical documentation management as a competence or gap.	INT-HF-04, INT-HF-05, INT-HF-06, INT-HF-07, INT-HF-10, INT-HF-11, INT-HF-13, INT-HF-14	8
N20	Quality assurance procedures	Mention of quality assurance/quality control as an expected competence.	INT-HF-06, INT-HF-07, INT-HF-11, INT-HF-13	4
N21	Evidence-based practice	Contested card (3.7). Mention of evidence-based practice / use of data and scientific literature to guide decisions.	: (none; cell left empty)	
N22	Team coordination and interprofessional communication	Mention of teamwork / working within multidisciplinary teams / interprofessional coordination. PROXY (teamwork). [PROXY]	INT-HF-03, INT-HF-06, INT-HF-11, INT-HF-13	4
N23	Communication with clinical staff and patients	Mention of communication with clinical staff / doctors / nurses / suppliers / between departments. PROXY (communication). [PROXY]	INT-HF-03, INT-HF-04, INT-HF-05, INT-HF-07, INT-HF-10, INT-HF-13, INT-HF-14, INT-HF-15	8

Card	Competence	Counting criterion (wordings that count as a mention)	Sheets that mention it (INT-HF-)	Count /15
N24	Problem-solving and critical thinking	Contested card (3.7). Mention of problem-solving / analysing a technical problem / autonomy in diagnosis / critical thinking. PROXY (autonomy/problem-solving). [PROXY]	INT-HF-05, INT-HF-10, INT-HF-14	3
N25	Continuous professional development	Mention of continuous professional development / willingness to learn / keep skills up to date. PROXY (motivation/willingness to learn). [PROXY]	INT-HF-09, INT-HF-10, INT-HF-13, INT-HF-14	4
N26	Project and resource management	Mention of project/resource management, maintenance management, maintenance contracts as an expected competence.	INT-HF-11, INT-HF-15	2
N27	Regulatory awareness and compliance	Mention of medical-device regulations, standards, certifications, regulatory monitoring/compliance as an expected competence.	INT-HF-01, INT-HF-02, INT-HF-06, INT-HF-15	4
INT-a	Medical gas systems	Explicit request for a medical gas systems module/competence.	INT-HF-02	1
INT-b	Medical biology for laboratory equipment	Explicit mention of medical biology / knowledge of the human body / interpreting laboratory results for laboratory equipment.	INT-HF-07, INT-HF-08	2
INT-c	Device regulation and conformity (certificate of conformity)	Explicit mention of certificate of conformity / device regulation and conformity as a distinct recurring employer request.	INT-HF-01, INT-HF-02, INT-HF-06, INT-HF-15	4
INT-d1	Reading of manufacturer technical documentation	Explicit mention of reading/understanding manufacturer technical documentation or technical manuals.	INT-HF-05, INT-HF-10, INT-HF-11, INT-HF-14	4
INT-d2	Technical biomedical English	Explicit mention of English / languages / technical biomedical English.	: (none; cell left empty)	

Notes on specific counts. N1: the near-universal expectation of a strong technical foundation is counted as a PROXY and read as a relevance signal, not as a specific gap. N14 (data protection) and N16 (electronic health records management): no sheet names the competence specifically; mentions of data management and of electronic records as infrastructure are not counted as the card. N15: under a strict telemaintenance and remote-diagnostics criterion the count is three (INT-HF-07, 08, 11); INT-HF-07, who also took part in focus group 2 as MC006, and INT-HF-08 are laboratory-supply respondents, and the remote reading in radiology reported by INT-HF-12 is a facility technology rather than a competence asked of the technician. N23 and N22: communication with clinical staff and suppliers is counted under N23 and teamwork or interprofessional work under N22, both as PROXY counts, so a sheet may appear in both. INT-d1 and INT-d2: the reading of manufacturer documentation is named in INT-HF-05, 10, 11 and 14 and by focus group 2 (section 3); technical English is named by focus group 2 only, so its employer cell is empty. INT-b: INT-HF-07 is also focus group participant MC006, so this is not independent convergence between the interviews and the focus groups.

Source: healthcare-sector interview sheets INT-HF-01 to 15 (ATAS, 2026), blocks 'Skills gaps and deficits', 'Competences needed for EQF 5', 'Employer expectations' and 'Digital health and emerging technologies'. A sheet counts once per card if it mentions the competence in any of the four blocks.

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