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Master level competences according to EQF and employer satisfaction

Nicolae IONESCU and **Madalin CATANA**

POLITEHNICA University of Bucharest

Contents

- Part 1. Master level competences related to Bachelor and PhD according to EQF
- Part 2. Assessment of graduates competence according to the awareness and satisfaction of employers
- Conclusions

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Introduction

- **European Qualifications Framework (EQF)**

  - relates different countries' national qualifications systems to a common European reference framework

  - permits better understanding and comparison of qualification levels of different countries and different education and training systems

  - defines eight reference levels for describing what a learner knows, understands and is able to do, that is, *learning outcomes*

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Competences according EQF

- **Descriptors for defining levels in the EQF** – acc. Council Recommendation of 22.05.2017

Levels	Knowledge	Skills	Responsibility and autonomy
Level 6 (**) The learning outcomes relevant to Level 6 are **BACHELOR**	***advanced knowledge*** of a field of work or study, involving a critical understanding of theories and principles	***advanced skills***, demonstrating mastery and innovation, required to solve ***complex and unpredictable problems*** in a specialized field of work or study	manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study ***contexts*** take responsibility for managing professional ***development of individuals and groups***
Level 7 (***) The learning outcomes relevant to Level 7 are **MASTER**	***highly specialized knowledge***, some of which is at the forefront of knowledge in a field of work or study, as the basis for original thinking and/or research critical awareness of knowledge issues in a field and at the interface between different fields	***specialized problem***-solving skills required in research and/or innovation in order to develop new knowledge and procedures and to integrate knowledge from different fields	manage and transform work or study ***contexts*** that are complex, unpredictable and require ***new strategic approaches*** take responsibility for contributing to professional knowledge and practice and/or for reviewing the ***strategic performance of teams***
Level 8 (****) The learning outcomes relevant to Level 8 are **PhD**	***knowledge at the most advanced frontier*** of a field of work or study and at the interface between fields	***the most advanced and specialized skills*** and techniques, including synthesis and evaluation, required to solve ***critical problems*** in research and/or innovation and to extend and redefine existing knowledge or professional practice	demonstrate substantial authority, innovation, autonomy, scholarly and professional integrity and sustained commitment to the ***development of new ideas or processes*** at the forefront of work or study ***contexts including research***

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Competences according EQF

- **Implementation of EQF in Romania** – acc. Romanian National Qualification Framework

Learning outcomes		Generic descriptors	BACHELOR	MASTER'S	PhD
Professional Competences	Cognitive dimension	1. Knowledge, understanding and use of specific language	***Knowledge and understanding*** of ***basic concepts, theories and methods*** within the field and the specialisation area; their adequate use in professional communication.	***In-depth knowledge of a specialisation area*** and, within it, of the programme specific theoretical, methodological and practical developments; appropriate use of specific language in communication with different professional environments.	***Systematic, advanced knowledge*** of concepts, research methods, controversies and new hypotheses specific to the field; communication with specialists in related fields.
		2. Explanation and interpretation	Use of ***basic knowledge*** to explain and interpret various types of ***concepts, situations, processes, projects*** etc. that are related to the field.	Use of ***specialised knowledge*** in order to explain and interpret ***new situations***, in ***wider contexts*** associated to the respective field.	Use of ***advanced principles and methods*** to explain and interpret, from multiple perspectives, ***new and complex*** theoretical and practical ***situations***/ problems specific to the field.

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Competences according EQF

- **Implementation of EQF in Romania** – acc. Romanian National Qualification Framework

Learning outcomes		Generic descriptors	BACHELOR	MASTER'S	PhD
Professional Competences	**Functional – actional dimension**	3. Application, transfer and problem solving	***Use of basic principles and methods*** for solving ***problems***/situations that are ***typical*** to the field, with partial qualified assistance.	***Integrated use of conceptual and methodological*** apparatus in incompletely defined situations in order to solve ***new*** theoretical and practical ***problems***.	***Selection and application of new*** principles, advanced theories and methods of knowledge, transfer of knowledge from one domain to another, ***interdisciplinary approaches*** to solve ***new and complex*** theoretical and practical ***problems***.
		4. Critical and constructive reflection	***Adequate use of standard assessment*** criteria and methods to ***appraise*** the quality, merits and limitations of processes, programmes, projects, concepts, methods and theories.	***Pertinent and appropriate use of assessment*** criteria and methods to formulate judgements and fundament ***constructive decisions***.	***Critically-constructive evaluation*** of the projects and the results of the scientific research, ***appreciation*** of the theoretical and methodological knowledge stage, ***identification*** of the knowledge and applicative ***priorities of the field***.
		5. Creativity and innovation	Development of ***professional projects*** by using ***well–known principles and methods*** within the field.	Development of ***professional and/ or research projects*** using a ***wide range*** of qualitative and quantitative ***methods*** in an ***innovative manner***.	Conceiving and carrying out ***original research***, based on ***advanced methods***, leading to the ***development of scientific knowledge***, technological and/or research methodologies.

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Competences according EQF

- **Implementation of EQF in Romania** – acc. Romanian National Qualification Framework

Learning outcomes		Generic descriptors	BACHELOR	MASTER'S	PhD
Transversal competences	Role competences	6. Autonomy and responsibility	Responsible performance of ***professional tasks*** in an autonomous manner, with ***qualified supervision***.	Undertaking ***complex professional tasks*** under autonomy and professional ***independence conditions***.	***Innovative initiation and development*** of theoretical and practical ***complex projects***.
		7. Social interaction	***Familiarisation with the teamwork***-specific roles and activities and with task allocation for subordinated levels (individuals or groups).	***Assuming management roles***/functions for the activities of professional groups or institutions.	***Assuming responsibility*** and ability ***to organize and manage*** the activity of professional groups, ***scientific research***, or institutions.
	Personal and professional development competences	8. Personal and professional development	***Awareness of the need*** for continuing ***training***, efficient use of learning techniques and resources for personal and professional development.	***Self-control*** of the learning process, diagnosis of training needs, reflective analysis on own professional activity.	Developing ***creativity-centered*** projects as a basis for ***self-realization***.

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Case study #1: Implementing EQF in Romanian Higher Education

- **Romanian National Qualifications Framework for Higher Education (NQFHE)**

  - developed under the coordination of the National Authority for Qualifications (ANC)

  - issued with the participation of POLITEHNICA University of Bucharest, the National Committee of Professional Qualifications (NCPQ) of France, the University of Bucharest, representative employers, professional associations and other stakeholders

  - uses a competences' grid specific for each study program, namely, *G1M grid*

  - G1M grid is used by each faculty to develop a detailed *G2 grid* for each study program, which shows the correlation among professional and transversal competences, content areas, study disciplines and credits allocated

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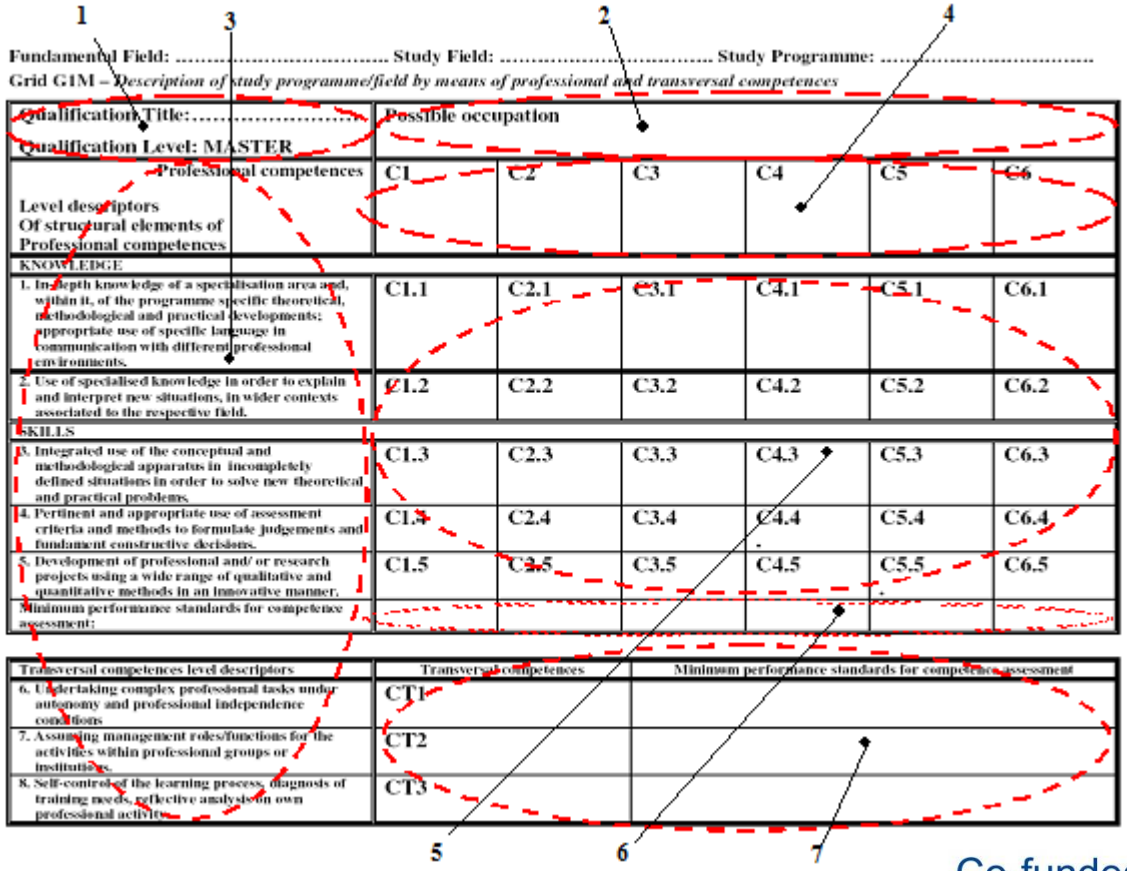
Case study #1: Implementing EQF in Romanian Higher Education

- **Structure of G1M grid used by Romanian NQFHE**



Fundamental Field: ..... Study Field: ..... Study Programme: .....

Grid G1M – *Description of study programme/field by means of professional and transversal competences*

Qualification Title: ..... Qualification Level: MASTER	Possible occupation					
Professional competences / Level descriptors Of structural elements of Professional competences	C1	C2	C3	C4	C5	C6
KNOWLEDGE						
1. In-depth knowledge of a specialisation area and, within it, of the programme specific theoretical, methodological and practical developments; appropriate use of specific language in communication with different professional environments.	C1.1	C2.1	C3.1	C4.1	C5.1	C6.1
2. Use of specialised knowledge in order to explain and interpret new situations, in wider contexts associated to the respective field.	C1.2	C2.2	C3.2	C4.2	C5.2	C6.2
SKILLS						
3. Integrated use of the conceptual and methodological apparatus in incompletely defined situations in order to solve new theoretical and practical problems.	C1.3	C2.3	C3.3	C4.3	C5.3	C6.3
4. Pertinent and appropriate use of assessment criteria and methods to formulate judgements and fundament constructive decisions.	C1.4	C2.4	C3.4	C4.4	C5.4	C6.4
5. Development of professional and/ or research projects using a wide range of qualitative and quantitative methods in an innovative manner.	C1.5	C2.5	C3.5	C4.5	C5.5	C6.5
Minimum performance standards for competence assessment:						

Transversal competences level descriptors	Transversal competences	Minimum performance standards for competence assessment
6. Undertaking complex professional tasks under autonomy and professional independence conditions	CT1	
7. Assuming management roles/functions for the activities within professional groups or institutions.	CT2	
8. Self-control of the learning process, diagnosis of training needs, reflective analysis on own professional activity	CT3	

LEGEND

1) Qualification title and the level of qualification – Master
2) Possible occupations in the Catalogue of Occupations in Romania (COR)
3) Level descriptors of competences based on the framework matrix of NQFHE Methodology
4) Six professional competences (C1, C2, C3, C4, C5, C6)
5) Detailed definition of each competence through level descriptors
6) Minimal standards of performance for each competence
7) Three transversal competences (CT1, CT2, CT3) and minimal corresponding performance standards

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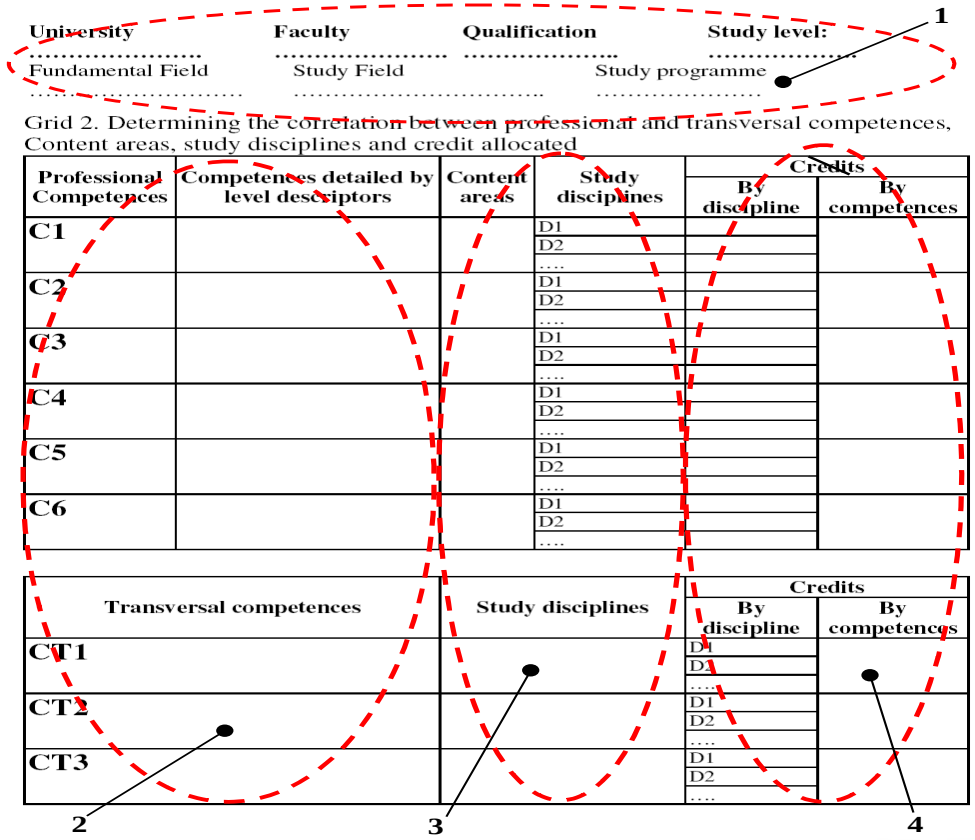
Master level competences related to Bachelor and PhD according to EQF

Case study #1: Implementing EQF in Romanian Higher Education

- **Structure of G2 grid for a study program in a Romanian university**



University ..... Faculty ..... Qualification ..... Study level: .....

Fundamental Field ..... Study Field ..... Study programme .....

1

Grid 2. Determining the correlation between professional and transversal competences, Content areas, study disciplines and credit allocated

Professional Competences	Competences detailed by level descriptors	Content areas	Study disciplines	Credits: By discipline	Credits: By competences
C1			D1 D2		
C2			D1 D2		
C3			D1 D2		
C4			D1 D2		
C5			D1 D2		
C6			D1 D2		

Transversal competences	Study disciplines	Credits: By discipline	Credits: By competences
CT1		D1 D2	
CT2		D1 D2	
CT3		D1 D2	

2 3 4

LEGEND

1) Data concerning the university, faculty, qualification, study level etc.
2) Professional competences, with explicit description by level descriptors, and transversal competences from grid G1M
3) Content area and study disciplines
4) Credits allocated by discipline and by competence

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Master level competences related to Bachelor and PhD according to EQF

Case study #2: Establishing competences of INPN Master study program graduates related to NSN Bachelor study program graduates

- **Level of professional competences**

	NSN Bachelor	INPN Master
C1	Performing calculations, demonstrations and applications to solve specific industrial engineering tasks based on knowledge of fundamental sciences.	Solving complex tasks specific to Industrial Engineering domain, using advanced knowledge of engineering sciences.
C2	Associating the knowledge, principles and methods of technical sciences of the Industrial Engineering field with graphic representations for solving specific tasks.	Mathematical and experimental modelling and optimization of technological processes, in general, and of those specific to non-conventional systems and nanostructures, in particular.
C3	Utilisation of software applications and digital technologies to solve specific industrial engineering tasks, in general, and tasks specific to nanotechnologies and non-conventional systems, in particular.	Use of advanced integrated software for solving complex tasks, mainly specific to non-conventional systems and nanotechnologies.
C4	Design of manufacturing technological flow, including mainly nanotechnologies and non-conventional methods and processes.	Conceptual and detailed design of manufacturing technologies and complex industrial systems, optimized, innovative, mainly specific to non-conventional processes and nanotechnologies.
C5	Design of manufacturing equipment for technological flows mainly specific to nanotechnology and non-conventional systems.	Conceptual and detailed design of complex technological systems and equipment, mainly specific to nanotechnologies and non-conventional processes.
C6	Planning, management and exploitation of manufacturing processes and systems, and inspection and quality assurance of products.	The design and development of the innovative products, the design, assurance and valorisation of their quality.

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Master level competences related to Bachelor and PhD according to EQF

Case study #2: Establishing competences of INPN Master study program graduates related to NSN Bachelor study program graduates

- **Level of "Knowledge, understanding and use of specific language" descriptor**

	NSN Bachelor	INPN Master
C1	**C1.1.** Proper identification of concepts, principles, theorems and basic methods in mathematics, physics, chemistry, technical drawing and computer programming.	**C1.1.** Identification and detailed description of a wide range of concepts, principles, theorems and methods of basic engineering sciences (mathematics, physics, chemistry, drawing, etc.).
C2	**C2.1.** Defining principles and methods for the basic sciences of industrial engineering associated with the graphics-technical drawing.	**C2.1.** Definition and detailed description of a wide range of optimization methods and mathematical and experimental modelling.
C3	**C3.1.** Identify concepts, theories and basic methods in the field of computer programming and applied informatics, mainly in the field of nanotechnology and non-conventional systems.	**C3.1.** Identification of concepts, theories and basic methods in the domain of software applications and modelling-simulation in particular for the nano-technology, and non-conventional systems.
C4	**C4.1.** Identify concepts, theories, methods and basic principles of design of the technological processes with operations mainly achieved through specific methods of nanotechnology and non-conventional systems.	**C4.1.** Identification of a wide range of theories, methods and basic principles for the conceptual design and detail design of technologies and complex industrial systems, in particular for the nanotechnology, and non-conventional systems.
C5	**C5.1.** Description of concepts, theories, methods and basic principles of the design of the technology equipment of manufacturing for operations carried out mainly by specific methods and processes specific for nanotechnology, and non-conventional systems.	**C5.1.** Identification of a wide range of theories, methods and basic principles for the conceptual design and detail design of technologies and complex industrial systems, in particular for the nanotechnology, and non-conventional systems.
C6	**C6.1.** Description of concepts, theories, methods and basic principles of planning, management and operation of manufacturing processes and systems, quality assurance and product inspection.	**C6.1**. Identification and detailed description of a wide range of product development methods, methods of design, achievement and valorising of the quality of products.

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Master level competences related to Bachelor and PhD according to EQF

Case study #2: Establishing competences of INPN Master study program graduates related to NSN Bachelor study program graduates

- **Level of "Explanation and interpretation" descriptor**

	NSN Bachelor	INPN Master
C1	**C1.2.** Use basic knowledge of fundamental subjects for explanation and interpretation of theoretical results, theorems, phenomena or processes specific to industrial engineering.	**C1.2.** Highly detailed explanation and interpretation of the possibilities of application of the basic concepts, principles, theorems and methods of engineering sciences in the new industrial projects related to engineering, with multiple hypotheses.
C2	**C2.2.** Use knowledge of basic engineering sciences for explaining and interpreting the theoretical and experimental results, detail design drawings and layout plans, phenomena and processes specific to industrial engineering.	**C2.2.** Extension / extrapolation of applying the main methods of optimization and mathematical and experimental modelling new processes, mainly specific to nanostructures and non-conventional systems.
C3	**C3.2.** Use basic knowledge associated with software and digital technologies for explanation and interpretation of issues arising in design and computer aided design of products, processes and technologies in theoretical and experimental investigation and computerized data processing specific to industrial engineering in general, nanotechnologies and non-conventional systems, in particular.	**C3.2.** Explaining and interpreting in detail the possible use of the software in computer-aided design of products, processes and technologies, in modelling, simulation and computer processing of data specific mainly of nanotechnologies, nanostructures and non-conventional systems.
C4	**C4.2.** Using the basic knowledge to explain and interpret different types of manufacturing technological processes with operations mainly achieved through specific methods and processes for nanotechnologies and non-conventional systems.	**C4.2.** Using expertise knowledge for explanation and interpretation of new uses of technology and complex industrial systems, optimized, innovative, specific to the nanotechnology- and non-conventional processes.
C5	**C5.2.** Use the basic knowledge to explain and interpret different types of projects relating to manufacturing equipment for operations conducted mainly by specific methods and processes specific to nanotechnologies and non-conventional systems.	**C5.2.** Using the expertise knowledge to explain and interpret new complex technological systems, specific to nanostructures, nanotechnology and non-conventional processes.
C6	**C6.2.** Use basic knowledge for explanation and interpretation of problems in the domain of planning, management and operation of processes and manufacturing systems, as well as quality assurance issues and product inspection.	**C6.2.** Explaining and interpreting in detail the methodology of developing innovative products and methods of design, insurance, manufacturing and valorising of products quality.

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Master level competences related to Bachelor and PhD according to EQF

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- **Level of "Application, transfer and problem solving" descriptor**

	NSN Bachelor	INPN Master
C1	**C1.3.** Application of theorems, principles and basic methods of fundamental subjects for elementary engineering calculations in design and operation of technical systems, specific to industrial engineering, under qualified assistance.	**C1.3.** Integrated application of a wide range of theorems, principles and methods of the fundamental subjects for developing and designing innovative products, ensuring product quality achievement and promotion.
C2	**C2.3.** Application of principles and methods of basic sciences in industrial engineering, and their association with graphics – technical drawing for resistance calculations, sizing, determining technical requirements, establishing correspondence between specified features and the functional role in specific applications of industrial engineering, under qualified assistance.	**C2.3.** Integrated application of a wide range of methods for optimization of technological processes of nano-processing by mathematical and experimental modelling.
C3	**C3.3.** Applying the basic principles and methods from software programmes and digital technologies for programming, database performance, assisted graphics, modelling, computer aided design products, processes and technologies, investigate and computerized data processing of the specific industrial engineering data in general, nanotechnology and non-conventional systems, in particular, under qualified assistance.	**C3.3.** Integrated application of a wide range of advanced software for programming, performance of database, assisted graphics, simulation, computer-aided design, investigation and computerized data processing, mainly specific for nanostructures and non-conventional systems.
C4	**C4.3.** Applying the basic principles and methods for design of manufacturing processes with operations mainly achieved through specific methods and processes specific to nanotechnology and non-conventional systems, with well-defined inputs under qualified assistance.	**C4.3.** Integrated application of a wide range of principles and methods for conceptual and detailed design of complex industrial technologies and systems, which are optimized and innovative, specific for the nanotechnologies and non-conventional processes.
C5	**C5.3.** Applying the basic principles and methods for the design of manufacturing technological equipment for operations conducted mainly by specific methods of nanotechnology and non-conventional systems, with inputs well-defined, under qualified assistance.	**C5.3.** Integrated application of a wide range of principles and methods for conceptual and detailed design of new complex technological systems, specific for the nanostructures, nanotechnologies and non-conventional processes.
C6	**C6.3.** Applying the basic principles and methods for planning, management and operation of manufacturing processes and systems, as well as for the quality assurance and inspection of products, by providing qualified assistance.	**C6.3.** Integrated application of a wide range of methods for developing innovative products, and designing, ensuring, achievement and valorisation of product quality.

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Master level competences related to Bachelor and PhD according to EQF

Case study #2: Establishing competences of INPN Master study program graduates related to NSN Bachelor study program graduates

- **Level of "Critical and constructive reflection" descriptor**

	NSN Bachelor	INPN Master
C1	**C1.4.** Appropriate use of standard evaluation criteria and methods of the fundamental disciplines for identifying, modelling, analysis, qualitative and quantitative assessment of phenomena and characteristic parameters, as well as for the processing and interpretation of results from specific industrial engineering processes.	**C1.4.** Critical, quantitative and qualitative assessment, as well as recommendation of solutions for various applications.
C2	**C2.4.** Appropriate use of standard evaluation criteria and methods of the basic engineering sciences, for identification, modelling, experimenting, qualitative and quantitative assessment of aspects, phenomena and defining parameters, as well as data collection, processing and interpretation of results from processes specific to industrial engineering.	**C2.4.** Assessment and determining of the most adequate methods for the mathematical and experimental modelling, optimisation of techno-logical processes in general, as well as for nanotechnologies and non-conventional systems, in particular.
C3	**C3.4.** Appropriate use of standard evaluation criteria and methods to assess the quality, advantages and limitations of software programmes and digital technologies for their use in achievement of specific tasks in industrial engineering in general, and nano-technology and non-conventional systems in particular	**C3.4.** Thorough and relevant use of standard evaluation criteria and methods for selecting software for their use in modelling-simulation, of nanotechnologies, nanostructures and non-conventional systems.
C4	**C4.4.** Appropriate use of standard evaluation criteria and methods to assess the quality, advantages and limitations of manufacturing processes with operations mainly achieved through specific methods and nanotechnology and conventional systems.	**C4.4.** Evaluating and determining optimal variants of technologies and complex industrial systems, optimized, innovative, specific for the nanostructures, nanotechnologies and non-conventional processes.
C5	**C5.4.** Appropriate use of standard evaluation criteria and methods to assess the quality, advantages and limitations of manufacturing technological equipment for operations conducted mainly by methods and processes specific to nanotechnologies and non-conventional systems	**C5.4.** Evaluating and determining optimal variants of technologic systems and complex equipment specific for the nanostructures, nanotechnologies and non-conventional processes.
C6	**C6.4.** Appropriate use of standard evaluation criteria and methods to assess the quality, advantages and limitations of the methods of planning, management and operation of manufacturing processes and systems, as well as of the methods of quality assurance and products inspection.	**C6.4.** Comparative evaluation of the innovation degree and quality of products.

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Master level competences related to Bachelor and PhD according to EQF

Case study #2: Establishing competences of INPN Master study program graduates related to NSN Bachelor study program graduates

- **Level of "Creativity and innovation" descriptor**

	NSN Bachelor	INPN Master
C1	**C1.5.** Preparing of models and professional projects specific for the industrial engineering based on the identification, selection and use of principles and optimal methods and specific solutions in fundamental disciplines.	**C1.5.** Conception and preparing of professional and/or research projects and models using innovation in a wide range of theorems, principles and methods of the fundamental disciplines.
C2	**C2.5.** Preparing of professional projects specific for the industrial engineering based on the selection, combination and utilisation of knowledge, principles and methods of basic sciences in the domain of industrial engineering, their association with the graphical representations – technical drawing.	**C2.5.** Preparing research projects, which require mathematical-experimental modelling and optimising
C3	**C3.5.** Preparing of professional projects specific for the industrial engineering in general, for nanotechnologies and non-conventional systems, in particular, based on selection, combining and utilisation of principle, methods, digital technologies, information systems and software tools dedicated to the field.	**C3.5.** Preparing of professional and/or research projects, specific to industrial engineering, in general, and nanotechnologies and non-conventional systems, in particular, using a wide range of methods, digital technologies, information systems and advanced software tools.
C4	**C4.5.** Preparing of professional projects specific for technological manufacturing processes with operations mainly achieved through specific methods of nanotechnologies and non-conventional systems.	**C4.5.** Preparing of professional and/or research projects including technologies and complex optimised innovation industrial systems, specific for nanostructures, nanotechnologies and non-conventional processes.
C5	**C5.5.** Preparing of professional projects of manufacturing technological equipment for operations mainly achieved through specific methods of nanotechnologies and non-conventional systems.	**C5.5.** Preparing of professional and/or research projects of technological systems and complex equipment specific to nanostructures, nanotechnologies and non-conventional processes.
C6	**C6.5.** Preparing of professional projects using the principles and methods specific to the field, relevant for planning, management, and exploitation of processes and manufacturing systems, as well as ensuring quality and product inspection.	**C6.5.** Preparing of professional and/or research projects of successful innovation high performance products.

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Master level competences related to Bachelor and PhD according to EQF

Case study #2: Establishing competences of INPN Master study program graduates related to NSN Bachelor study program graduates

- **Minimal standards of performance for assessing professional competences**

	NSN Bachelor	INPN Master
C1	**Standard**: Correct solving of calculations and complex issues related to fundamental engineering disciplines within specific industrial engineering tasks. **Minimal level:** Solving correct calculations and medium complexity problems related to fundamental disciplines (mathematics, physics, etc.); specific tasks within industrial engineering.	**Standard**: Optimum solving of a wide range of advanced calculations and complex problems related to the fundamental disciplines of engineering in the framework of tasks specific to industrial engineering. **Minimal level**: Correct solving of advanced calculations, as well as complex problems relating with the fundamental disciplines of engineering in the framework of tasks specific to industrial engineering.
C2	**Standard**: Optimal solving of complex problems requiring corroboration of best knowledge in the technical sciences in the domain, with graphical representation by technical drawing. **Minimal level**: Correct solving of average complexity problems that require corroboration of knowledge of technical sciences in the field with graphics – technical drawing (the correct interpretation and representation of drawings - graphic medium complexity, specifying technical conditions, the association of characteristics prescribed and the functional role of surfaces, parts, subassemblies and assemblies, achieving size and resistance calculations, prescribing materials, etc.).	**Standard**: Optimising of different types of technologic processes based on mathematical and experimental solving. **Minimal level**: Mathematical and experimental modelling of the principal technological processes specific to nanotechnologies and non-conventional systems.
C3	**Standard**: Optimal solving of complex problems, mostly in the domain of nanotechnology and non-conventional systems, using operation systems, software equipment, databases and CAD activities **Minimal level**: Correct solving of average complexity problems, mostly in the domain of nanotechnology and non-conventional systems, regarding programming, data base management, experimental data processing, 2D and 3D modelling.	**Standard**: Optimal solving of complex tasks, mainly in the domain of nanostructures, nanotechnologies and non-conventional systems, which require a wide range of advanced software applications. **Minimal level**: Correct solving of tasks, mainly in the domain of nanostructures, nanotechnologies and non-conventional systems, regarding programming, management of data bases, processing of experimental data, 2D and 3D modelling, detailed design of complex industrial products and systems.

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Master level competences related to Bachelor and PhD according to EQF

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- **Minimal standards of performance for assessing professional competences**

	NSN Bachelor	INPN Master
C4	**Standard**: Design of an optimum manufacturing technological process with operations mainly achieved by means of methods and processes specific to nanotechnologies and non-conventional systems. **Minimal level**: Designing of a manufacturing technologic process with operations mainly achieved by means of methods and processes specific to nanotechnologies and non-conventional systems, medium complexity, in the case of working with compulsory data.	**Standard**: Conceptual design and detail design of a manufacturing technology and an optimal complex innovation industrial system that are specific to nanotechnologies and non-conventional processes Minimal level: **Detail design of a manufacturing technology, or an industrial system specific to nanotechnologies and non-conventional processes.**
C5	**Standard**: Design of manufacturing technological equipment for operations mainly achieved by means of methods and processes specific to nanotechnologies and non-conventional systems. **Minimal level**: Design of technological equipment for operations mainly achieved by means of methods and processes specific to nanotechnologies and non-conventional systems, of average complexity, in the case of working with compulsory data.	**Standard**: Preparing of an optimal technologic system project and/or complex technologic equipment specific to nanotechnologies and non-conventional processes. **Minimal level**: Elaboration of a technologic system project specific to nanotechnologies and non-conventional processes.
C6	**Standard**: Optimal solving of issues relating with planning, management and exploitation of processes and systems of manufacturing mainly non-conventional, as well as ensuring the quality and inspection of products. **Minimal level**: Correct solving of average complexity problems regarding planning, management and exploitation of processes and systems of manufacturing mainly non-conventional, as well as quality assurance and product inspection.	**Standard**: Preparing of a successful high-performance innovation product. **Minimal level**: Preparing the development project of a new product, with high quality characteristics.

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Case study #2: Establishing competences of INPN Master study program graduates related to NSN Bachelor study program graduates

- **Level of transversal competences**

NSN Bachelor	INPN Master
CT1. Applying the values and engineer profession ethics and perform the professional duties in an environment of relative autonomy and qualified support. Promoting the logical reasoning, convergent and divergent, the practical applicability, the evaluation and self-evaluation in decision-making.	**CT1.** Apply values and ethics of the profession of engineer and responsible performance of complex professional tasks showing autonomy and professional independence, promoting logical reasoning, convergent and divergent, practical applicability, self-assessment and decision making. (Performance of complex professional duties with high responsibility).
CT2. Carrying out activities and develop roles that are specific for team work on different professional hierarchical levels. Promoting the spirit of initiative, dialogue, co-operation, positive attitude and respect for others, diversity and multiculturalism and continuous activities self-improvement.	**CT2.** Carrying out activities while undertaking the roles specific for the team work performance on different hierarchical levels and assuming leadership roles; promoting initiative, dialogue, cooperation, positive attitude and respect for others, diversity and multiculturalism, continuous improvement of own activity. (Communication, teamwork and assuming of leadership).
CT3. Self-evaluation of the need for continuous professional formation for insertion in the labour market, for adaptation to the dynamic requirements of this market and for personal and professional development. Efficient use of linguistic skills and ICT knowledge.	**CT3.** Objective self-assessment and diagnose of the continuous professional training needs, targeting insertion on the labour market, adaptation to the dynamics of market requirements, as well as personal and professional development. Self-control of learning, effective use of language skills and of the knowledge in the field of information technology and communication. (Manager of owns continuous training).

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Master level competences related to Bachelor and PhD according to EQF

Case study #2: Establishing competences of INPN Master study program graduates related to NSN Bachelor study program graduates

- **Evaluation standards for transversal competences**

	NSN Bachelor	INPN Master
CT1	**Standard:** Preparing yearly projects and licence project. **Minimal level**: preparing yearly projects for products of medium complexity and of the licence project comprising minimum two parts (technological process and equipment) with correct use of bibliography, normative, standards and specific methods, under restricted autonomy and qualified assistance, as well as supporting them by providing demonstration of the qualitative and quantitative assessment capacity with respect to the technical solutions in the domain and to their own achievements.	**Standard:** Achievement of yearly projects and final dissertation, under autonomy status and professional independence. **Minimal level**: Achievement of yearly projects and final dissertation with elements of research and scientific innovation, correct use of bibliography, norms, standards and specific methods, under autonomy status and professional independence, presenting these projects to specialist audience, while proving qualitative and quantitative assessment capacity of technical solutions in the domain, as well as of own achievements.
CT2	**Standard:** Team work achievement of works or projects, identifying and describing the professional roles at team level. **Minimal level**: Achievement by team working of works or projects of medium complexity, with identification and adequate description of professional roles at team level, while observing the main rules of team work.	**Standard:** Achieving and conducting works or team projects, with identification and description of professional role at team level; participation in research works. **Minimal level**: Implementation and management of complex works or group projects, with proper identification and description of professional roles in the team and respect the main attributes of teamwork, participation as a team member in at least one research project.
CT3	**Standard:** Identify the need for professional training, with the critical assessment of own training activity and of the professional development, efficient use of communication resources and professional training (Internet, e-mail, data bases, on-line training courses etc.), including foreign language use. **Minimal level**: Identify the need of professional training, while providing satisfactory assessment of own training activity and professional development, adequate use of communication and professional training resources (Internet, e-mail, data bases, on-line courses etc.), including use of at least one foreign language.	**Standard:** Identifying and diagnosing of the training needs with reflective analysis of own level of training and professional development, self-control of learning and effective use of communication resources and training (Internet, e-mail, databases, online courses etc.), including using foreign languages, publication of scientific papers. **Minimal level:** Identification and diagnosis of training needs, with satisfactory analysis of own level of training and professional development, self-control of learning and appropriate use of communication and training resources (Internet, e-mail, databases, on-line courses, etc.), including using at least one foreign language, and at least two articles published locally.

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Introduction

- **Issues in achieving the expected quality of higher education**

  - failure to design the educational process by recognizing its two different types of clients: students (internal clients); society stakeholders (external clients)

  - failure to implement in the practice of educational process the acquired knowledge, methods and techniques that have been proven highly efficient at international level

  - lack to assess employers level of satisfaction with graduates' competences

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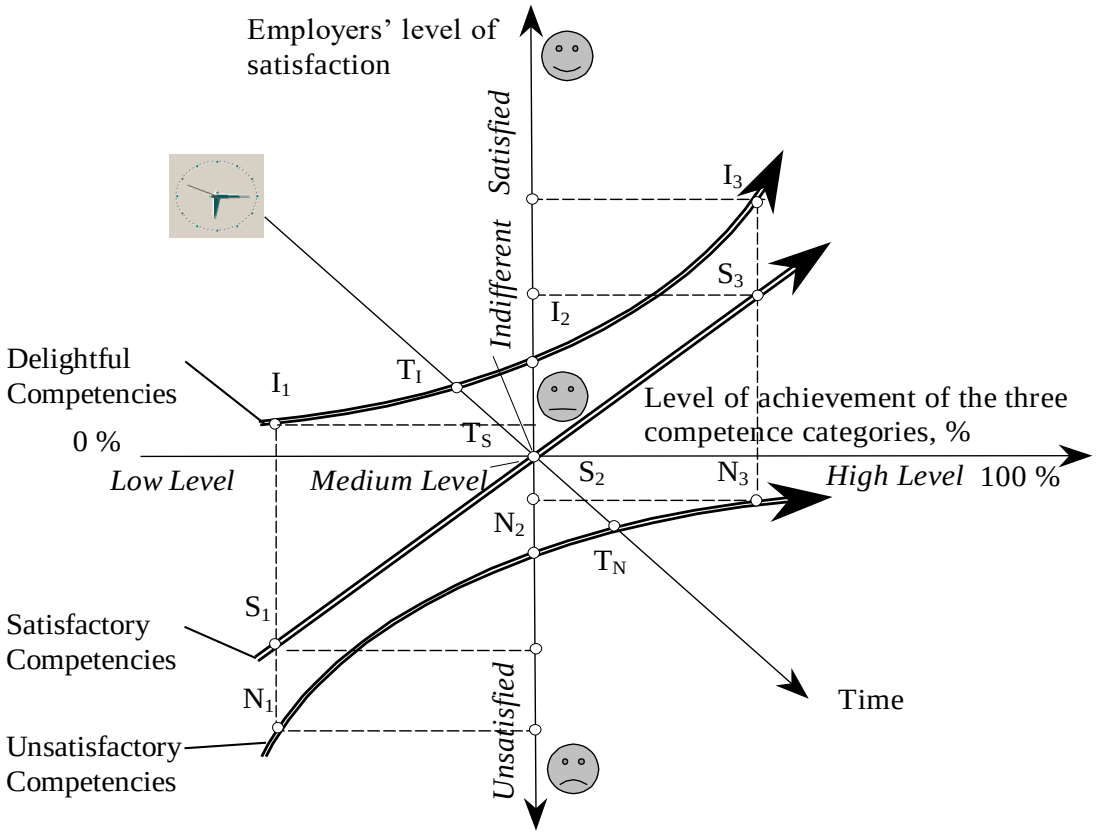
Definition of satisfaction-based graduates' competence

- **Employers' satisfaction function of graduates' competence** – adaptation of Kano model



LEGEND

N_1 - *expected competence* with low level of achievement, when the employer is mostly unsatisfied

N_2 - *expected competence* with medium level of achievement, when the employer is unsatisfied

N_3 - *expected competence* with high level of achievement, when the employer is indifferent because this level is presumed to exist

S_1 - *desired competence* with low level of achievement, when the employer is unsatisfied

S_2 - *desired competence* with medium level of achievement, when the employer is indifferent

S_3 - *desired competence* with high level of achievement, when the employer is satisfied

I_1 - *surprise competence* with low level of achievement, when the employer shows relatively low satisfaction, but not indifference

I_2 - *surprise competence* with medium level of achievement, when the employer has a relatively high satisfaction

I_3 - *surprise competence* with high level of achievement, and high satisfaction of employer

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Definition of satisfaction-based graduates' competence

- **Unsatisfactory (BASIC) graduates' competence** – related to characteristic points N_1, N_2 and N_3 in the model

  - represents the quality of the graduates expected (presumed) to exist by the employers

  - refers to basic knowledge and skills of graduates not questioned about by employers

  - an increasing level of achievement of this type of graduates' competence produces a decreasing level of employers' dissatisfaction, from highest dissatisfaction of point N_1 to indifference (no dissatisfaction, but also no satisfaction) of point N_3

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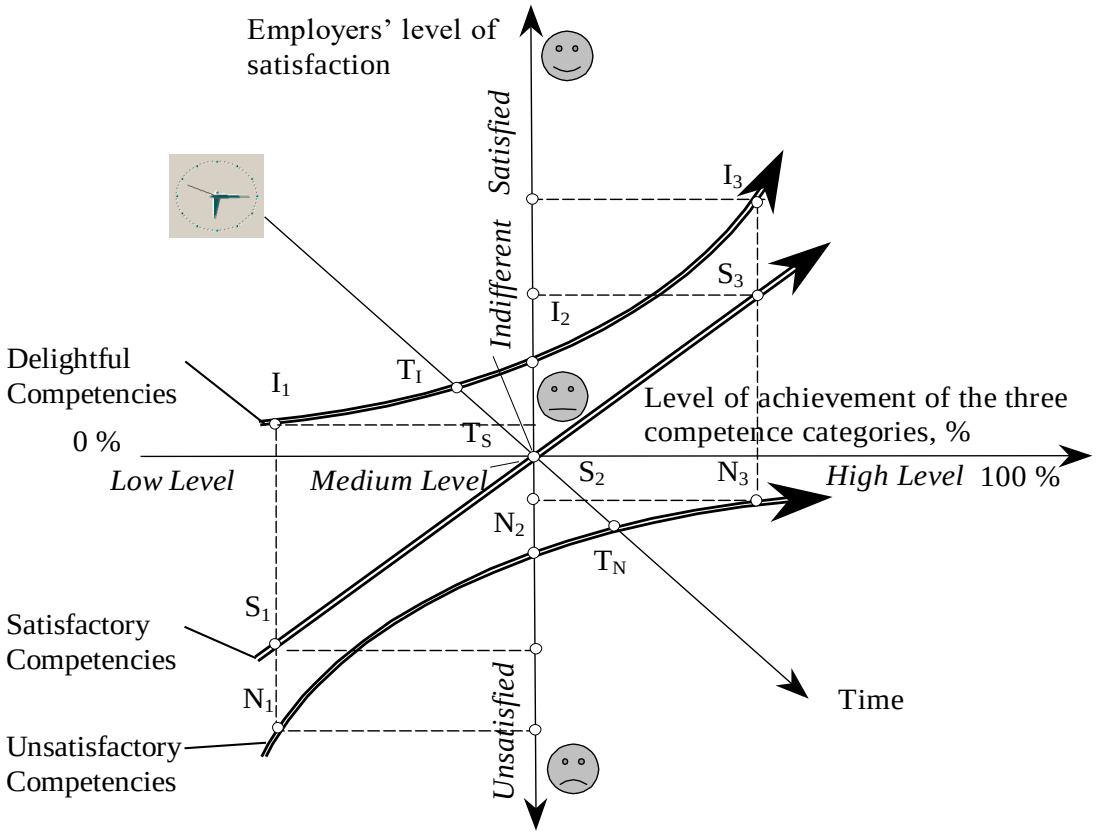
Definition of satisfaction-based graduates' competence

- **Employers' satisfaction function of graduates' competence** – adaptation of Kano model



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Definition of satisfaction-based graduates' competence

- **Satisfactory (PERFORMANCE) graduates' competence** – related to characteristic points S_1, S_2 and S_3 in the model

  - represents the quality of the graduates required (desired) to exist by the employers

  - refers to specific, performance knowledge and skills of graduates that are known, needed and demanded by employers

  - an increasing level of achievement of this type of graduates' competence produces a proportional increasing level of employers' satisfaction, from lowest satisfaction (highest dissatisfaction) of point S_1 to highest satisfaction of point S_3 (passing through indifference, when the level of achievement in medium)

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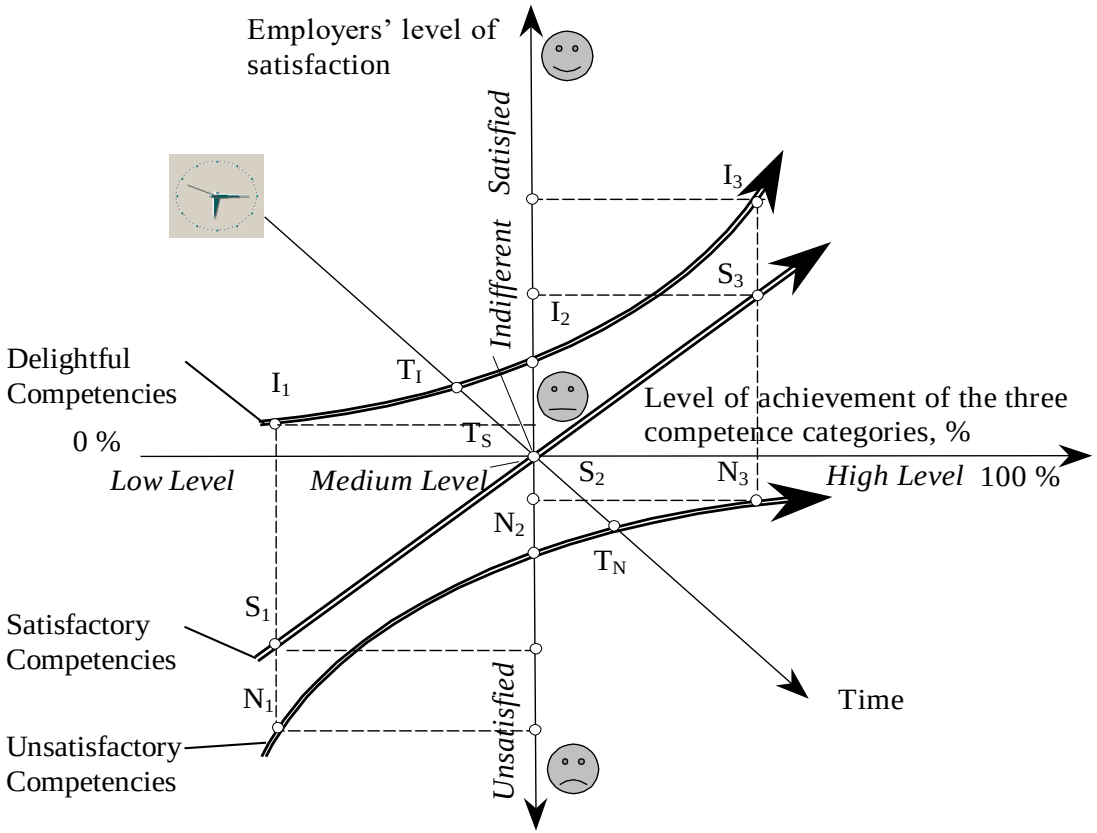
Definition of satisfaction-based graduates' competence

- **Employers' satisfaction function of graduates' competence** – adaptation of Kano model



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Definition of satisfaction-based graduates' competence

- **Delightful (ENTHUSIASTIC) graduates' competence** – related to characteristic points I_1, I_2 and I_3 in the model

  - represents the quality of the graduates unexpected to exist by the employers

  - refers to high-performance knowledge and skills of graduates that are not anticipated and therefore not demanded by employers, despite that are highly needed

  - an increasing level of achievement of this type of graduates' competence produces a considerable increasing level of employers' satisfaction, from lowest satisfaction (but not indifference) of point I_1 to highest satisfaction of point I_3

  - should be planned by universities in accordance with international best practices and with local employers' (and society's) present and future needs

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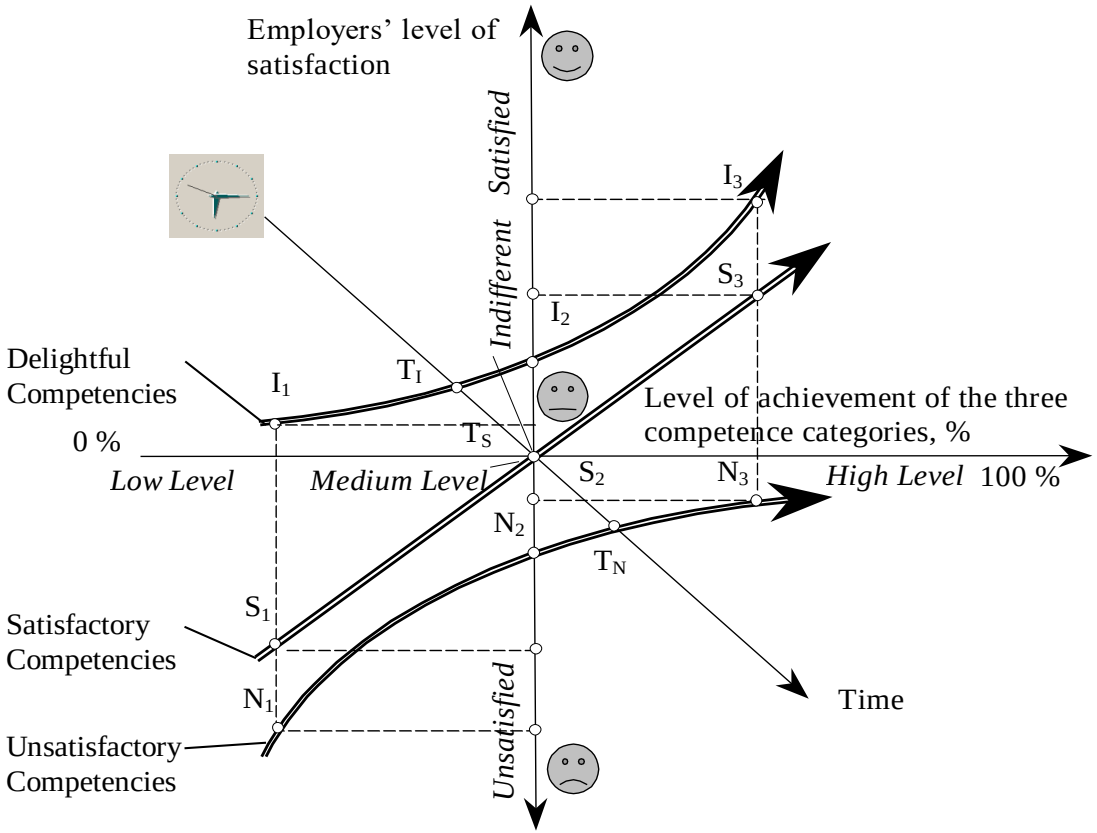
Definition of satisfaction-based graduates' competence

- **Employers' satisfaction function of graduates' competence** – adaptation of Kano model



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Definition of satisfaction-based graduates' competence

- **Degradation in time of graduates' competence** – related to points T_I, T_S and T_N in the model

  - refers to the transformation of a high-satisfaction competence into a low-satisfaction competence during the passage of time, along with the awareness of employers and with the evolution of work (best) practices

  - must be taken into account by universities when formulating educational targets, so as to ensure the update of all three types of graduates' competence and maximum levels of achievement for satisfactory and unsatisfactory competence of graduates

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Definition of satisfaction-based graduates' competence

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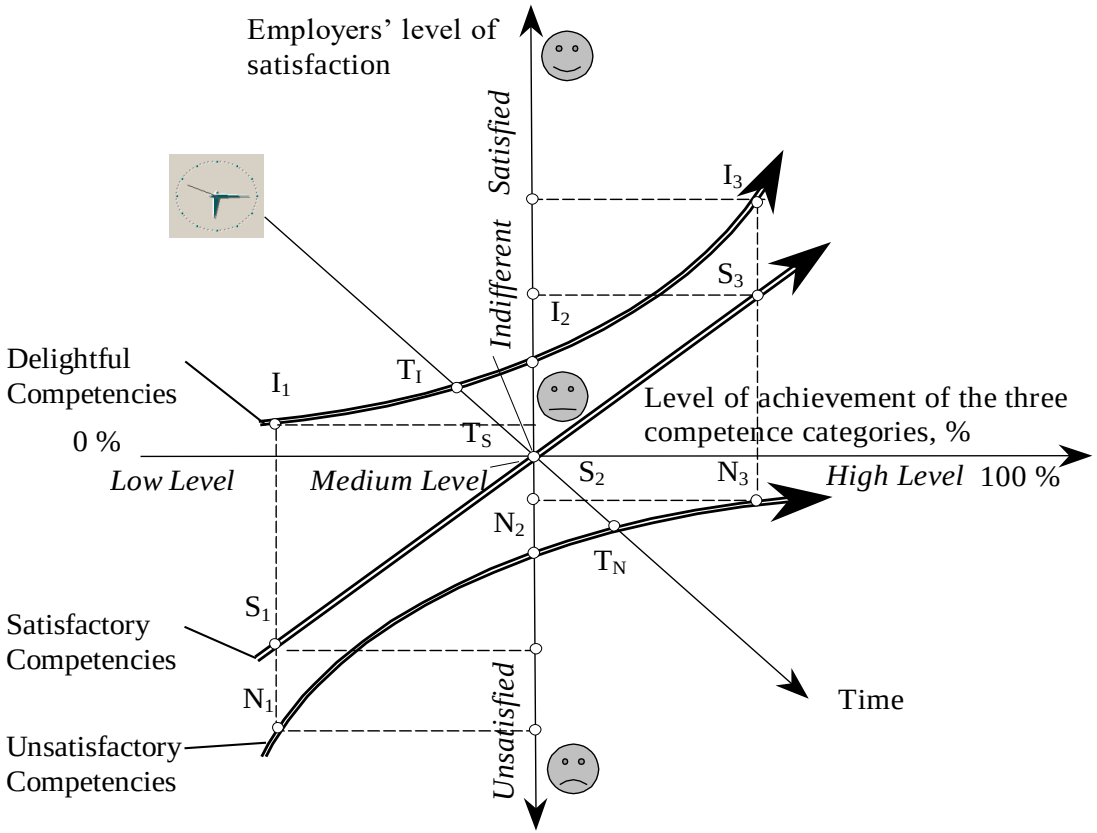

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Conclusions

- Master level competences should be designed in correlation with those of Bachelor and PhD study levels, according to EQF and NQFHE standards
- A comparison of competences of two study levels was provided for the case of INPN Master study program and NSN Bachelor study program
- A model for defining and continuous updating three types of graduates' competence based on the level of satisfaction of employers was suggested

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Thank You

Curriculum Development

of Master's Degree Program in

Industrial Engineering for Thailand Sustainable Smart Industry