Education for zero energy Buildings using Building Information Modelling

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O2.4 Report on current training skills of the construction industry

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Contents

1 Executive Summary

This report collates information which provides an overview of both national and at EU level on the following:

1. The existing qualifications of select categories, educational background, specialisation, experience;
2. Skills requirements with emphasis on BIM and nZEB, and other AI understandings.

The aim is to provide continuous training for construction workers by gathering information and spreading awareness of future and current regulations regarding BIM and nZEB. It is also intended that SMEs may benefit from the trainings in an economical and employable way.

The level and type of input from the SMEs and industry to the training programmes are also discussed.

2 Introduction

Within task **T.2.3 Training Needs Analysis** the research aimed to review the training needs of the construction industry for a number of categories: general operatives, apprentices, craftworkers, site managers, managers and current students in higher education. Outcomes will be determined for levels, type and need of trainings both for the short and long term.

The training needs of the educators is also assessed to determine their level of skill and knowledge for BIM in nZEB trainings.

To carry out this analysis, UZ-FCE and TEA developed the framework for analysing the data.

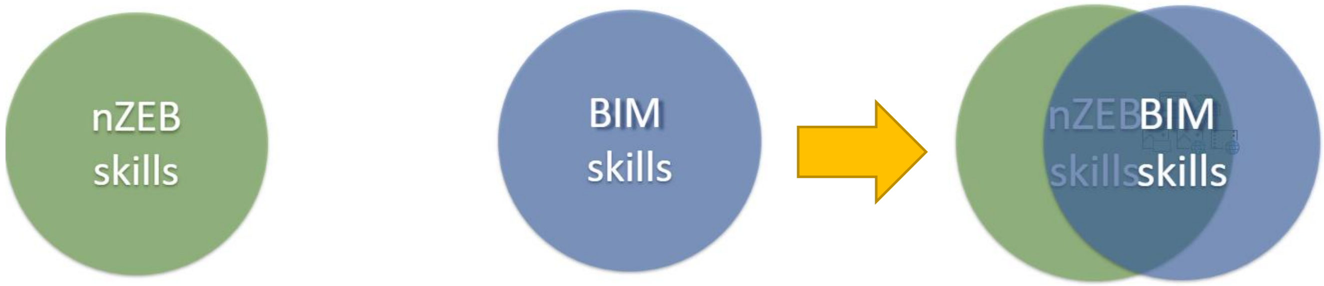
This task involves desktop research, surveys and reporting using the following method:

- on-line research of training needs in the construction industry and educators at HEIs and VETs in partner countries.
- questionnaires/survey assessing training needs of workers in SMEs and industry (10 SMEs and 25 Industry stakeholders per country – 140 in total) and educators in HEIs and VETs (15 per country – 60 in total)

Results of on-line research of training needs was reported in O 2.1.

3 Methodology

In order to assess training needs we needed to establish a framework of skills of BIM for nZEB. Literature review showed that there is no existing framework but there are skills and knowledge frameworks for both areas separate. Therefore, first part research was to determine the overlapping part of each framework.



For nZEB skills the PROF/TRAC framework was used and for BIM the BIM knowledge and skills framework developed by BuildingSmart Australia was used.
PROF/TRAC framework identified 4 groups of skills: nZEB skills identified: (Figure 1)

- Energy Management (EM)
- Energy Production (EP)
- Energy Reduction (ER)
- Interdisciplinary Skills (IS)
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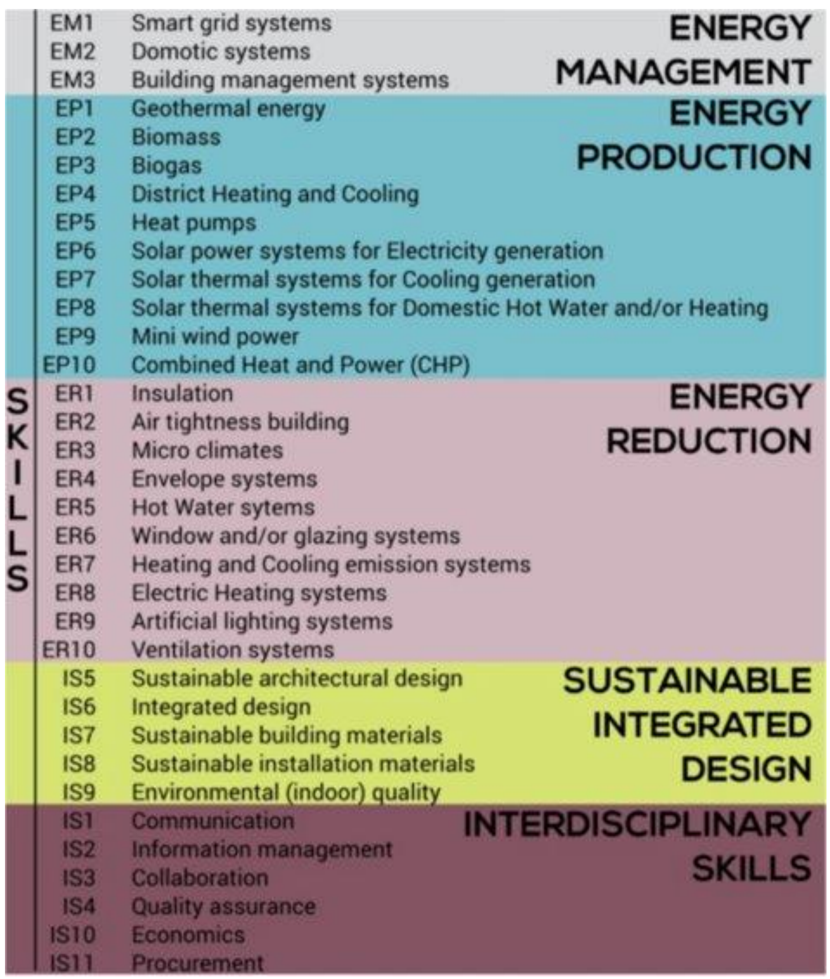


SKILLS

EM1	Smart grid systems	ENERGY MANAGEMENT
EM2	Domotic systems	
EM3	Building management systems	
EP1	Geothermal energy	ENERGY PRODUCTION
EP2	Biomass	
EP3	Biogas	
EP4	District Heating and Cooling	
EP5	Heat pumps	
EP6	Solar power systems for Electricity generation	
EP7	Solar thermal systems for Cooling generation	
EP8	Solar thermal systems for Domestic Hot Water and/or Heating	
EP9	Mini wind power	
EP10	Combined Heat and Power (CHP)	
ER1	Insulation	ENERGY REDUCTION
ER2	Air tightness building	
ER3	Micro climates	
ER4	Envelope systems	
ER5	Hot Water sytems	
ER6	Window and/or glazing systems	
ER7	Heating and Cooling emission systems	
ER8	Electric Heating systems	
ER9	Artificial lighting systems	
ER10	Ventilation systems	
IS5	Sustainable architectural design	SUSTAINABLE INTEGRATED DESIGN
IS6	Integrated design	
IS7	Sustainable building materials	
IS8	Sustainable installation materials	
IS9	Environmental (indoor) quality	
IS1	Communication	INTERDISCIPLINARY SKILLS
IS2	Information management	
IS3	Collaboration	
IS4	Quality assurance	
IS10	Economics	
IS11	Procurement	

Figure 1 PROF/TRAC nZEB skills framework

Each group had a sub-group of skills for:

- General
- Predesign
- Design
- Tendering and contracting
- Realisation
- Commissioning
- Use/maintain

BIM skills framework have also skills grouped according to project phases: (Figure 2)

- **1.000** Introduction
- **2.000** Start Up
- **3.000** Initiation
- **4.000** Planning
- **5.000** Execution / Operation
- **6.000** Monitoring And Controlling
- **7.000** Closeout / Handover / Commission

Each Knowledge group is divided in several Process Groups and the skills and knowledge is connected to concept which is explained by descriptors.(Figure 2)

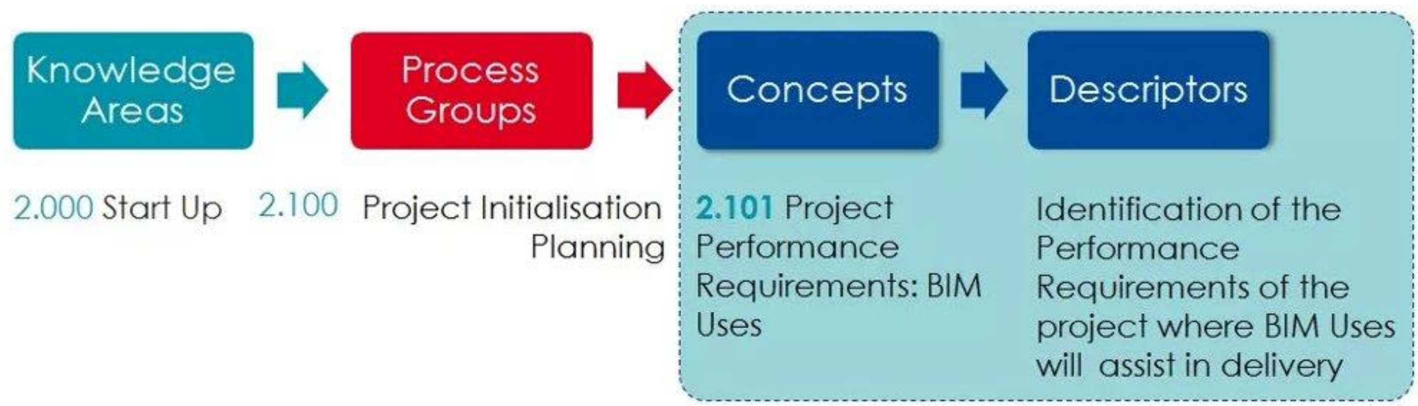


Figure 2 Example of BIM skills and knowledge framework

After identifying these two areas of skills (BIM and nZEB) we invited BIMzeED National Steering Group (NSG) to act as expert group to prioritize skills specific to the overlapping area of BIM and NZEB. We also engaged the NSG to identify training skills of educators, since most of educators from both areas were invited to join the group.

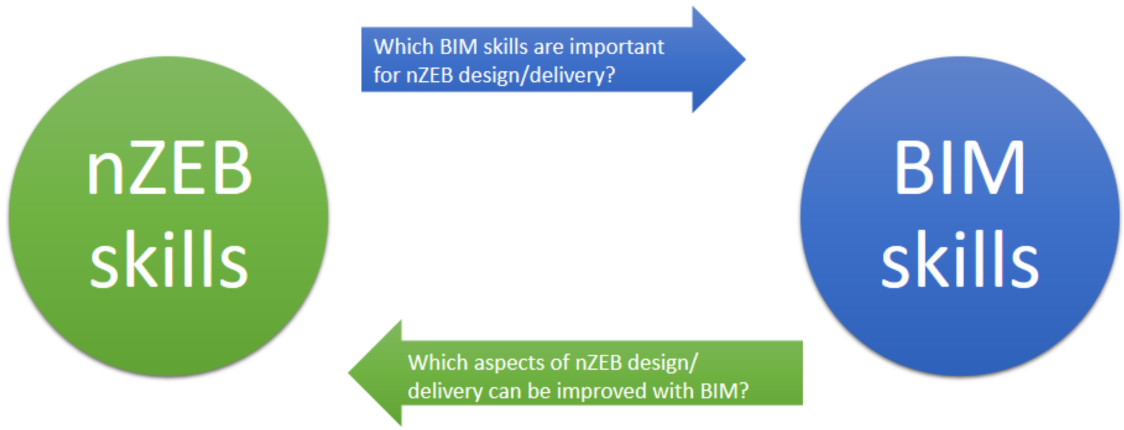


Figure 3 Research questions for identifying overlapping skills for nZEB and BIM

Priority analysis was used to select important skills in BIM and nZEB, which was then used to identify training needs in the construction industry and to evaluate current training skills of educators involved in construction studies. Expert group members assessed the importance of each skill by answering two questions in the Figure 3. BIM skills were assessed how important are they for nZEB design, and nZEB skills were assessed how important is BIM for improving nZEB skills. Skills that have importance equal and greater than average importance of the each group were selected for further research. (**Error! Not a valid bookmark self-reference.**)

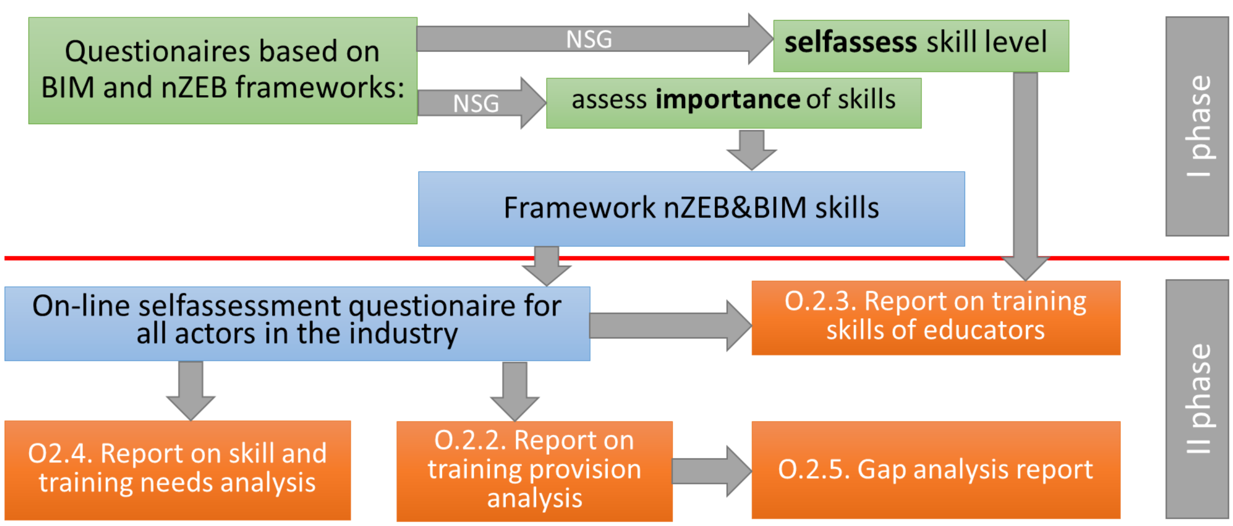


Figure 4 Research design map

4 The existing qualifications of select categories, educational background, specialization, experience

Construction industry is well known to be fragmented and lot of different stakeholders are important for delivering the project. With application of nZEB policy and introduction of BIM each of them needs to adapt to new way of delivering projects in very near future. In this research we will assess the readiness of stakeholders for new way of work to establish need for developing educational program.

4.1 Identification of profiles and specializations for nZEB

List of roles was identified od the EU level taking into account that there is 4 partners representing different professional environment and way of doing business:

- Policy Makers (a person responsible for or involved in formulating policies, especially in politics)
- Public Administrator (public servants working in public departments and agencies, at all levels of government)
- Facility Managers (job role that is responsible for making sure that buildings and their services meet the needs of the people that work in them. Facilities managers are accountable for services such as cleaning, security and parking, to make sure the surrounding environment is in a suitable condition to work)
- Developers (a person whose job involves buying and selling buildings and land, and arranging for new buildings to be built)
- Project managers (is accountable for the success or failure of a project. Typical responsibilities of a project manager include: Planning, Executing, and Closing Projects — defining the project, building its comprehensive work plan, and managing to the budget.)
- Consultants (is someone who has extensive knowledge and experience in a specific professional field, and who shares their expertise in order to solve business-related issues or problems)
- Designers (professionals who are involved in developing design of a building or other construction)
- Site Supervisors (is responsible to assess hazards, determine risks, conduct regular inspections, and maintain a safety programme.)
- Site Engineers (members of site management team of contractor responsible for security, health and safety, and organising and supervising materials and people, make sure designs are applied correctly and liaise with main and sub-contractors)
- Construction Managers (plans, coordinates, budgets, and supervises construction projects from early development to completion, and leads site management team during construction)
- Technicians (is a worker in a field of technology who is proficient in the relevant skill and technique, with a relatively practical understanding of the theoretical principles.)
- Craftsman (a worker skilled in a particular craft)

- Apprentices (a person who is learning a trade from a skilled employer, having agreed to work for a fixed period at low wages.)
- Students (a person who is studying at a university or other place of higher education)
- Specialists in Green Building (an expert who can give professional advice on several aspects of building design so it minimizes resource consumption (materials, energy, water) as well as providing a healthy and comfortable internal condition whilst minimising negative impacts on its surrounding)
- Quantity Surveyors (responsible for calculating and managing the costs relating to projects, from helping create initial estimates to finalising the complete budget requirements)
- Workers (employed in the physical construction, primarily described by the type of work they perform)
- Owners (natural person (private or professional) or a private legal entity (company or association) or public institution (the State or a local authority) who assumes the financing of the project of house, building or infrastructure, and contracts the services of third parties involved in the design and construction of the house or building)

Table 1 Qualification requirements for target groups

Role	EQF Qualification requirements			
	Croatia	Hungary	Ireland	Spain
Policy makers	6-7	6-7	4-5	4-5
Public administrator	4-5-6-7	4-5	3-4	4-5-6-7
Facility managers	6-7	6-7	6-7	7
Developers	5-6	5-6	5-6	5-6
Project managers	6-7	7	6-7	7
Consultants	6-7	7	6-7-8	6-7
Designers	6-7	6-7	6-7-8	6-7
Site engineers	6-7	6-7	6-7	6-7
Construction managers	6-7	7	6-7	6-7
Site supervisors	6-7	7	6-7	6-7
Technicians	4-5	4-5	5-6	4-5
Craft workers	3-4	3-4	4-5	3-4
Apprentices	3-4	3-4	4-5	3-4
Students	4-5	4-5-6	4-5-6	4-5-6
Specialists in green building	6-7	6-7	6-7	6-7
Quantity surveyors	no	4-5	6-7	5-6-7
Construction Workers	2-3	2-3	3-4	2-3
Owners	all	all	all	all

In the next table we are bringing review of national qualification frameworks.

Table 2 Qualification requirements for target groups

Country	Scope of the framework	Number of levels	Level descriptors	Legal basis/stage of development	NQF linked to EQF	NQF/EQF website
Croatia	Designed as a comprehensive NQF including all levels and types of qualification from formal education and training. It is a qualifications and credit framework.	Eight, with sublevels at levels 4, 7 and 8	• knowledge • skills • autonomy and responsibility	CROQF Act (2013, amendments in 2016 and 2018) (in Croatian) (Early) operational	2012	http://www.kvalifikacije.hr/en
Hungary	Comprehensive NQF for lifelong learning encompassing all Staterecognised national qualifications acquired in general education, HE, and the vocational qualifications in the national vocational qualifications register.	Eight	• knowledge • skills • attitudes • autonomy and responsibility	Government Decision 1229/2012 on the Hungarian qualifications framework (in Hungarian) (Early) operational	2015	https://www.magyarkepesites.hu/
Ireland	Comprehensive NQF including all types and levels of qualification from formal education and training.	10 with five classes of award type: major, minor, special-purpose, professional and supplemental	• knowledge • skills • competence	Qualifications (Education and Training) Act (1999) (in English) Qualifications and Quality Assurance (Education and Training) Act 2012 (in English) Operational	2009	https://www.qqi.ie/Articles/Pages/National-Framework-of-Qualifications-(NFQ).aspx
Spain	Comprehensive NQF including all levels and types of qualification from formal education and training. Open to qualifications awarded outside the formal education system.	Eight	• knowledge • skills • competence	Ordinance (2015:545) on qualifications framework for lifelong learning, including the general framework (in force since October 2015) and the application procedure (in force since January 2016. (in Swedish) (Early) operational	2016	https://www.seqf.se/

4.2 Identification of profiles and specializations for BIM

Currently in Spain there are no official bodies certifying capacities, abilities or competences for training professional profiles in BIM methodologies[1]. However, there are private bodies and professional associations that have set a CPD (Continuing Professional Development) certification processes focussed on BIM skills[2].

Regarding academic recognitions, to date there are not specific university degrees but there are several masters and post-degree studies on BIM methodology.

Besides, a minimum of three BIM profiles have been envisaged in non-regulatory documents issued by regional public bodies such as the BIM Guide[3], the BIM Handbook[4] and the BIM White Book[5] published by Generalitat de Catalunya. These profiles are BIM Manager, BIM Coordinator and BIM Modeler.

In Croatia, currently there is no national standard that defines requirements for existing BIM professional profiles. BIM professional profiles with their tasks and competencies in BIM projects are covered, i.e. scarcely defined in "General guidelines for BIM approach in civil engineering" published by Croatian Chamber of Civil Engineers in June 2017. As its name says, those guidelines are quite general and do not elaborate BIM professional profiles in detail.

Figure 5 shows hierarchical organizational structure of BIM roles/responsibilities.

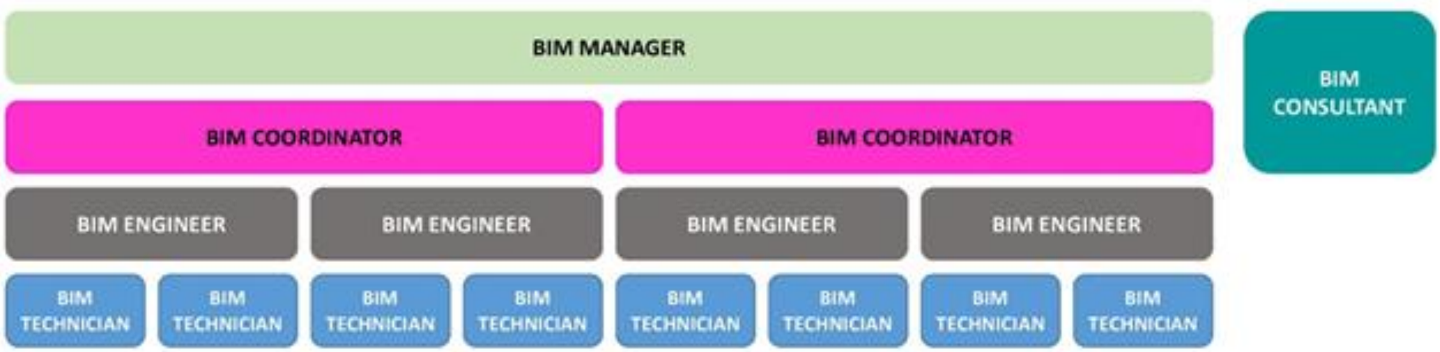


Figure 5 Hierarchical organizational structure of BIM roles/responsibilities

By implementing BIM approach, new processes requiring new project roles/tasks and responsibilities are being driven. Croatian Chamber of Civil Engineers has proposed the assignment of corresponding roles in BIM projects in relation to the standard roles in construction projects (see Figure 6).

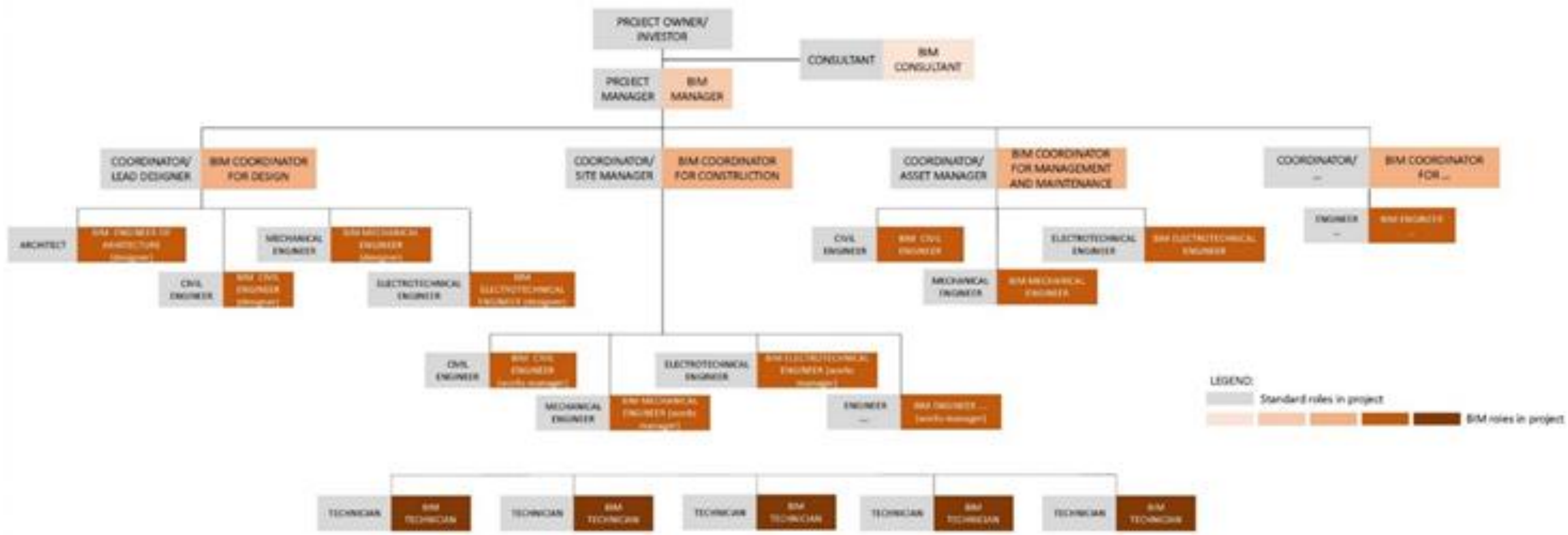


Figure 6 Standard roles/ responsibilities in project vs. BIM roles/ responsibilities in project

It has to be noted that regulations, processes and stakeholders involved in building life cycle in Croatia form a complex matrix which requires more comprehensive analysis and definition of BIM profiles, as well as their corresponding roles which differ substantially from those presented in Figure 2.

BIM Consultant

EQF	Level 7
Working field	Construction management
	Financing and procurement
	Building management

BIM Consultant leads and consults stakeholders of construction project that will or currently are in phase of adopting BIM approach in their project but they don't have experienced BIM experts in team.

There are three types of BIM Consultant:

Strategic Consultant - generates strategies that are typically medium to long term and are based on a vision of achievement;

Functional Consultant - generates action plans in accordance with these strategies;

Operational Consultant - consults in process of BIM implementation

TASKS
Leads and consults stakeholders of construction project (designers, contractors, investors, project managers, supervision engineers, developers, etc.) that will or currently are in phase of adopting BIM approach in their project but they don't have experienced BIM experts in team.

BIM Manager

EQF	Level 7
Working field	Construction management
	Financing and procurement
	Building management

When the BIM project is being considered, it is necessary to name a person who defines BIM goals and requirements of the project, moreover who collects and manages project information. This role can be carried out by an independent party working for the investor/ project owner, e.g. project manager; or by the project's independent party, e.g. the main/ lead designer.

The role of BIM Manager is to set up the rules that need to be followed during the lifetime of construction project - from initiation/planning through constructing to handing over the building. He ensures that exchange of information among project parties is in accordance with Contractual rules.

For BIM Manager to be able to manage and perform his tasks, it is desirable to have experience in construction industry and to be familiar with BIM software tools.

TASKS
Defines BIM goals and requirements for the project; collects project information and manage them.
Sets up the rules that need to be followed during the lifetime of construction project - from initiation/planning through constructing to handing over the building.

Ensures that the information being exchanged among project parties is in accordance with the Contractual rules in the context of: a) content (e.g. amount of information); b) form (e.g. file type, communication through E-mail or Cloud service); c) time (timeliness of information and BIM tasks in accordance with time plan of project); d) ownership, privacy and security questions.
Determination of different development levels of the model in accordance with the development phases of the project.
Defining the frequency of updating and coordinating the model with the project parties.
Defining the process of information exchange with regard to the use of software platform and project tools from different project stakeholders and other parties.
Informing the project stakeholders about the needs and requirements of other parties.
Organization of coordination meetings.
Assessment and optimization of collaboration and information exchange to prevent the loss of information.

BIM Coordinator

EQF	Level 7
Working field	Architecture
	Structural engineering
	Mechanical engineering
	Electrical engineering
	Construction management

In hierarchy of BIM projects, next to the BIM Manager there is a BIM Coordinator for each specific profession or a narrower area of profession, i.e. technical and/or architectural elements such as architectural shaping, load-bearing structure, electrical installations, etc. BIM Coordinator is a direct link between BIM Manager and other stakeholders involved in project. He is an expert for information management and modelling by using the specific software tools that are also being used by other project parties under his coordination. Moreover, BIM Coordinator knows which information (and in what format) he needs to collect from other project stakeholders in order to deliver what is required and agreed in BIM protocol of specific projects, i.e. specific professions.

TASKS
Provide technical leadership for data management and modelling using specific softwares that are being used by parties under his governance.
Interface directly with stakeholders of project and other parties to collect required and valid data; thereby to assure the quality delivery of collaborative digital deliverables as agreed in BIM protocol of specific projects (specific professions).

BIM Engineer

EQF	Level 7
Working field	Architecture
	Structural engineering
	Mechanical engineering
	Electrical engineering

	Construction management

BIM Engineer usually uses appropriate BIM software tools to develop his part of BIM project. By using BIM software tools, he is developing model and technical documentation.

This role can be carried out by highly educated professional, e.g. with Master degree, with few years of professional work experience.

TASKS
Uses appropriate BIM softwares for developing his part of BIM project. By that, he develops whole BIM model and technical documentation.
Manage and coordinate project deliveries. Define tasks together with project team.
Learn and demonstrate proficiency in softwares related to BIM.
Learn and demonstrate proficiency in construction trade knowledge.
Strive to build strong network connections with project stakeholders.
Working on BIM 3D models, 2D shop drawings, as-built models.

BIM Technician/ Modeler

EQF	Level 5, 6 or 7
Working field	Architecture
	Structural engineering
	Mechanical engineering
	Electrical engineering

BIM Technician/ Modeler is an expert with developed modelling skills for BIM software tools and solid understanding of specific design professions. BIM Technician models technical and/or functional elements using BIM software tools, whereby he must be well-versed and understand the project aspects of the specific profession.

This role can be carried out by a professional with vocational education and few years of professional work experience or with recently gained Master degree with no or little work experience.

TASKS
Modelling of individual technical and/or functional assemblies in BIM softwares, where he must be well-versed and understand the project aspects of the specific profession.
BIM modeling for specific design profession in project.
Working under direction of BIM engineer and BIM coordinator.
Ensure accuracy of model and output documentation.
Collaborate and coordinate with other professions during project changes.
Follow accepted BIM content standard.
Prepare drawing print settings for project team and participate in project review.
Export documents in format needed for internal and external project communication.

As the result of the tasks provided for BIM professional profiles, the requirements of these profiles are identified and digitized in terms of competences:

BIM CONSULTANT	BIM MANAGER	BIM COORDINATOR	BIM ENGINEER	BIM TECHNICIAN/ MODELER
Capability to lead.	Capability to make decisions.	Capability to apply knowledge of BIM standards.	Capable of adapting to different working environments.	Capability to use BIM software tools for modelling at advanced level with solid understanding of specific design profession.
Capability to communicate effective.	Capability to communicate well.	Capability to update knowledge of BIM development.	Capability to update knowledge of BIM development.	Capability to apply technical skills and knowledge.
Capability to understand processes.	Capability to update knowledge of BIM development.	Capability to lead.	Capability to apply knowledge of BIM standards.	Capability to understand working environment of another profession.
	Capability to apply BIM fluently.	Capability to apply modelling skills.	Capability to apply modelling skills.	Capability to communicate and collaborate.
	Capability to apply technical skills and knowledge.	Capability to collaborate and coordinate.	Capability to apply technical skills and knowledge.	
	Capability to lead.	Capability to apply technical skills and knowledge.	Capability to work in a team.	
	Capability to collaborate and coordinate.		Capability to communicate and collaborate.	
	Capability to be BIM goal oriented.			
	Capability to provide discipline essential for project quality and success.			

4.3 Construction industry knowledge and skills in nZEB and BIM

Using standardized questionnaires, a survey was conducted in all partner countries. In total, we have 237 respondents, where 140 were from Croatia, 30 from Ireland, 36 from Spain, 24 from Hungary and 7 from other countries, and 63,72% of them have more than 5 years of experience. (**Error! Reference source not found.**,**Error! Reference source not found.**) Survey showed that the respondents who are interested in nZEB with BIM are in the role of designer, project manager, consultant and owner. (**Error! Reference source not found.**) The majority of specializations include project management, architecture, construction management, energy evaluation, structural analysis and energy reduction systems.(**Error! Reference source not found.**)

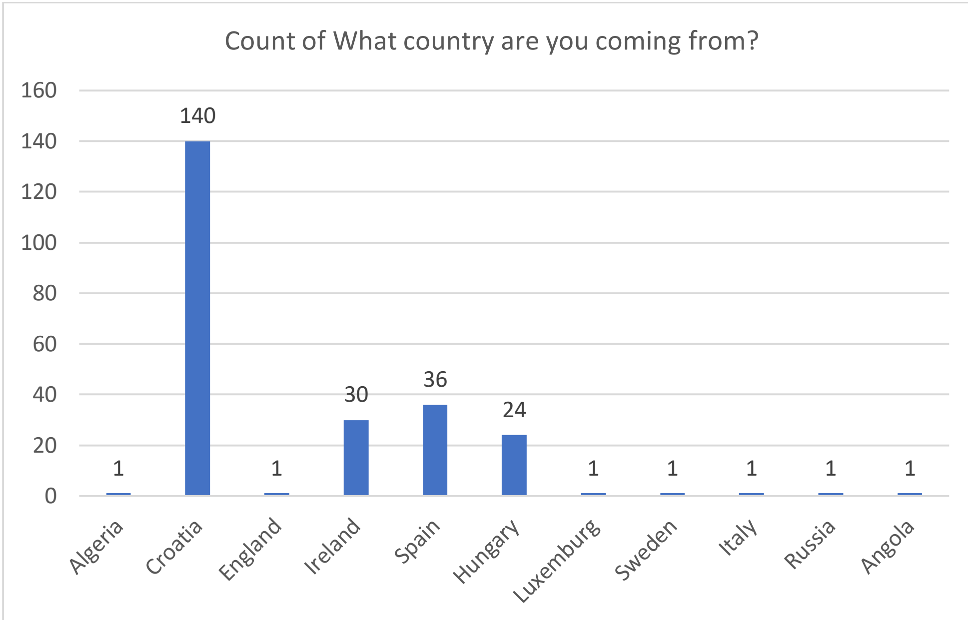


Figure 7 Country of respondents

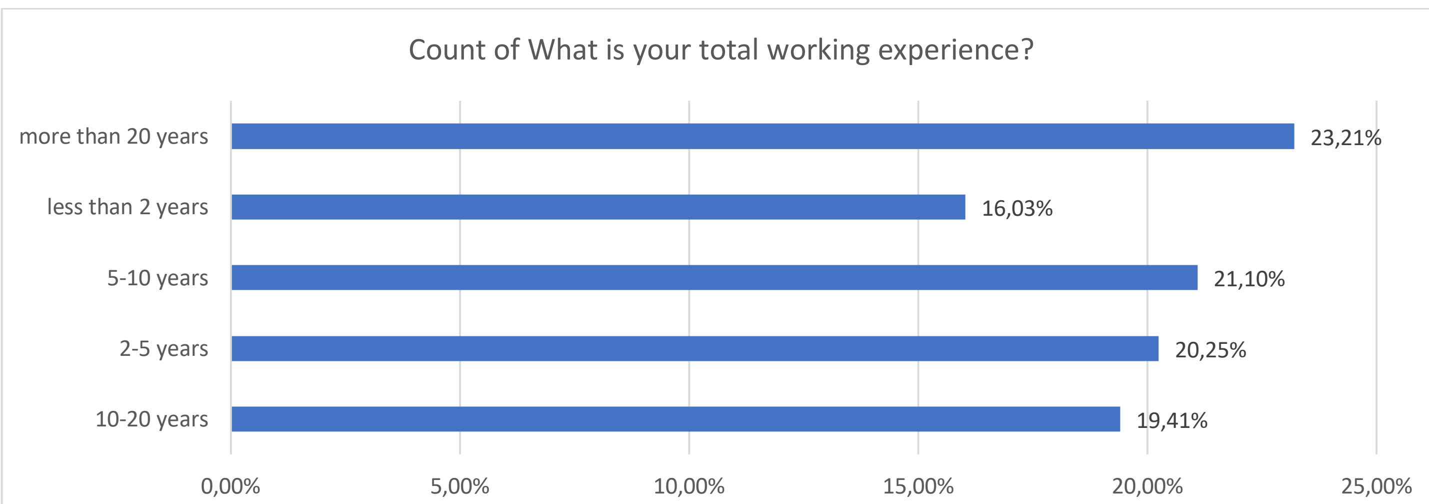


Figure 8 Working experience

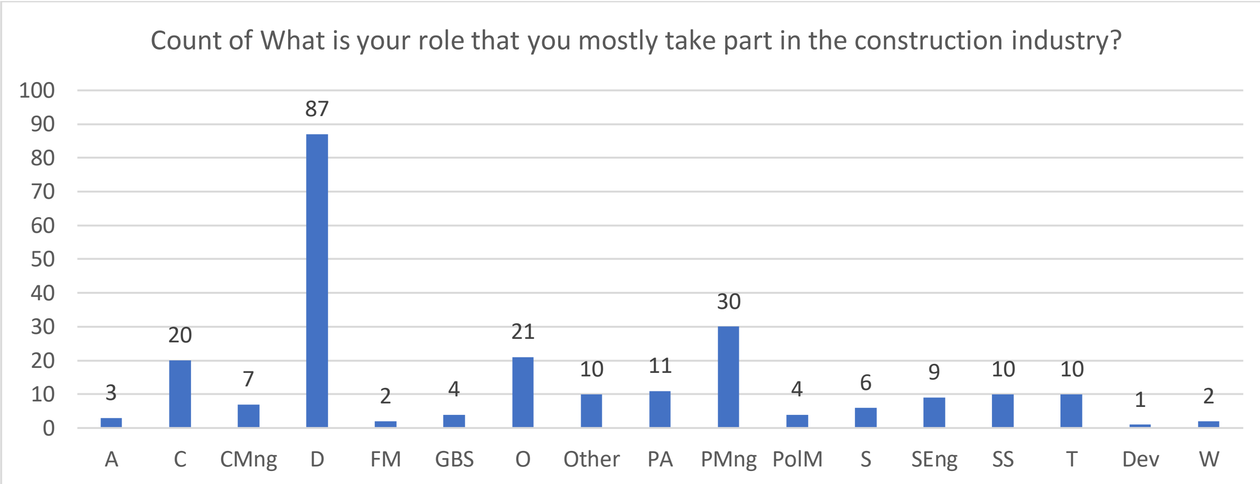


Figure 9 Role of respondents

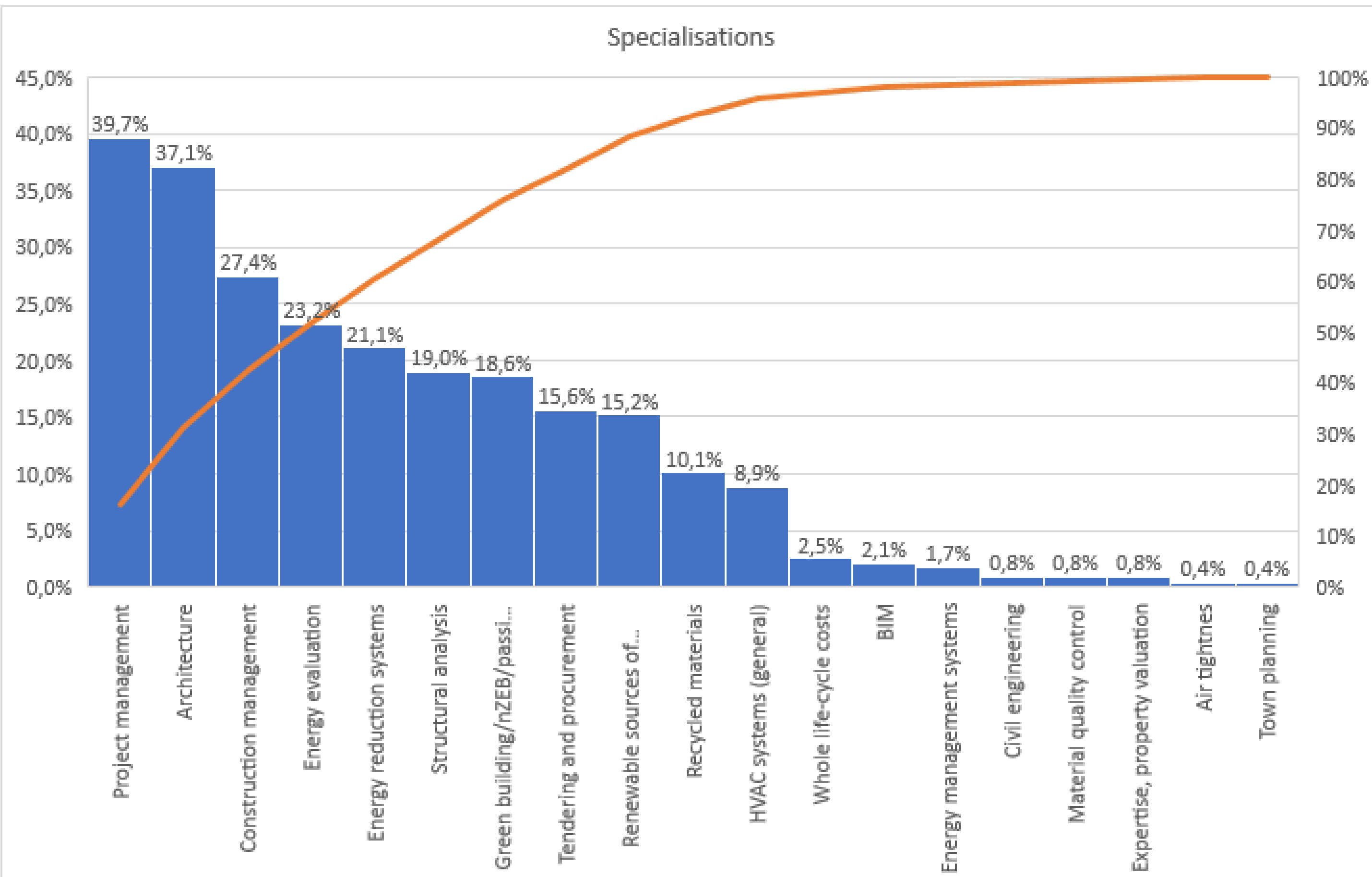


Figure 10 Specialization of respondents

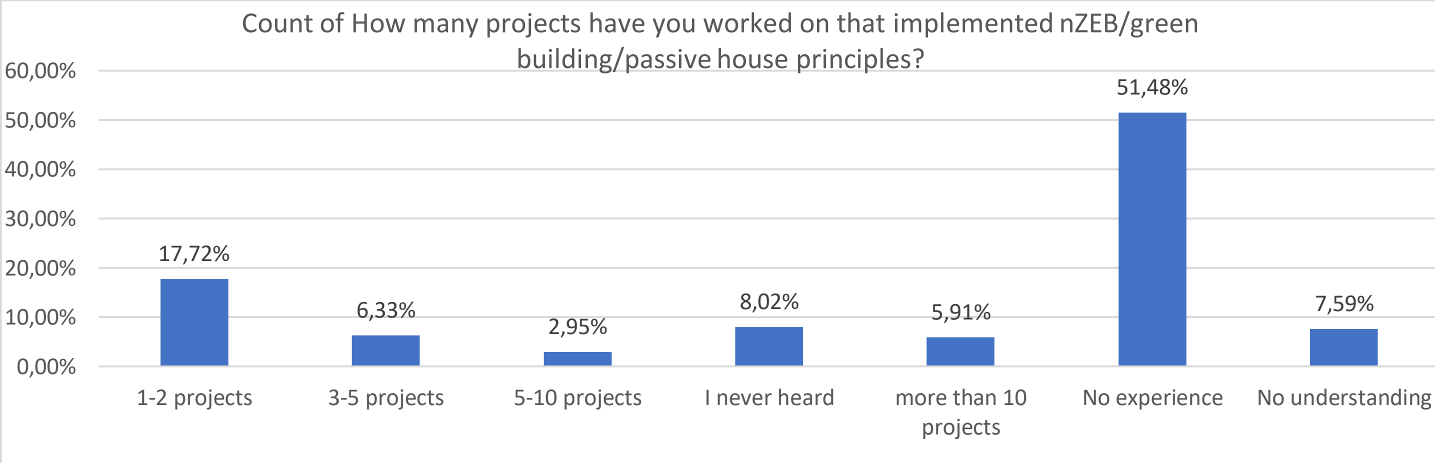


Figure 11 Experience in nZEB

Generally respondents do not have experience in working on projects with the application of nZEB/green building/passive house principles.(**Error! Reference source not found.**) Also, respondents with no experience have received no training or education in nZEB.

The survey also showed that the majority of respondents have not received any training in nZEB and respondents who received education or training did not had BIM included. Trainings which included BIM with nZEB was by University of Zagreb Faculty of Civil engineering within the EU project Net-UBIEP, BME Magasépítési Tanszék, Building Energy Professional Engineer Education, Budapest University of Techonology and Economics (BUTE) and Waterford Institute of Technology. Therefore, we can conclude that there is need for training in the construction industry on European level.

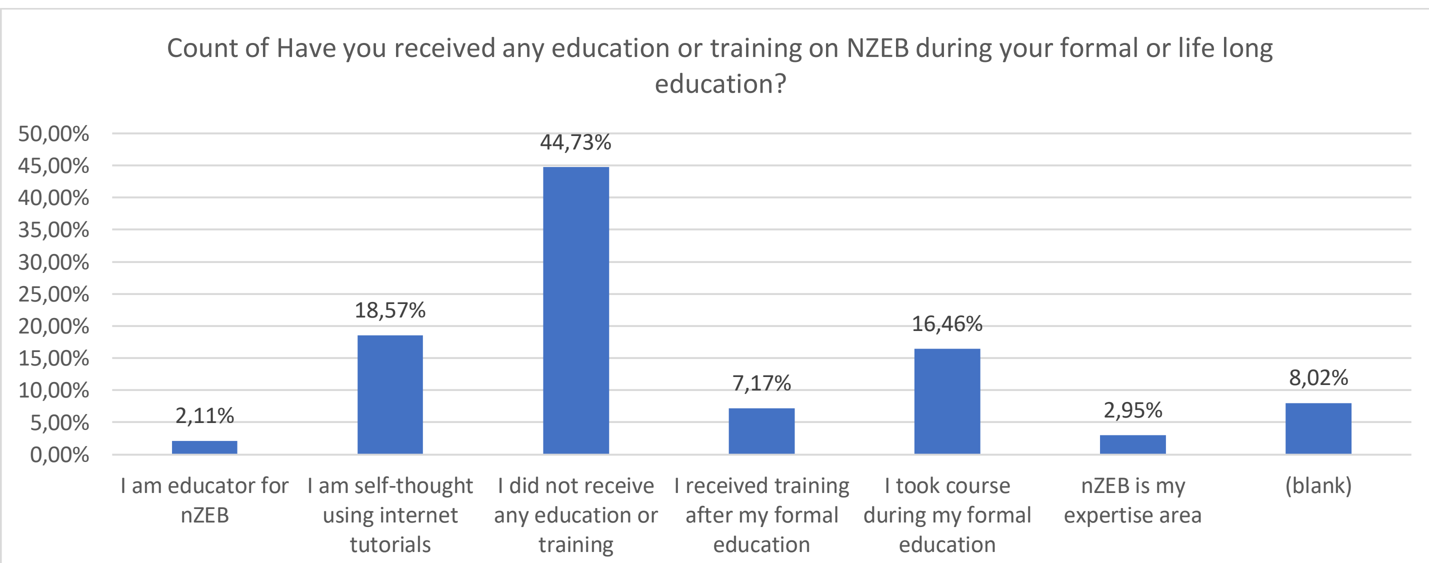


Figure 12 Education in nZEB

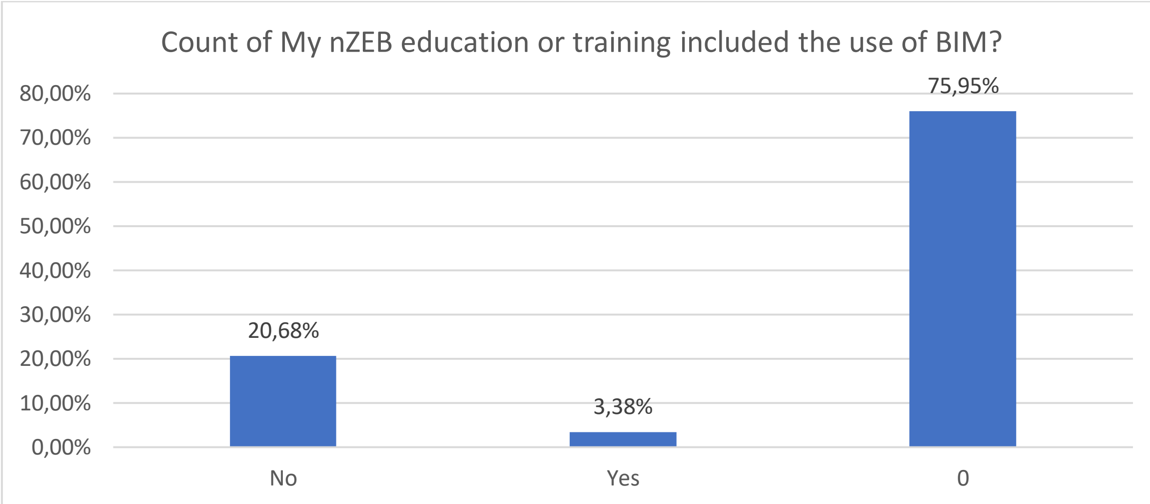


Figure 13 Education on BIM&nZEB

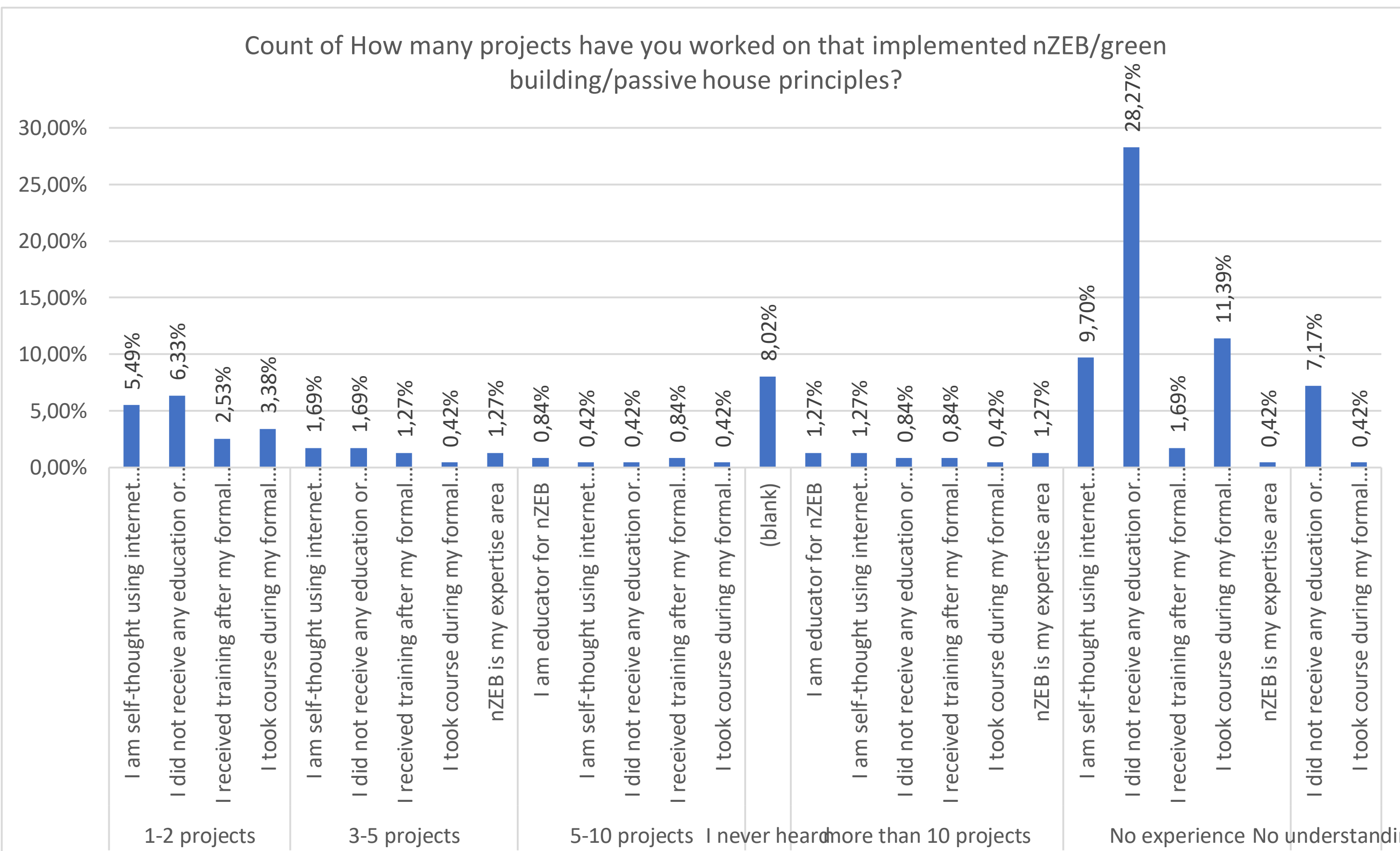


Figure 14 nZEB implementation and education

Currently, more than 50% respondents do not know what the nZEB concept is, have no experience and the majority of these have received no training.

Therefore, we can conclude that there is practically no experience in the application of nZEB principles and that people need to receive training in nZEB.

4.3.1 Construction industry level of skills and knowledge

As it was stated in the Introduction, we applied the expertise of the NSG to identify relevant parts from both of the skills frameworks, for nZEB and BIM. The NSG consisted of representatives from education, industry and experts from these two fields. They identified the importance of each nZEB skill and how this can be improved by using BIM, and which BIM skills are needed to improve to achieve nZEB projects design/delivery.

Below is list of nZEB and BIM knowledge and skills.

Table 3 ***NZEB skills and knowledge***

NZEB skills and knowledge

General nZEB group of skills and knowledge	NZEB 1.1.	[Understand influence of heating and cooling generation on energy performance]
	NZEB 1.2.	[Understand specifics and basic parameters of heating and cooling]
	NZEB 1.3.	[Understand different energy production systems in relation to energy performance]
	NZEB 1.4.	[Understand importance of energy reduction systems in relation to energy performance]
	NZEB 1.5.	[Understand the impact of architectural design on sustainability and energy performance]
	NZEB 1.6.	[Understand integrated design processes and concepts]
	NZEB 1.7.	[Understand the interaction of building location, design, use and outdoor climate]
	NZEB 1.8.	[Understand sustainable materials and the importance of its appropriate application]
	NZEB 1.9.	[Understand sustainable building technologies and appropriate application]
	NZEB 1.10.	[Understand the interaction between energy performance and IEQ]
	NZEB 1.11.	[Understand design methods for passive energy technologies]
	NZEB 1.12.	[Understand effective communication within projects aimed to achieve nZEB]
	NZEB 1.13.	[Understand interdisciplinary teamwork towards common goals]
Pre-design nZEB group of skills and knowledge	NZEB 2.1.	[Perform energy simulations]
	NZEB 2.2.	[Perform a feasibility study]
	NZEB 2.3.	[Assess systems related to building function and architecture]
	NZEB 2.4.	[Investigate, determine and advise on energy reduction systems to reach nZEB]
	NZEB 2.5.	[Select sustainable constructions technologies and materials]
	NZEB 2.6.	[Design passive energy measures]
	NZEB 2.7.	[Define and communicatie integrated design goals]

	NZEB 2.8.	[Knowledge on various installation materials, their performance, benefits versus costs]
	NZEB 2.9.	[Understand performance, benefits and costs of various technologies]
	NZEB 2.10.	[Understand application of passive or active technologies]
	NZEB 2.11.	[Present the design and reach consensus on decisions.]
Design nZEB group of skills and knowledge	NZEB 3.1.	[Design and engineer energy reduction systems to reach nZEB]
	NZEB 3.2.	[Design of an architectural sustainable building (including sustainable and flexible floorplan)]
	NZEB 3.3.	[Evaluate the integrated design]
	NZEB 3.4.	[Select sustainable materials and technologies in nZEB design]
	NZEB 3.5.	[Use of information modelling in design teams and management of information modelling within the nZEB design]
Tendering/contracting nZEB group of skills and knowledge	NZEB 4.1.	[Specify energy reduction systems in tender documents]
	NZEB 4.2.	[Define performance of materials in tender documents]
	NZEB 4.3.	[Communicate in contracting phase, understand and respect the role of all actors involved.]
Realization and Commissioning nZEB group of skills and knowledge	NZEB 5.1.	[Quality assurance of different energy production systems]
	NZEB 5.2.	[Quality assurance of energy reduction systems]
	NZEB 5.3.	[Coordinate the project team to ensure building quality]
	NZEB 5.4.	[Quality assurance of sustainable materials]
	NZEB 5.5.	[Coordinate contractors and suppliers by effective communication]
	NZEB 5.6	[Communicate with customers on construction progress and effectuation of building performance]
	NZEB 5.7.	[Manage data, keep records of implementation, monitor outcome.]
	NZEB 5.8.	[Financial management]
	NZEB 5.9	[Monitor project realisation and handle deviations]
Use and maintaining nZEB group of skills and knowledge	NZEB 6.1.	[Ensure optimal use of different energy production systems]
	NZEB 6.2.	[Communicate the appropriate use and maintenance of different energy production systems]
	NZEB 6.3.	[Instruct the facility manager on running and maintaining the buildings energy performance]
	NZEB 6.4.	[Ensure optimal maintenance of materials and technologies]
	NZEB 6.5.	[Communication with suppliers and facility employers on energy performance]
	NZEB 6.6.	[Instruct users and facility managers on energy performance of the building]
	NZEB 6.7.	[Monitor building performance]

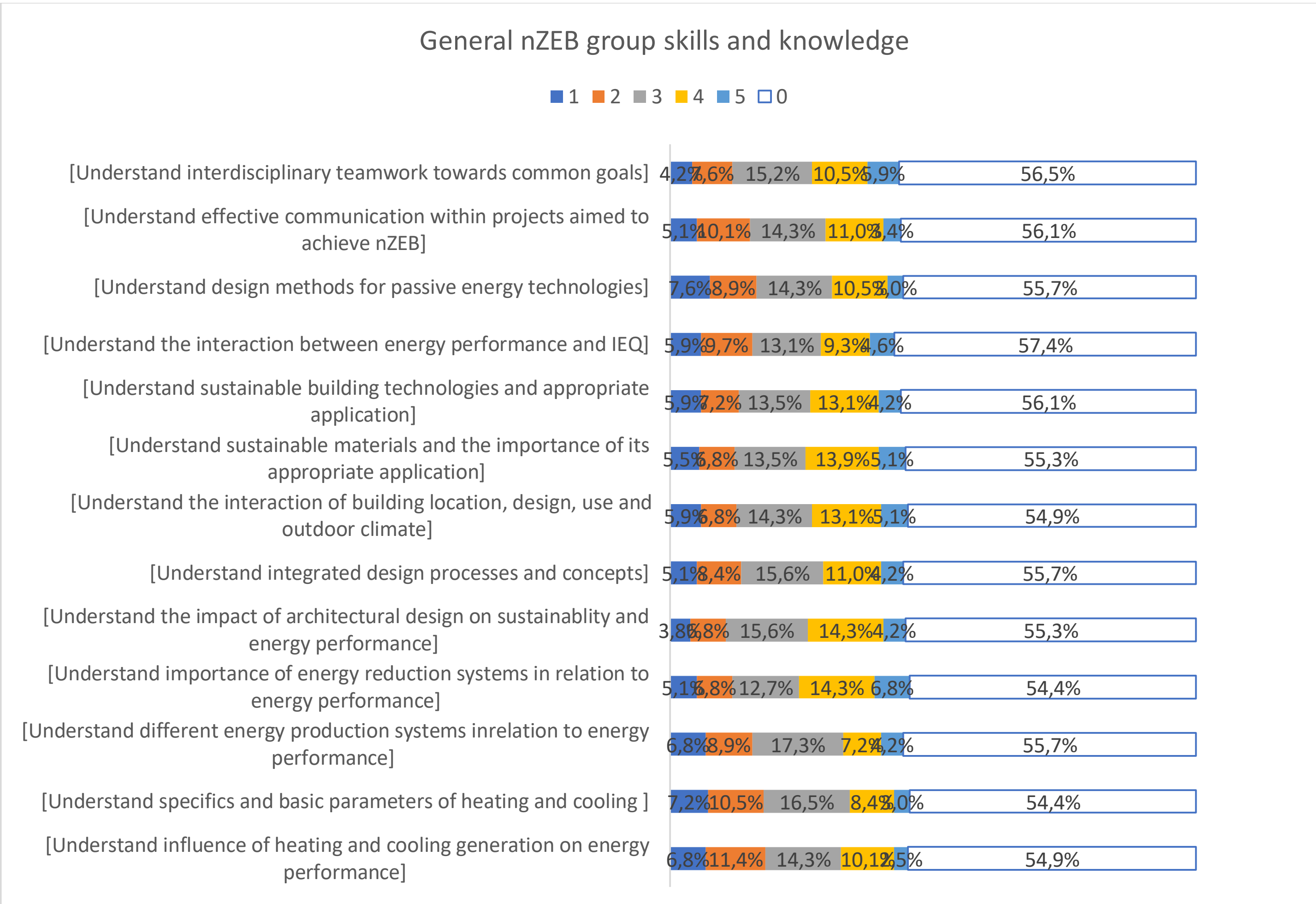
*Table 4 **BIM skills and knowledge***

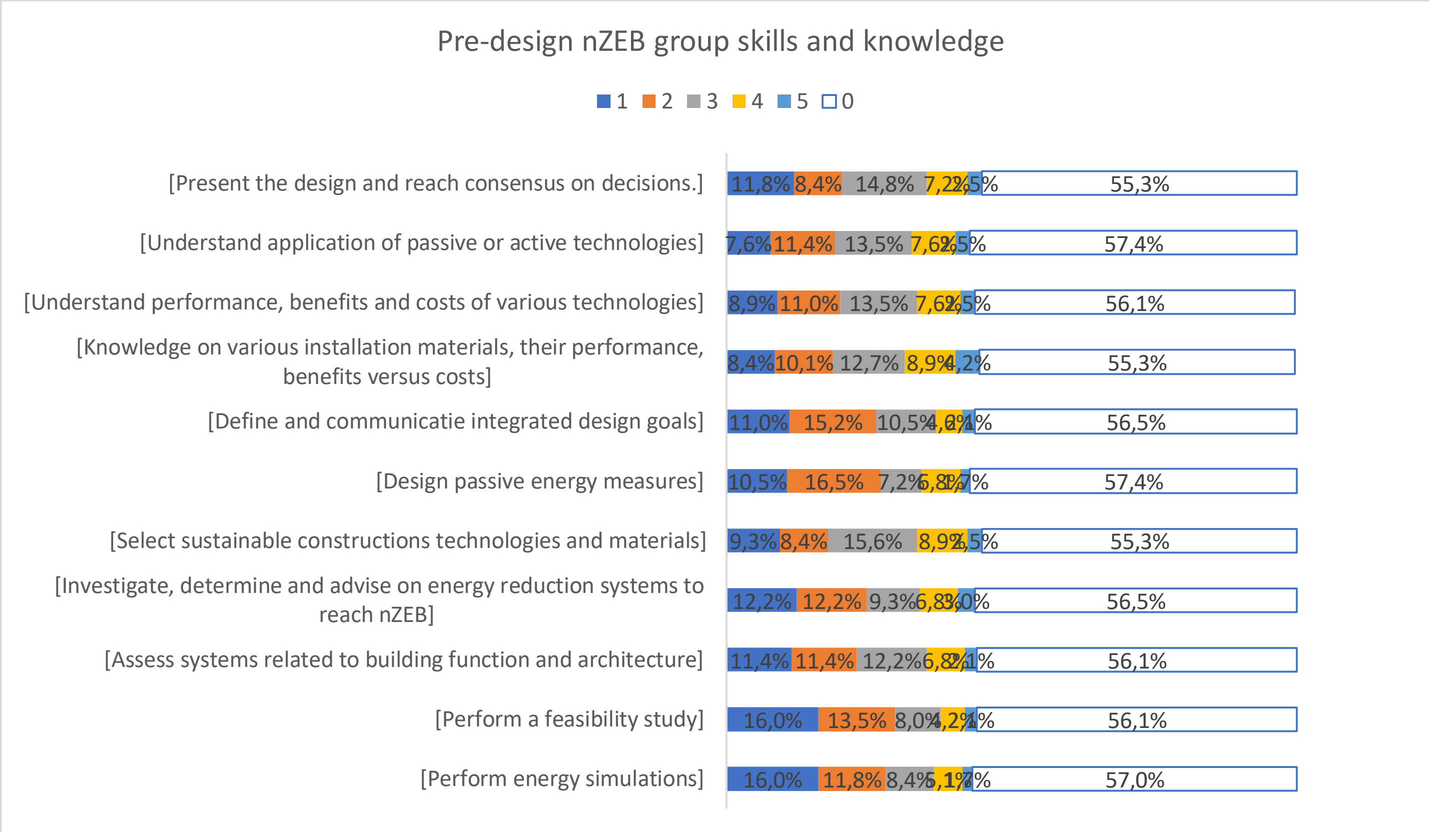
Introduction to BIM	BIM 1.1.	[What is BIM?]
	BIM 1.2.	[Industry Scope (definition and application)]
	BIM 1.3.	[BIM Requirements and Market Value]
	BIM 1.4.	[Impacts to Stakeholder Relationships]
	BIM 1.5.	[Impacts to Asset and Facilities Management]
	BIM 1.6.	[Impacts to Cost Models (Billing Model)]
Group of BIM knowledge and skills - Project startup	BIM 2.1.	[Project Performance Requirements]
	BIM 2.2.	[Project Roles and Responsibilities - Contractual Hierarchy]
	BIM 2.3.	[Project Collaboration Requirements]
	BIM 2.4.	[Project Procurement Model Requirements]
	BIM 2.5.	[Delivery Model (Contract)]
	BIM 2.6.	[BIM Protocols]
	BIM 2.7.	[Employers Information Requirements - EIR]
	BIM 2.8.	[BIM Management Plan (BMP) - Pre Contract]
	BIM 2.9.	[Additional BIM Use: Specialised and or Expert requirements]
	BIM 2.10.	[BIM Maturity Level]
	BIM 2.11.	[Statement of Requirements (SOR) or Statement of Work (SOR)]
	BIM 2.12.	[BIM Dimensions]
	BIM 2.13.	[BIM Uses]
	BIM 2.14.	[BIM Detail / Development Levels]
	BIM 2.15.	[Add: Environmental / Innovation Claims]
Group of BIM knowledge and skills - Tendering	BIM 3.1.	[Pre Contract Planning: BIM Management Plan (BMP)]
	BIM 3.2.	[BIM Examples]
	BIM 3.3.	[BIM LOD]
	BIM 3.4.	[Design Model Review]
	BIM 3.5.	[Design Model Estimations - Constructability]
	BIM 3.6.	[Design Model Interpretation]
	BIM 3.7.	[Evaluation and assessment of BIM deliverables, requirements, expectations and weighting]
Group of BIM knowledge and skills - Initiation (Integration and Communication)	BIM 4.1.	[Market Demand]
	BIM 4.2.	[Business Need]
	BIM 4.3.	[Technological Advancement]
	BIM 4.4.	[BIM Roles and Responsibilities]
Group of BIM knowledge and skills - Planning (Integration)	BIM 5.1.	[BIM Agreement]
	BIM 5.2.	[Information communication Framework]
	BIM 5.3.	[Information coordination]
	BIM 5.4.	[Classification Systems]

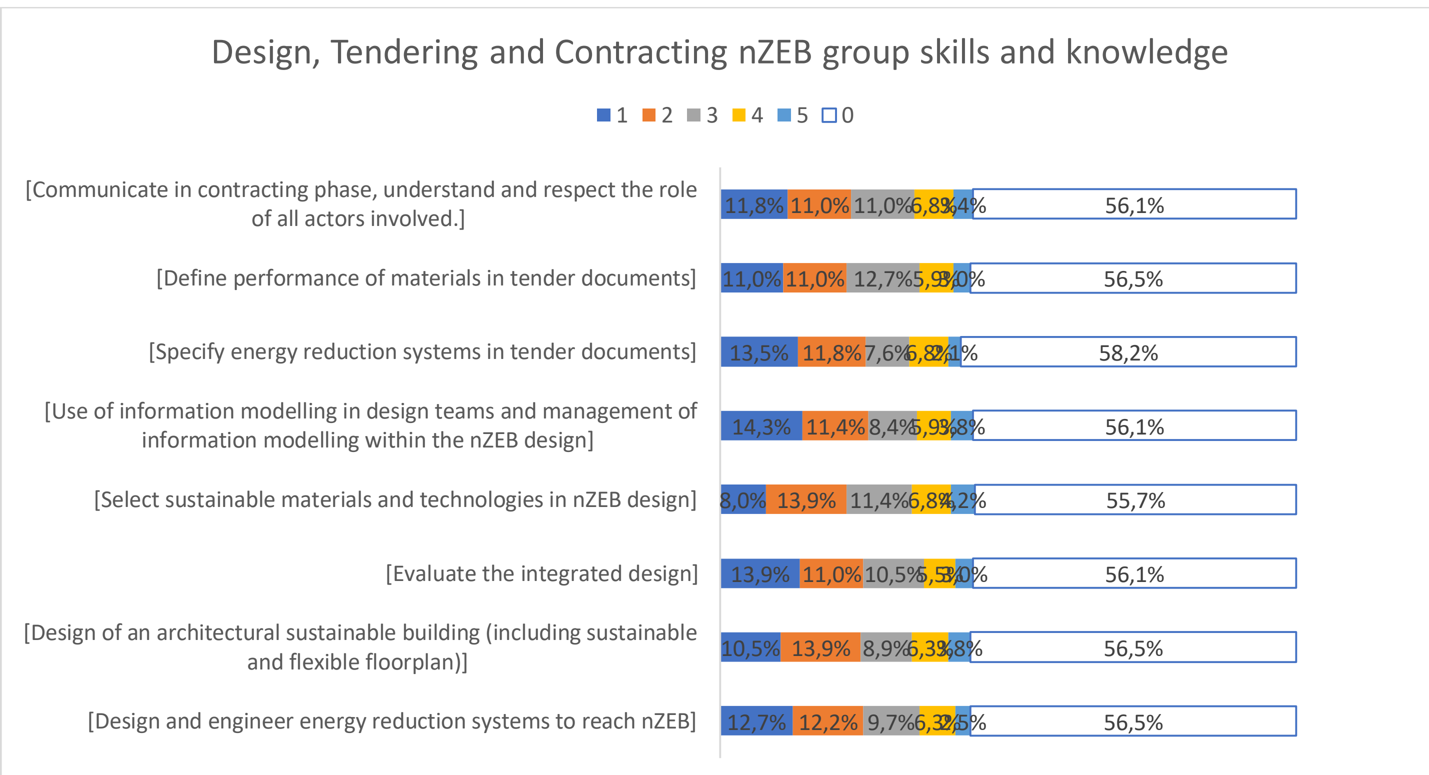
	BIM 5.5.	[BIM Requirements]
	BIM 5.6.	[Software Interoperability]
	BIM 5.7.	[Data Repository]
	BIM 5.8.	[BIM Workflow]
	BIM 5.9.	[Scope Management and Control]
Group of BIM knowledge and skills - Planning (Scope, Time, Cost, Quality, Risks)	BIM 6.1.	[Delivery Management - Models]
	BIM 6.2.	[Project Interactions - Model Use]
	BIM 6.3.	[Time / Programme Forecasting - 4D]
	BIM 6.4.	[Formal Cost Plans - Technology Integration]
	BIM 6.5.	[Quality Checking - Standards]
	BIM 6.6.	[Quality Checking - Design]
	BIM 6.7.	[BIM Quality plan]
	BIM 6.8.	[Model Checking]
	BIM 6.9.	[Construction Optimisation]
	BIM 6.10.	[Material / Element Tracking]
	BIM 6.11.	[Construction Progress Tracking]
	BIM 6.12.	[Construction Coordination - Clash Simulation]
Group of BIM knowledge and skills - Monitoring and Controlling	BIM 7.1.	[Sustainability reporting and testing]
	BIM 7.2.	[Performance based analysis]
	BIM 7.3.	[Construction Coordination - Clash Simulation]
	BIM 7.4.	[Delivery Management - Cost Mapping - 5D]
	BIM 7.5.	[Time / Programme Forecasting - 4D]
Group of BIM knowledge and skills - Execution/Operation	BIM 8.1.	[BIM Management Plan - Post Contract]
	BIM 8.2.	[Model Coordination - Clash Simulation]
	BIM 8.3.	[Model Coordination - Availability]
	BIM 8.4.	[Model Coordination - Common Data Environment]
	BIM 8.5.	[Collaborative Workflows - Native and Non-Native Applications]
	BIM 8.6.	[Expectations of BIM]
	BIM 8.7.	[Information Distribution]
	BIM 8.8.	[Change Process - Design Model Change Registry]
	BIM 8.9.	[As-Built Validation]

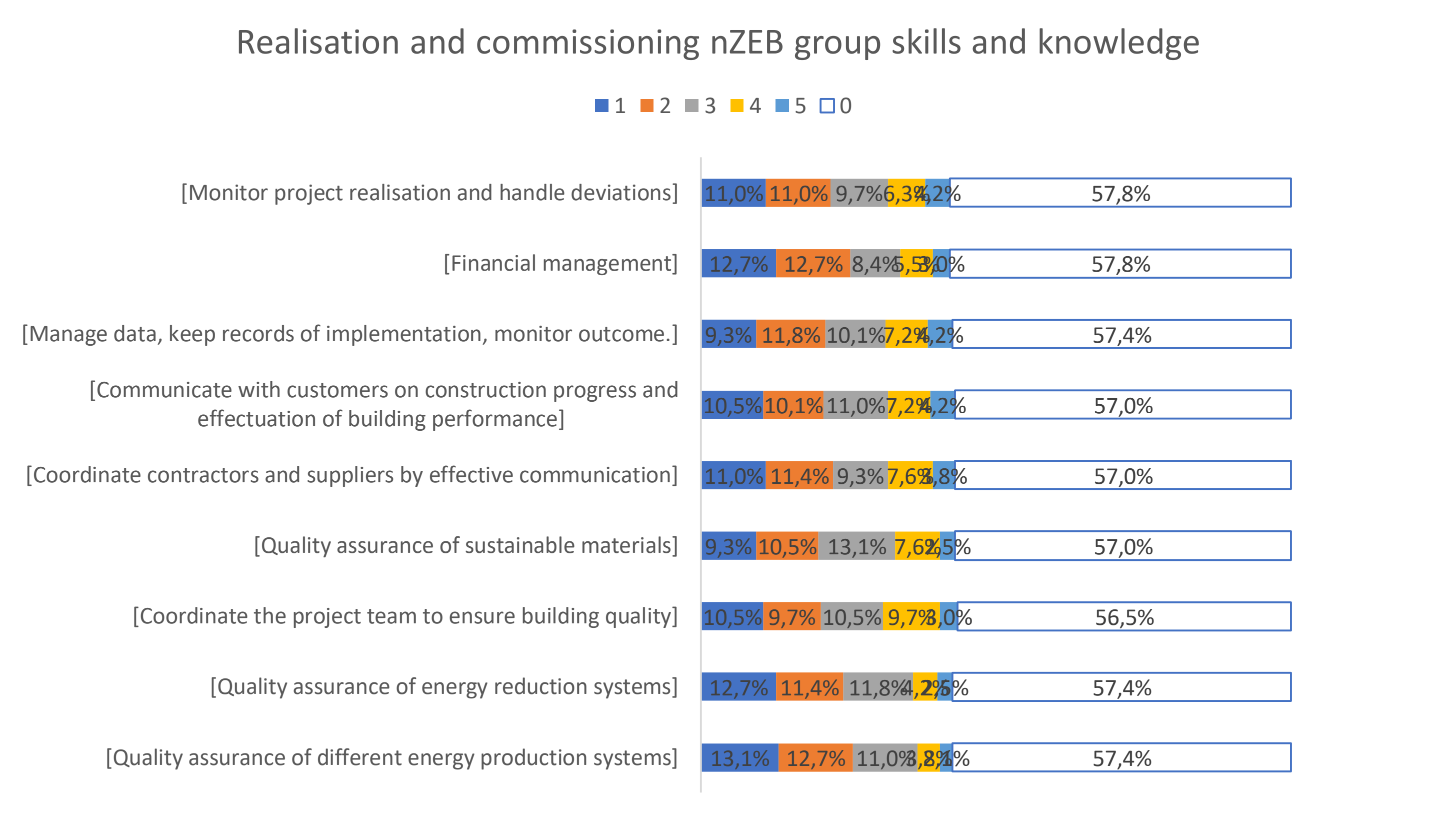
4.3.2 Construction industry level of skills and knowledge in nZEB field

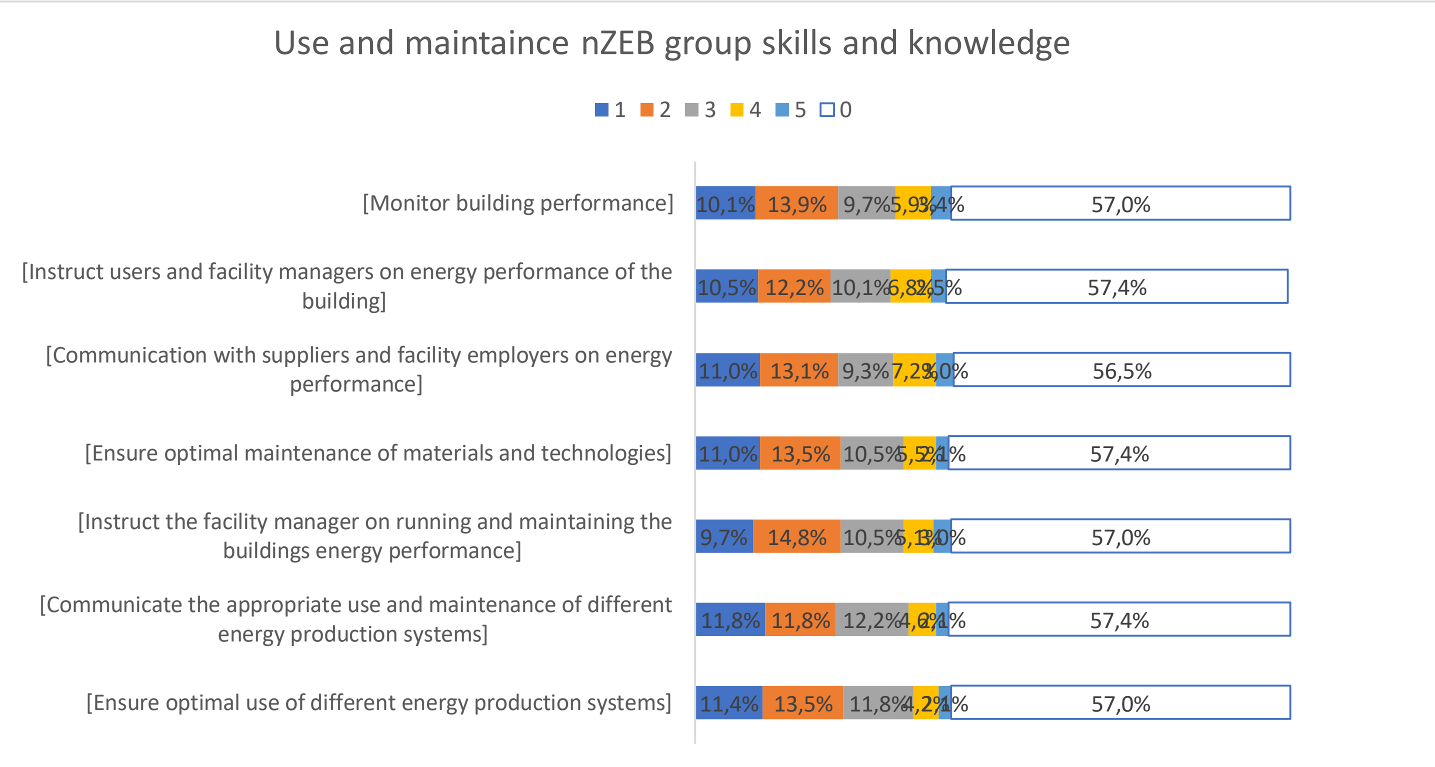
The results of this analysis in nZEB field are presented in the following graphs:




Pre-design nZEB group skills and knowledge
1 2 3 4 5 0
[Present the design and reach consensus on decisions.]
11,8% 8,4% 14,8% 55,3%
[Understand application of passive or active technologies]
7,6% 11,4% 13,5% 57,4%
[Understand performance, benefits and costs of various technologies]
8,9% 11,0% 13,5% 56,1%
[Knowledge on various installation materials, their performance, benefits versus costs]
8,4% 10,1% 12,7% 8,9% 55,3%
[Define and communicatie integrated design goals]
11,0% 15,2% 56,5%
[Design passive energy measures]
10,5% 16,5% 57,4%
[Select sustainable constructions technologies and materials]
9,3% 8,4% 15,6% 55,3%
[Investigate, determine and advise on energy reduction systems to reach nZEB]
12,2% 12,2% 9,3% 56,5%
[Assess systems related to building function and architecture]
11,4% 11,4% 56,1%
[Perform a feasibility study]
16,0% 13,5% 56,1%
[Perform energy simulations]
16,0% 11,8% 57,0%


Design, Tendering and Contracting nZEB group skills and knowledge
1 2 3 4 5 0
[Communicate in contracting phase, understand and respect the role of all actors involved.]
11,8% 11,0% 56,1%
[Define performance of materials in tender documents]
11,0% 11,0% 12,7% 56,5%
[Specify energy reduction systems in tender documents]
13,5% 11,8% 58,2%
[Use of information modelling in design teams and management of information modelling within the nZEB design]
14,3% 11,4% 56,1%
[Select sustainable materials and technologies in nZEB design]
8,0% 13,9% 55,7%
[Evaluate the integrated design]
13,9% 11,0% 56,1%
[Design of an architectural sustainable building (including sustainable and flexible floorplan)]
10,5% 13,9% 56,5%
[Design and engineer energy reduction systems to reach nZEB]
12,7% 12,2% 56,5%


Realisation and commissioning nZEB group skills and knowledge
1 2 3 4 5 0
[Monitor project realisation and handle deviations]
[Financial management]
[Manage data, keep records of implementation, monitor outcome.]
[Communicate with customers on construction progress and effectuation of building performance]
[Coordinate contractors and suppliers by effective communication]
[Quality assurance of sustainable materials]
[Coordinate the project team to ensure building quality]
[Quality assurance of energy reduction systems]
[Quality assurance of different energy production systems]
11,0% 11,0% 9,7% 6,3% 4,2% 57,8%
12,7% 12,7% 8,4% 57,8%
9,3% 11,8% 10,1% 7,2% 4,2% 57,4%
10,5% 10,1% 11,0% 7,2% 4,2% 57,0%
11,0% 11,4% 9,3% 7,6% 57,0%
9,3% 10,5% 13,1% 7,6% 57,0%
10,5% 9,7% 10,5% 9,7% 56,5%
12,7% 11,4% 11,8% 57,4%
13,1% 12,7% 57,4%


Use and maintaince nZEB group skills and knowledge
1 2 3 4 5 0
[Monitor building performance]
[Instruct users and facility managers on energy performance of the building]
[Communication with suppliers and facility employers on energy performance]
[Ensure optimal maintenance of materials and technologies]
[Instruct the facility manager on running and maintaining the buildings energy performance]
[Communicate the appropriate use and maintenance of different energy production systems]
[Ensure optimal use of different energy production systems]
10,1% 13,9% 9,7% 57,0%
10,5% 12,2% 57,4%
11,0% 13,1% 9,3% 56,5%
11,0% 13,5% 57,4%
9,7% 14,8% 57,0%
11,8% 11,8% 12,2% 57,4%
11,4% 13,5% 11,8% 57,0%

4.3.3 Construction industry level of skills and knowledge in BIM field

The survey identified that majority of respondents heard about the BIM but have no experience in implementing it (Figure 15) BIM implementation is still on the Level 1 or Level 2 but in 30% of cases.(Figure 16)

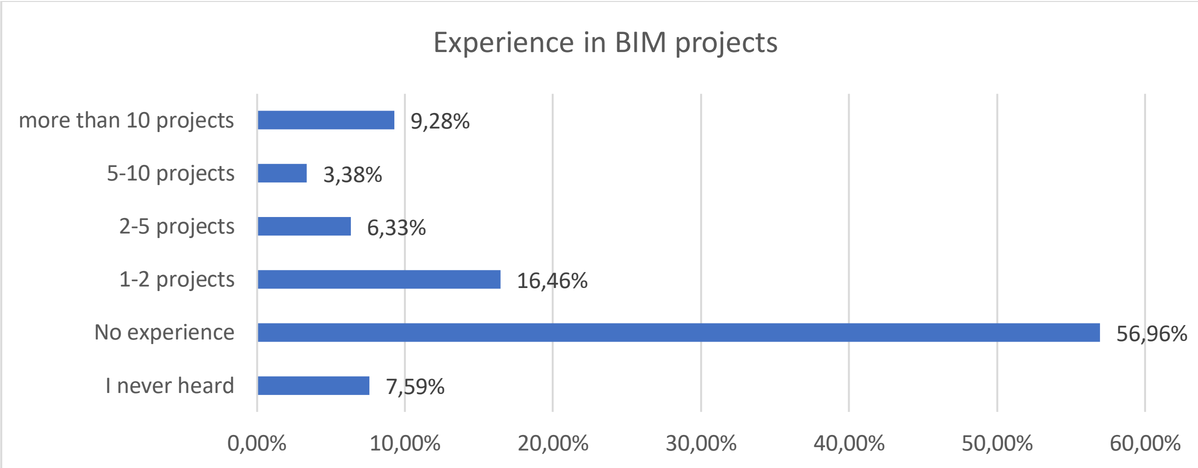


Figure 15 Experience in BIM projects

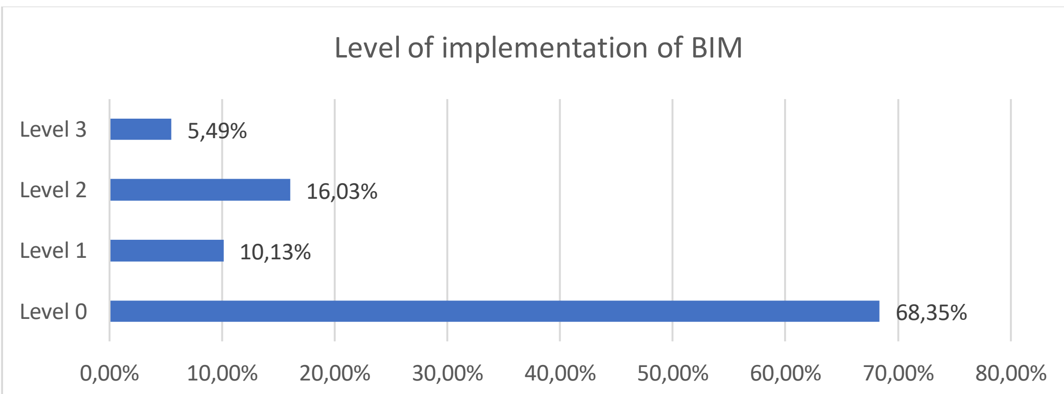


Figure 16 Level of implementation of BIM in projects

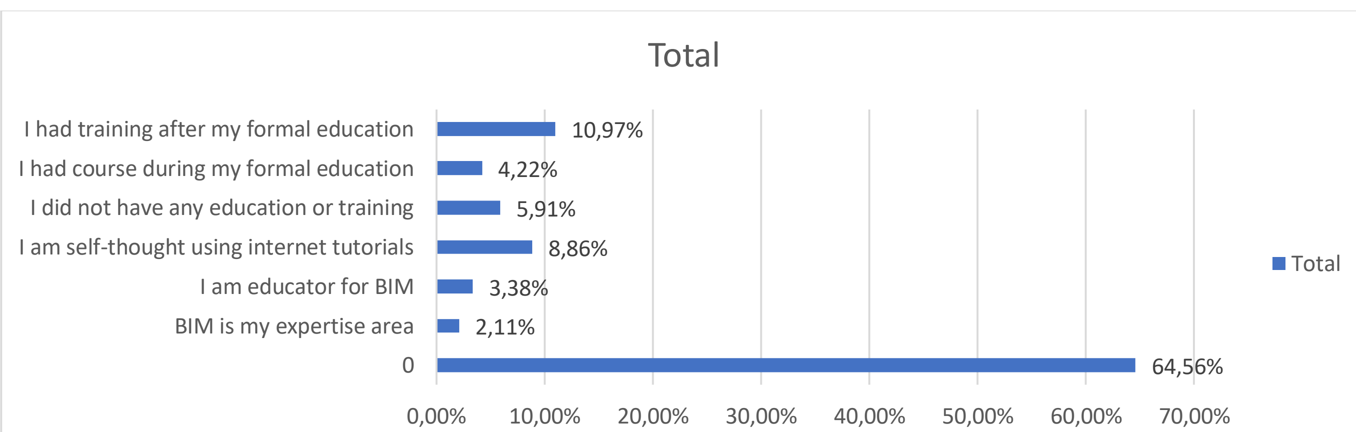


Figure 17 Education in BIM field

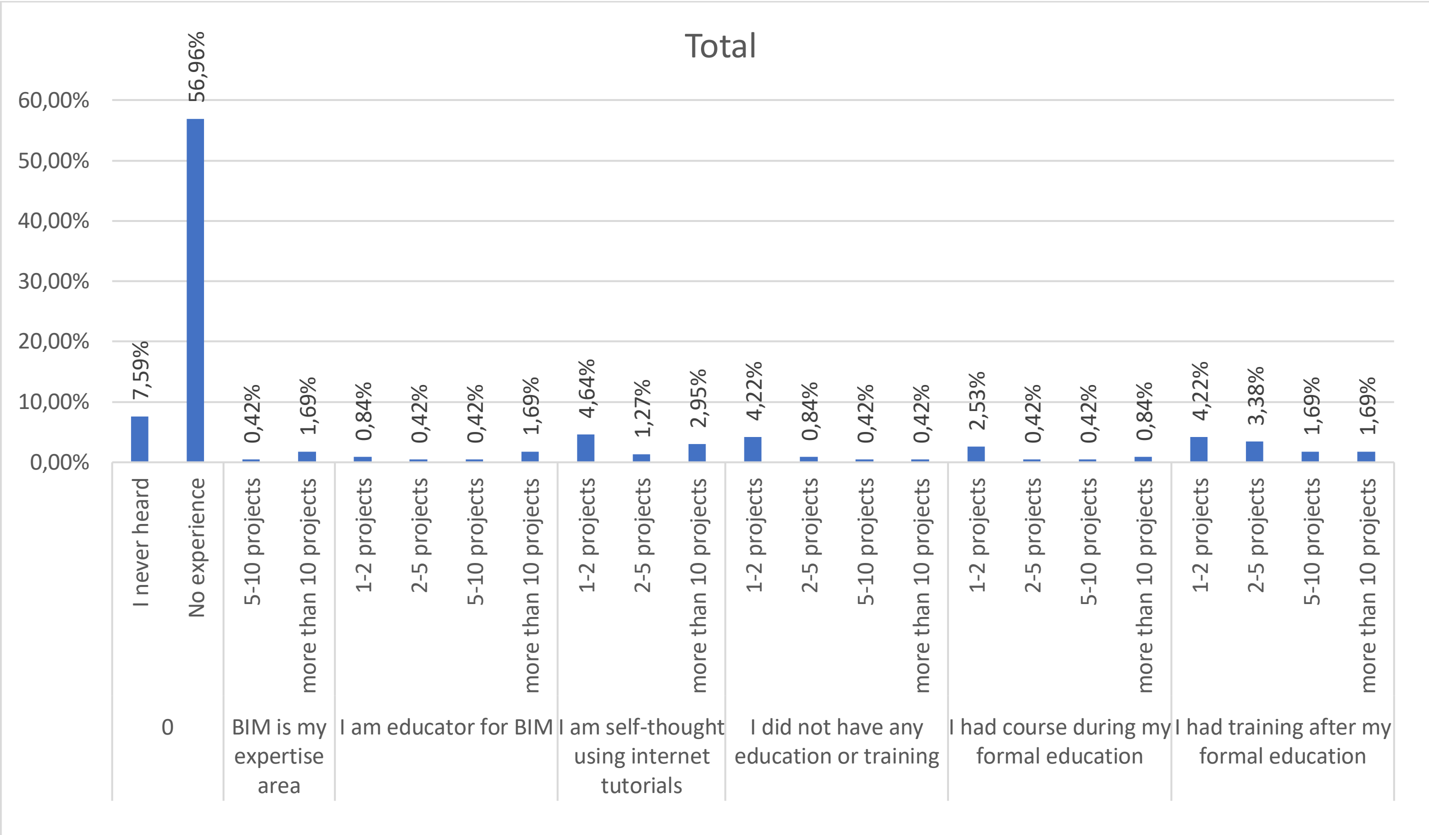
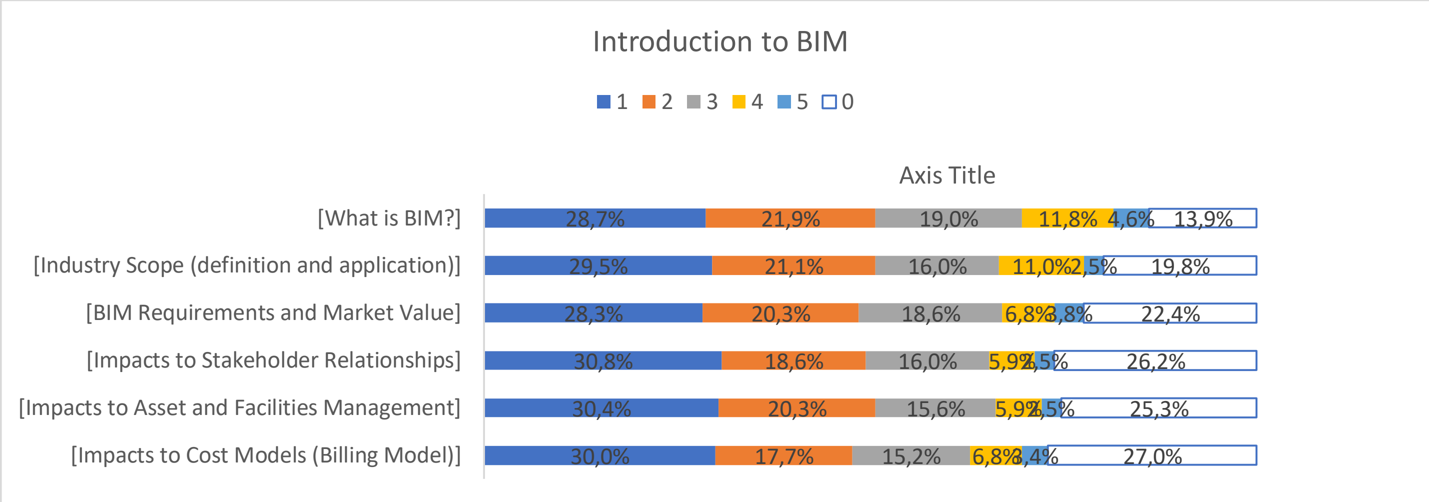
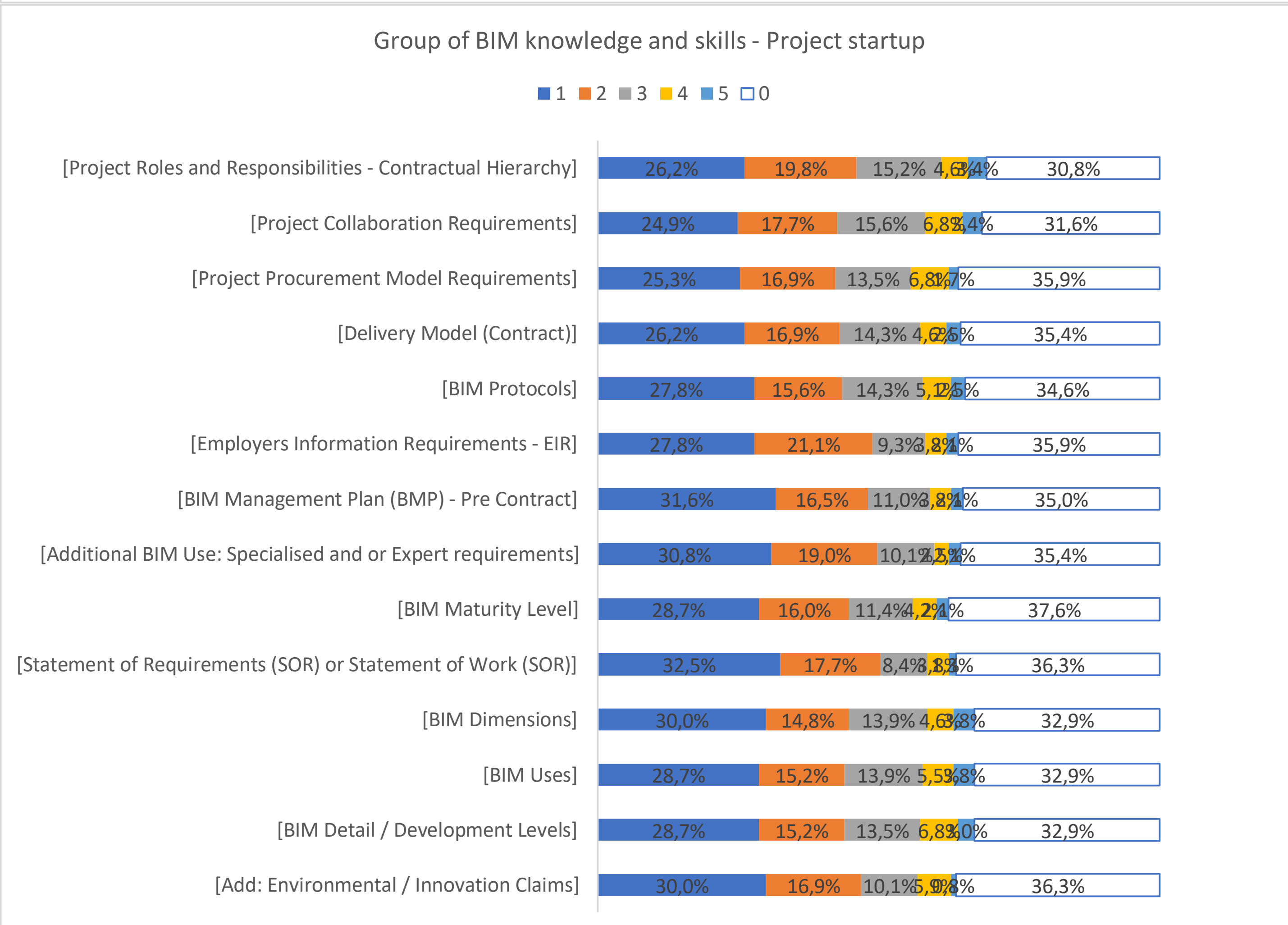


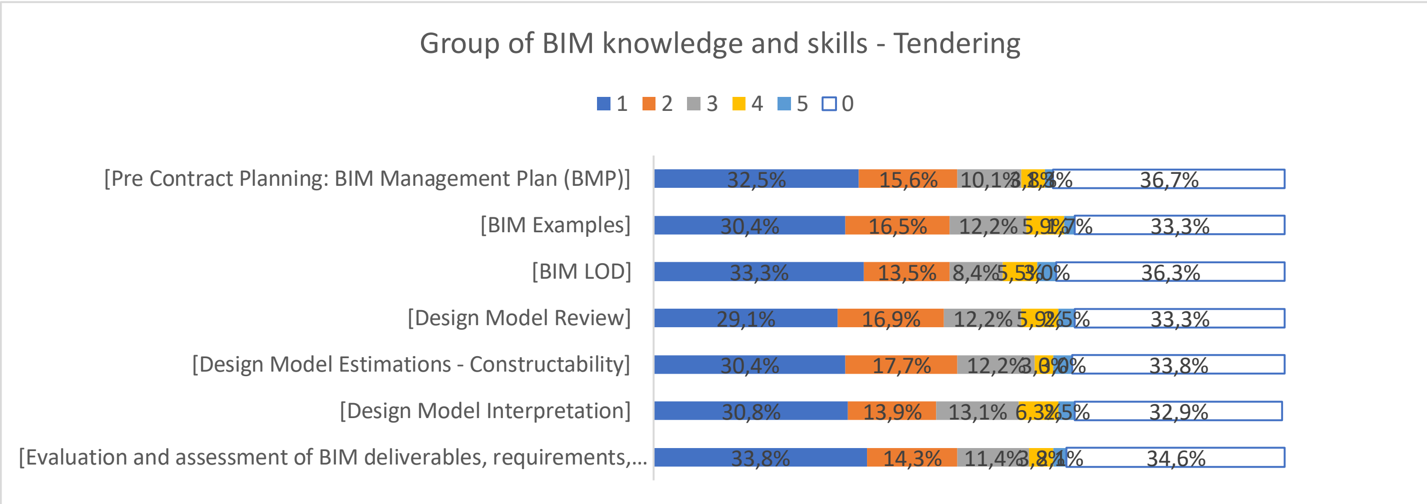
Figure 18 Number of BIM in projects depending on education

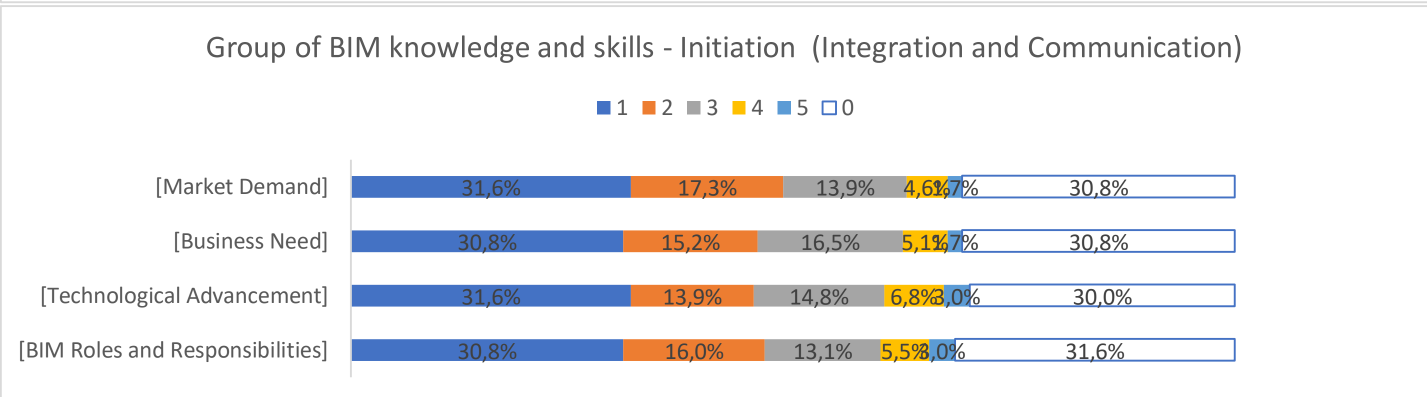
Moreover, majority of respondents did not receive any training nor education in BIM.field (Figure 17) Also, we have 9% self-thought respondents with experience in BIM implementation and respondents with experience in BIM projects but never received any training or education in BIM.(Figure 18)

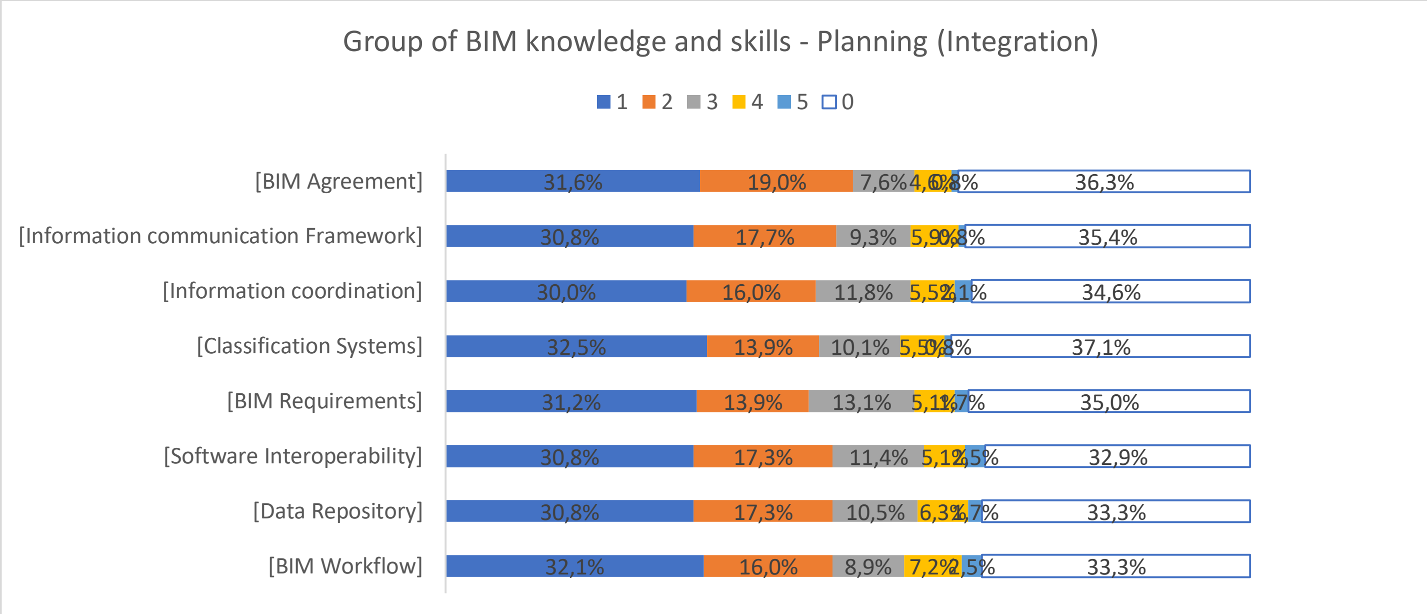
The results of self-assessments of respondents in BIM field are presented in the following graphs:

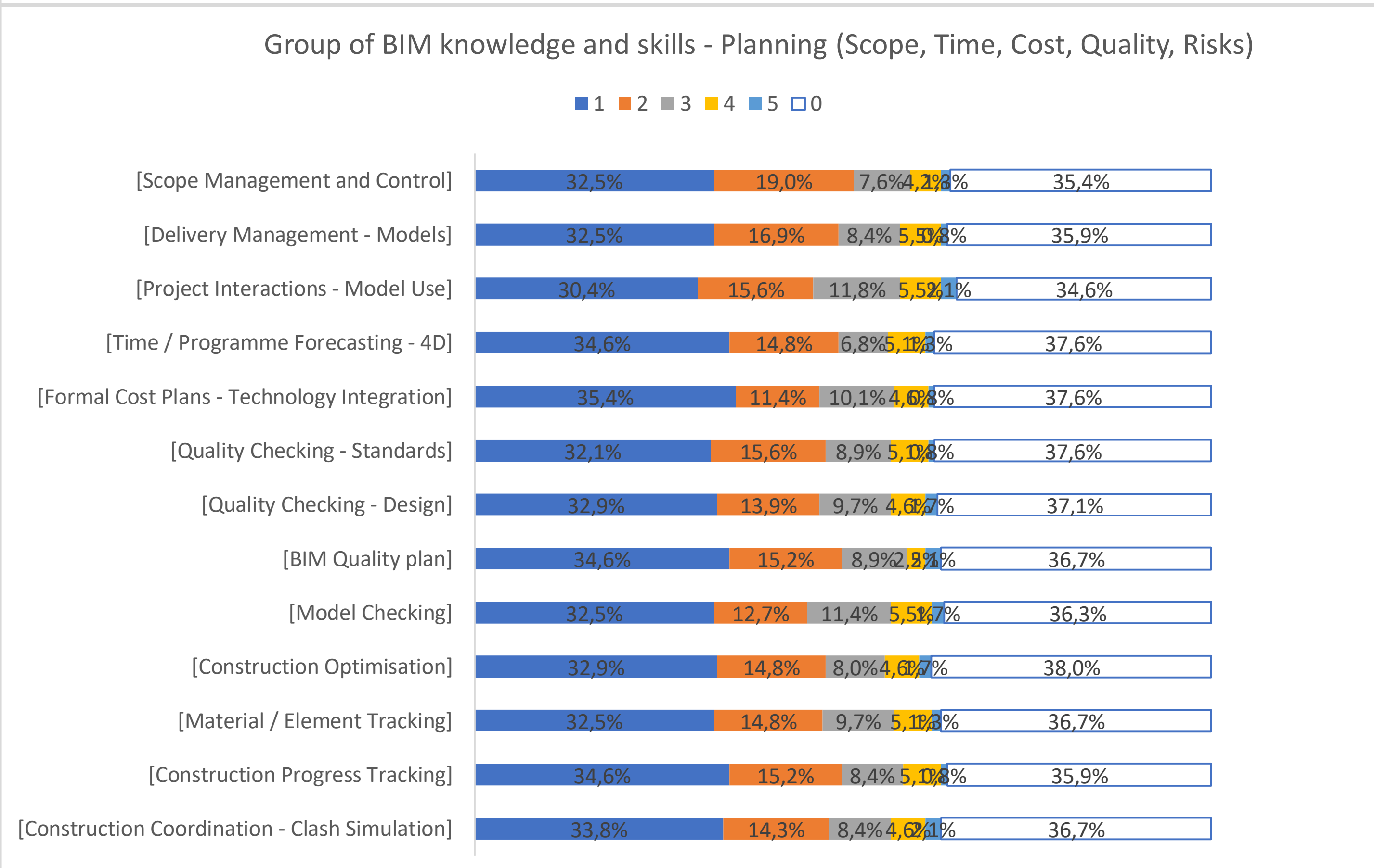

Introduction to BIM
1 2 3 4 5 0
Axis Title
[What is BIM?]
[Industry Scope (definition and application)]
[BIM Requirements and Market Value]
[Impacts to Stakeholder Relationships]
[Impacts to Asset and Facilities Management]
[Impacts to Cost Models (Billing Model)]
28,7% 21,9% 19,0% 11,8% 4,6% 13,9%
29,5% 21,1% 16,0% 11,0% 2,5% 19,8%
28,3% 20,3% 18,6% 22,4%
30,8% 18,6% 16,0% 26,2%
30,4% 20,3% 15,6% 25,3%
30,0% 17,7% 15,2% 27,0%

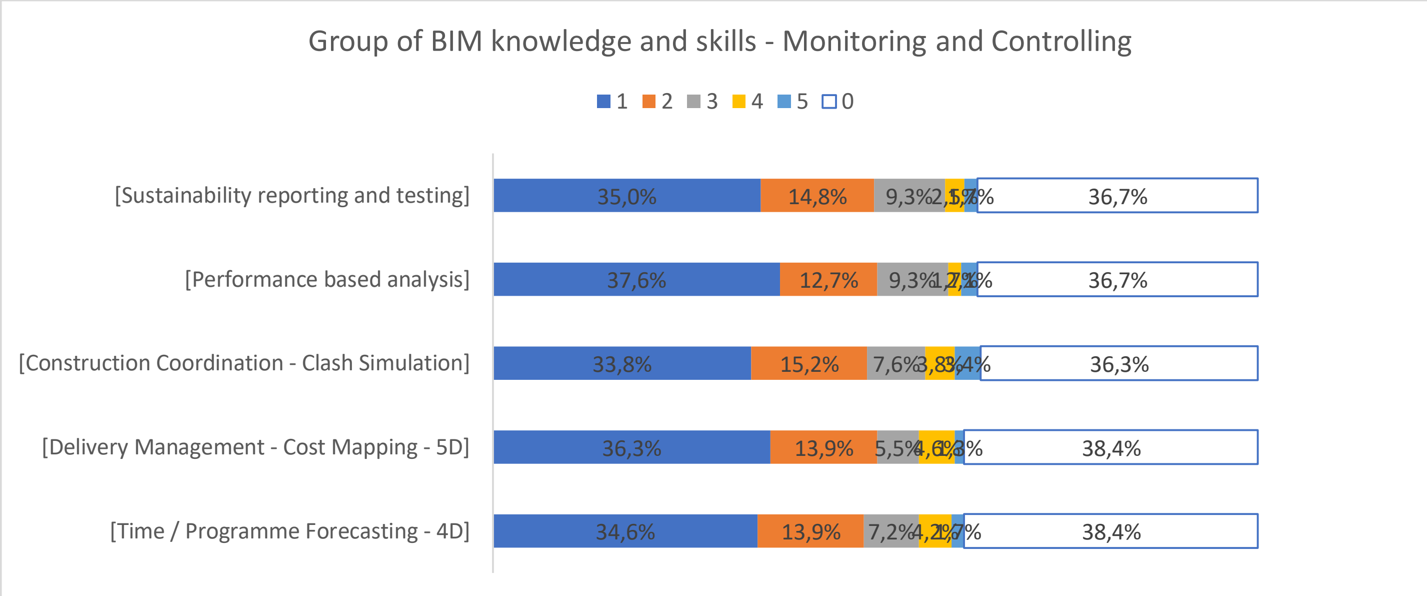

Group of BIM knowledge and skills - Project startup
1 2 3 4 5 0
[Project Roles and Responsibilities - Contractual Hierarchy]
[Project Collaboration Requirements]
[Project Procurement Model Requirements]
[Delivery Model (Contract)]
[BIM Protocols]
[Employers Information Requirements - EIR]
[BIM Management Plan (BMP) - Pre Contract]
[Additional BIM Use: Specialised and or Expert requirements]
[BIM Maturity Level]
[Statement of Requirements (SOR) or Statement of Work (SOR)]
[BIM Dimensions]
[BIM Uses]
[BIM Detail / Development Levels]
[Add: Environmental / Innovation Claims]
26,2% 19,8% 15,2% 30,8%
24,9% 17,7% 15,6% 31,6%
25,3% 16,9% 13,5% 35,9%
26,2% 16,9% 14,3% 35,4%
27,8% 15,6% 14,3% 34,6%
27,8% 21,1% 35,9%
31,6% 16,5% 35,0%
30,8% 19,0% 35,4%
28,7% 16,0% 37,6%
32,5% 17,7% 36,3%
30,0% 14,8% 13,9% 32,9%
28,7% 15,2% 13,9% 32,9%
28,7% 15,2% 13,5% 32,9%
30,0% 16,9% 36,3%

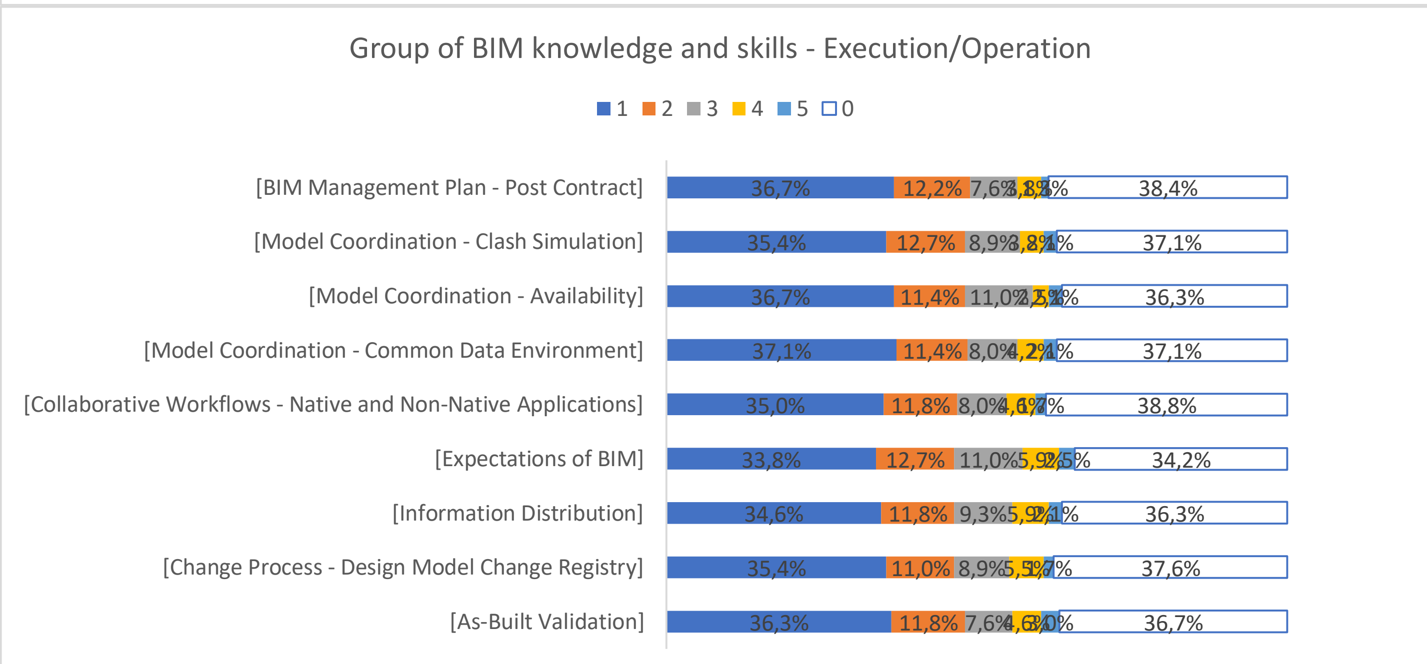

Group of BIM knowledge and skills - Tendering
1 2 3 4 5 0
[Pre Contract Planning: BIM Management Plan (BMP)]
32,5% 15,6% 36,7%
[BIM Examples]
30,4% 16,5% 12,2% 33,3%
[BIM LOD]
33,3% 13,5% 8,4% 36,3%
[Design Model Review]
29,1% 16,9% 12,2% 33,3%
[Design Model Estimations - Constructability]
30,4% 17,7% 33,8%
[Design Model Interpretation]
30,8% 13,9% 13,1% 32,9%
[Evaluation and assessment of BIM deliverables, requirements,…
33,8% 14,3% 34,6%


Group of BIM knowledge and skills - Initiation (Integration and Communication)
1 2 3 4 5 0
[Market Demand]
31,6% 17,3% 13,9% 30,8%
[Business Need]
30,8% 15,2% 16,5% 30,8%
[Technological Advancement]
31,6% 13,9% 14,8% 6,8% 30,0%
[BIM Roles and Responsibilities]
30,8% 16,0% 13,1% 31,6%


Group of BIM knowledge and skills - Planning (Integration)
1 2 3 4 5 0
[BIM Agreement] 31,6% 19,0% 7,6% 4,6% 0,8% 36,3%
[Information communication Framework] 30,8% 17,7% 9,3% 5,9% 0,8% 35,4%
[Information coordination] 30,0% 16,0% 11,8% 5,5% 2,1% 34,6%
[Classification Systems] 32,5% 13,9% 10,1% 5,5% 0,8% 37,1%
[BIM Requirements] 31,2% 13,9% 13,1% 5,1% 1,7% 35,0%
[Software Interoperability] 30,8% 17,3% 11,4% 5,1% 2,5% 32,9%
[Data Repository] 30,8% 17,3% 10,5% 6,3% 1,7% 33,3%
[BIM Workflow] 32,1% 16,0% 8,9% 7,2% 2,5% 33,3%


Group of BIM knowledge and skills - Planning (Scope, Time, Cost, Quality, Risks)
1 2 3 4 5 0
[Scope Management and Control] 32,5% 19,0% 7,6% 4,2% 1,3% 35,4%
[Delivery Management - Models] 32,5% 16,9% 8,4% 5,5% 0,8% 35,9%
[Project Interactions - Model Use] 30,4% 15,6% 11,8% 5,5% 2,1% 34,6%
[Time / Programme Forecasting - 4D] 34,6% 14,8% 6,8% 5,1% 1,3% 37,6%
[Formal Cost Plans - Technology Integration] 35,4% 11,4% 10,1% 4,6% 0,8% 37,6%
[Quality Checking - Standards] 32,1% 15,6% 8,9% 5,1% 0,8% 37,6%
[Quality Checking - Design] 32,9% 13,9% 9,7% 4,6% 1,7% 37,1%
[BIM Quality plan] 34,6% 15,2% 8,9% 2,5% 2,1% 36,7%
[Model Checking] 32,5% 12,7% 11,4% 5,5% 1,7% 36,3%
[Construction Optimisation] 32,9% 14,8% 8,0% 4,6% 1,7% 38,0%
[Material / Element Tracking] 32,5% 14,8% 9,7% 5,1% 1,3% 36,7%
[Construction Progress Tracking] 34,6% 15,2% 8,4% 5,1% 0,8% 35,9%
[Construction Coordination - Clash Simulation] 33,8% 14,3% 8,4% 4,6% 2,1% 36,7%


Group of BIM knowledge and skills - Monitoring and Controlling
1 2 3 4 5 0
[Sustainability reporting and testing]
35,0%
14,8%
36,7%
[Performance based analysis]
37,6%
12,7%
36,7%
[Construction Coordination - Clash Simulation]
33,8%
15,2%
36,3%
[Delivery Management - Cost Mapping - 5D]
36,3%
13,9%
38,4%
[Time / Programme Forecasting - 4D]
34,6%
13,9%
38,4%


Group of BIM knowledge and skills - Execution/Operation
1 2 3 4 5 0
[BIM Management Plan - Post Contract]
36,7%
12,2%
38,4%
[Model Coordination - Clash Simulation]
35,4%
12,7%
37,1%
[Model Coordination - Availability]
36,7%
11,4%
36,3%
[Model Coordination - Common Data Environment]
37,1%
11,4%
37,1%
[Collaborative Workflows - Native and Non-Native Applications]
35,0%
11,8%
38,8%
[Expectations of BIM]
33,8%
12,7%
11,0%
34,2%
[Information Distribution]
34,6%
11,8%
36,3%
[Change Process - Design Model Change Registry]
35,4%
11,0%
37,6%
[As-Built Validation]
36,3%
11,8%
36,7%

5 Skills requirements with emphasis on BIM and nZEB, and other AI understandings

The survey showed that respondents basic all have limited or no experience nether in nZEB or BIM implementation.(Figure 19) Also, more than 40% of respondents did not have education in BIM and nZEB. (Figure 20)

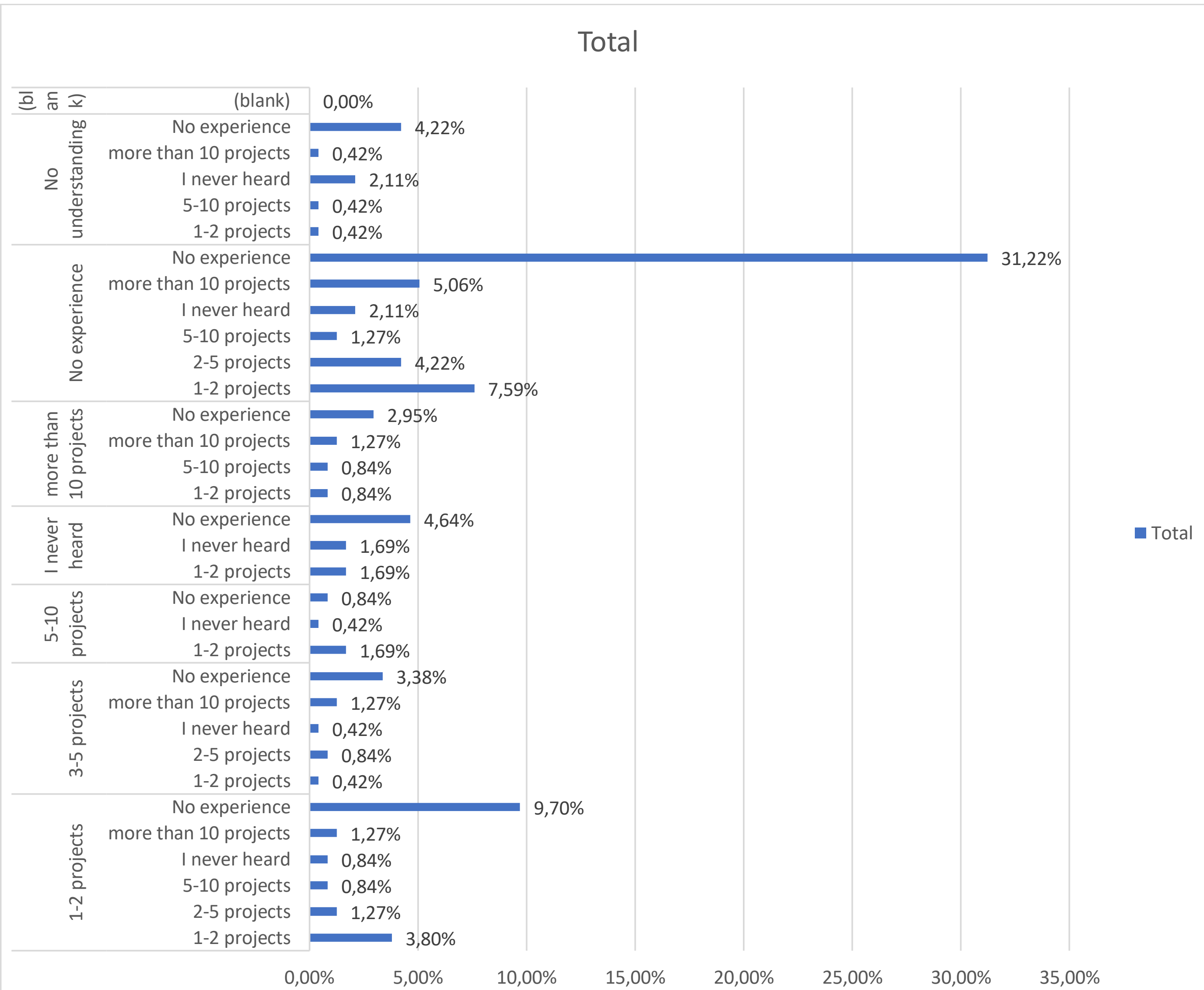


Figure 19 Experience of respondents I both nZEB and BIM projects

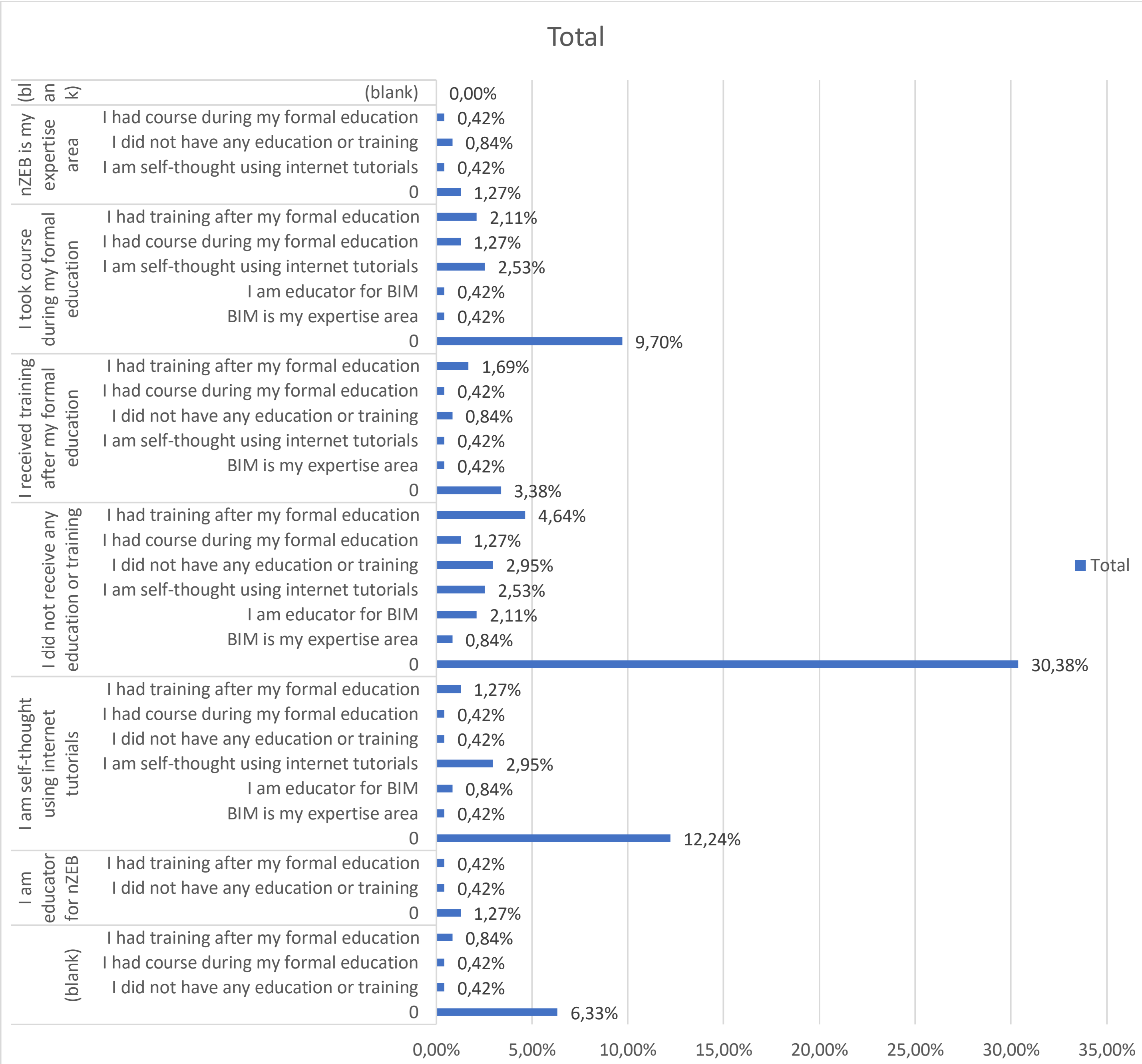


Figure 20 Number of BIM in projects depending on education

As it was stated in Introduction, we used NSG to identify parts of two skills frameworks, for nZEB and BIM. NSG was constituted of representatives from two educators and experts from those two fields. They identified the importance of each nZEB skill can be improved by using BIM, and which BIM skills are needed to improve nZEB projects design/delivery.

Grades were set as following:

- 1 Fundamental Awareness (basic knowledge)
- 2 Novice (limited experience/Basic Level of Competency)
- 3 Intermediate (practical application/Proficient)
- 4 Advanced (applied theory)
- 5 Expert (recognised authority)

Table 5 Average grade of construction industry in nZEB

General nZEB group of skills and knowledge	3,00	[Understand influence of heating and cooling generation on energy performance]	2,79
		[Understand specifics and basic parameters of heating and cooling]	2,77
		[Understand different energy production systems inrelation to energy performance]	2,85
		[Understand importance of energy reduction systems in relation to energy performance]	3,24
		[Understand the impact of architectural design on sustainablity and energy performance]	3,19
		[Understand integrated design processes and concepts]	3,02
		[Understand the interaction of building location, design, use and outdoor climate]	3,10
		[Understand sustainable materials and the importance of its appropriate application]	3,14
		[Understand sustainable building technologies and appropriate application]	3,06
		[Understand the interaction between energy performance and IEQ]	2,93
		[Understand design methods for passive energy technologies]	2,83
		[Understand effective communication within projects aimed to achieve nZEB]	2,94
		[Understand interdisciplinary teamwork towards common goals]	3,15
Pre-design nZEB group of skills and knowledge	2,48	[Perform energy simulations]	2,18
		[Perform a feasibility study]	2,15
		[Assess systems related to building function and architecture]	2,47
		[Investigate, determine and advise on energy reduction systems to reach nZEB]	2,45
		[Select sustainable constructions technologies and materials]	2,71
		[Design passive energy measures]	2,36
		[Define and communicatie integrated design goals]	2,35
		[Knowledge on various installation materials, their performance, benefits versus costs]	2,78
		[Understand performance, benefits and costs of various technologies]	2,63
		[Understand application of passive or active technologies]	2,67
		[Present the design and reach consensus on decisions.]	2,56
Design nZEB group of skills and knowledge	2,47	[Design and engineer energy reduction systems to reach nZEB]	2,40
		[Design of an architectural sustainable building (including sustainable and flexible floorplan)]	2,51
		[Evaluate the integrated design]	2,38
		[Select sustainable materials and technologies in nZEB design]	2,67
		[Use of information modelling in design teams and management of information modelling within the nZEB design]	2,39
Tendering/ contracting nZEB	2,46	[Specify energy reduction systems in tender documents]	2,33
		[Define performance of materials in tender documents]	2,51

		[Communicate in contracting phase, understand and respect the role of all actors involved.]	2,52
Realization and Commissioning nZEB group of skills and knowledge	2,52	[Quality assurance of different energy production systems]	2,28
		[Quality assurance of energy reduction systems]	2,36
		[Coordinate the project team to ensure building quality]	2,65
		[Quality assurance of sustainable materials]	2,62
		[Coordinate contractors and suppliers by effective communication]	2,58
		[Communicate with customers on construction progress and effectuation of building performance]	2,64
		[Manage data, keep records of implementation, monitor outcome.]	2,65
		[Financial management]	2,37
		[Monitor project realisation and handle deviations]	2,57
Use and maintaining nZEB group of skills and knowledge	2,44	[Ensure optimal use of different energy production systems]	2,35
		[Communicate the appropriate use and maintenance of different energy production systems]	2,38
		[Instruct the facility manager on running and maintaining the buildings energy performance]	2,46
		[Ensure optimal maintenance of materials and technologies]	2,40
		[Communication with suppliers and facility employers on energy performance]	2,50
		[Instruct users and facility managers on energy performance of the building]	2,49
		[Monitor building performance]	2,50

Table 6 Average grade of construction industry in BIM

Introduction to BIM	2,16	[What is BIM?]	2,32
		[Industry Scope (definition and application)]	2,20
		[BIM Requirements and Market Value]	2,20
		[Impacts to Stakeholder Relationships]	2,06
		[Impacts to Asset and Facilities Management]	2,06
		[Impacts to Cost Models (Billing Model)]	2,12
BIM - Project startup	2,02	[Project Performance Requirements]	2,10
		[Project Roles and Responsibilities - Contractual Hierarchy]	2,12
		[Project Collaboration Requirements]	2,21
		[Project Procurement Model Requirements]	2,11
		[Delivery Model (Contract)]	2,08
		[BIM Protocols]	2,06
		[Employers Information Requirements - EIR]	1,93
		[BIM Management Plan (BMP) - Pre Contract]	1,90
		[Additional BIM Use: Specialised and or Expert requirements]	1,86
		[BIM Maturity Level]	1,96
		[Statement of Requirements (SOR) or Statement of Work (SOR)]	1,80
		[BIM Dimensions]	2,07
		[BIM Uses]	2,11
		[BIM Detail / Development Levels]	2,11

		[Add: Environmental / Innovation Claims]	1,91
BIM - Tendering	1,95	[Pre Contract Planning: BIM Management Plan (BMP)]	1,83
		[BIM Examples]	1,98
		[BIM LOD]	1,92
		[Design Model Review]	2,04
		[Design Model Estimations - Constructability]	1,95
		[Design Model Interpretation]	2,04
		[Evaluation and assessment of BIM deliverables, requirements, expectations and weighting]	1,87
BIM - Initiation (Integration and Communication)	2,02	[Market Demand]	1,95
		[Business Need]	2,01
		[Technological Advancement]	2,08
		[BIM Roles and Responsibilities]	2,03
BIM - Planning (Integration)	1,93	[BIM Agreement]	1,81
		[Information communication Framework]	1,89
		[Information coordination]	1,99
		[Classification Systems]	1,86
		[BIM Requirements]	1,95
		[Software Interoperability]	1,97
		[Data Repository]	1,96
		[BIM Workflow]	1,98
BIM - Planning (Scope, Time, Cost, Quality, Risks)	1,84	[Scope Management and Control]	1,80
		[Delivery Management - Models]	1,84
		[Project Interactions - Model Use]	1,98
		[Time / Programme Forecasting - 4D]	1,78
		[Formal Cost Plans - Technology Integration]	1,78
		[Quality Checking - Standards]	1,83
		[Quality Checking - Design]	1,86
		[BIM Quality plan]	1,77
		[Model Checking]	1,92
		[Construction Optimisation]	1,83
		[Material / Element Tracking]	1,86
		[Construction Progress Tracking]	1,79
		[Construction Coordination - Clash Simulation]	1,85
BIM - Monitoring and Controlling	1,76	[Sustainability reporting and testing]	1,75
		[Performance based analysis]	1,71
		[Construction Coordination - Clash Simulation-M&C]	1,87
		[Delivery Management - Cost Mapping - 5D]	1,71
		[Time / Programme Forecasting - 4D_M&C]	1,77
BIM - Execution/Operation	1,82	[BIM Management Plan - Post Contract]	1,71
		[Model Coordination - Clash Simulation]	1,80
		[Model Coordination - Availability]	1,77
		[Model Coordination - Common Data Environment]	1,77
		[Collaborative Workflows - Native and Non-Native Applications]	1,79
		[Expectations of BIM]	1,95

		[Information Distribution]	1,89
		[Change Process - Design Model Change Registry]	1,83
		[As-Built Validation]	1,83

In order to evaluate current effects of nZEB and BIM development we calculated level of knowledge of respondents who stated that have any knowledge or skills in certain field. The result is that we have slightly better situation in nZEB field than in BIM.

Skill and knowledge level	nZEB	BIM
1	9,8%	31,8%
2	11,0%	15,7%
3	11,8%	11,2%
4	7,7%	5,1%
5	3,3%	2,1%
0	56,4%	34,1%

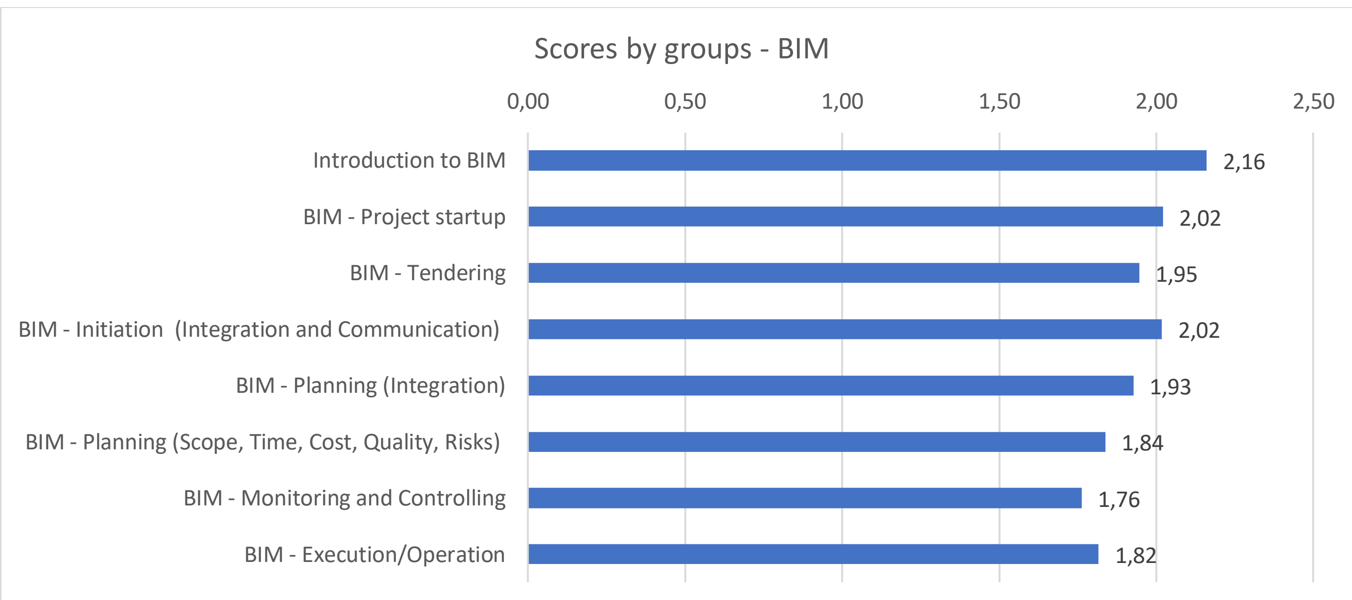


Figure 21 Average scores by groups - BIM

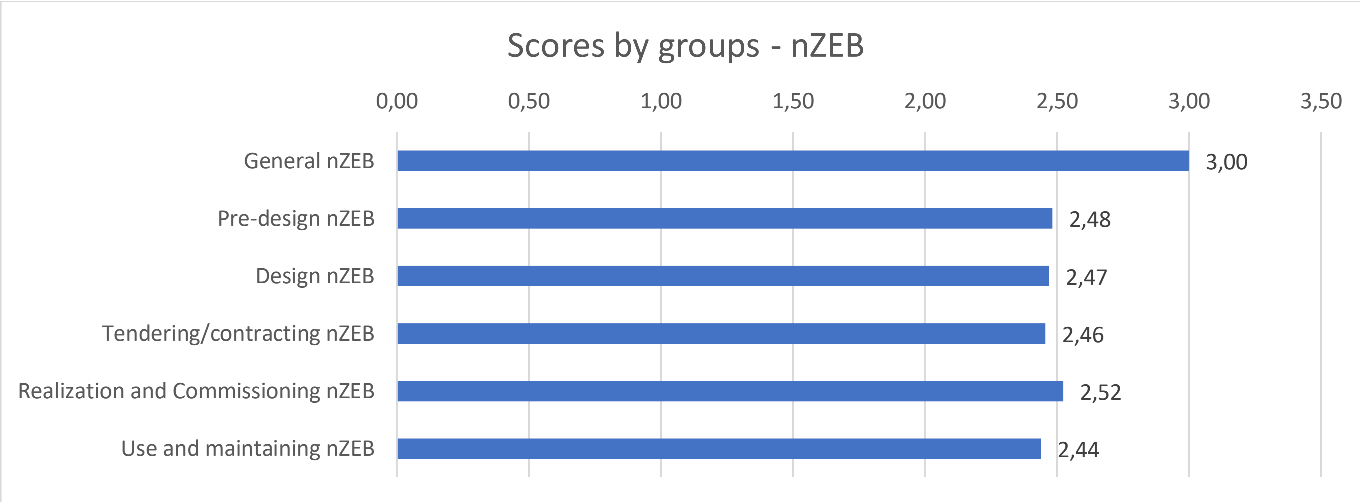


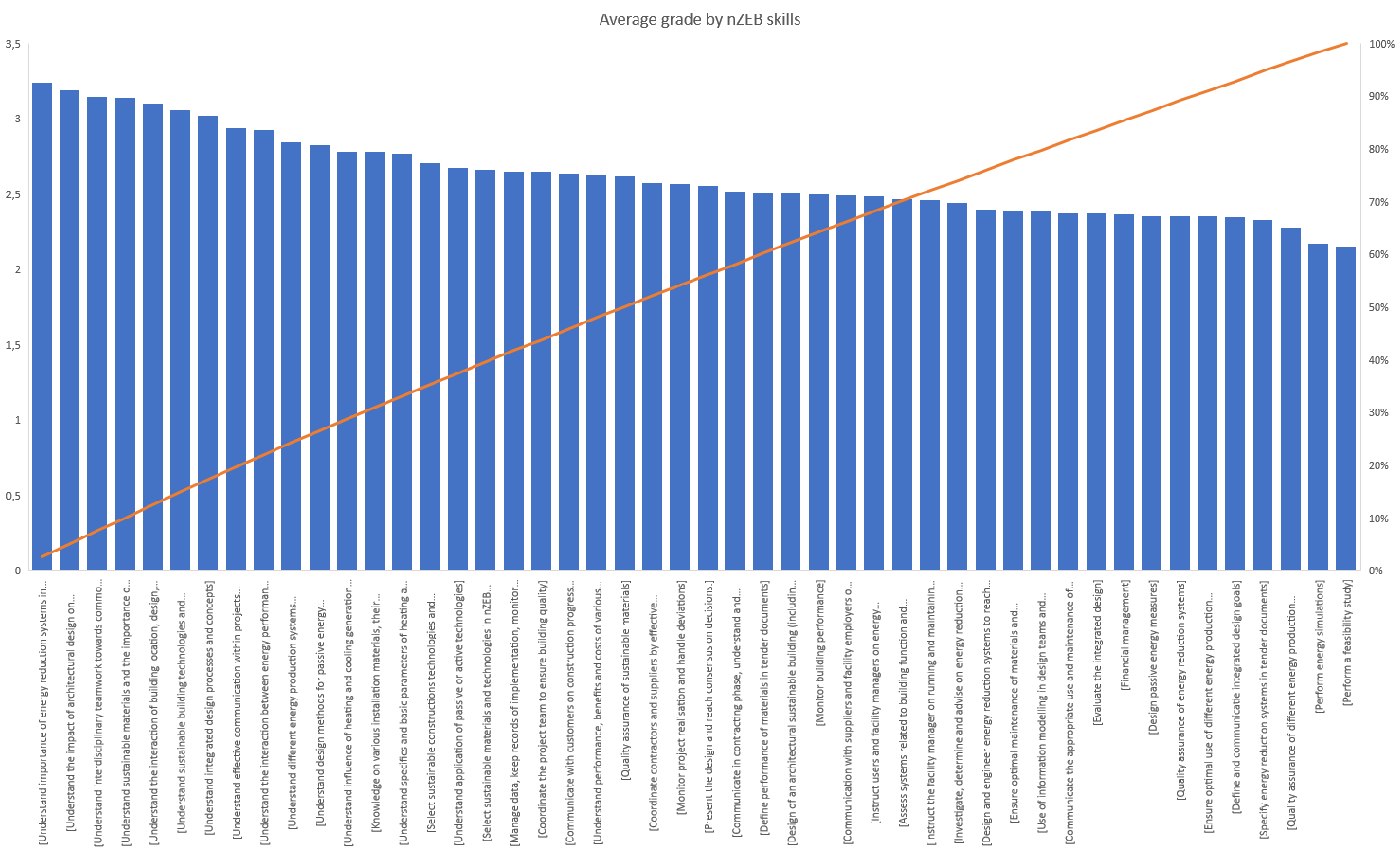
Figure 22 Average scores by groups - nZEB

In following graphs specific knowledge and skills are calculated taking each level as grade, and sorted according to average grade. In following table we can see top and bottom 10% skills and overall grade for **nZEB is 2,62** and for **BIM is 1,93.**

NZEB knowledge and skills - Top 10 %		BIM knowledge and skills - Top 10 %	
[Understand importance of energy reduction systems in relation to energy performance]	3,24	[What is BIM?]	2,32
[Understand the impact of architectural design on sustainablity and energy performance]	3,19	[Industry Scope (definition and application)]	2,20
[Understand sustainable materials and the importance of its appropriate application]	3,14	[BIM Requirements and Market Value]	2,20
[Understand interdisciplinary teamwork towards common goals]	3,15	[Impacts to Cost Models (Billing Model)]	2,12
		[Project Roles and Responsibilities - Contractual Hierarchy]	2,12
		[Project Collaboration Requirements]	2,21

nZEB knowledge and skills - Bottom 10 %		BIM knowledge and skills – Bottom 10 %	
[Perform energy simulations]	2,18	[BIM Quality plan]	1,77
[Perform a feasibility study]	2,15	[Sustainability reporting and testing]	1,75

[Specify energy reduction systems in tender documents]	2,33	[Performance based analysis]	1,71
[Quality assurance of different energy production systems]	2,28	[Delivery Management - Cost Mapping - 5D]	1,71
		[BIM Management Plan - Post Contract]	1,71
		[Model Coordination - Common Data Environment]	1,77


Average grade by nZEB skills

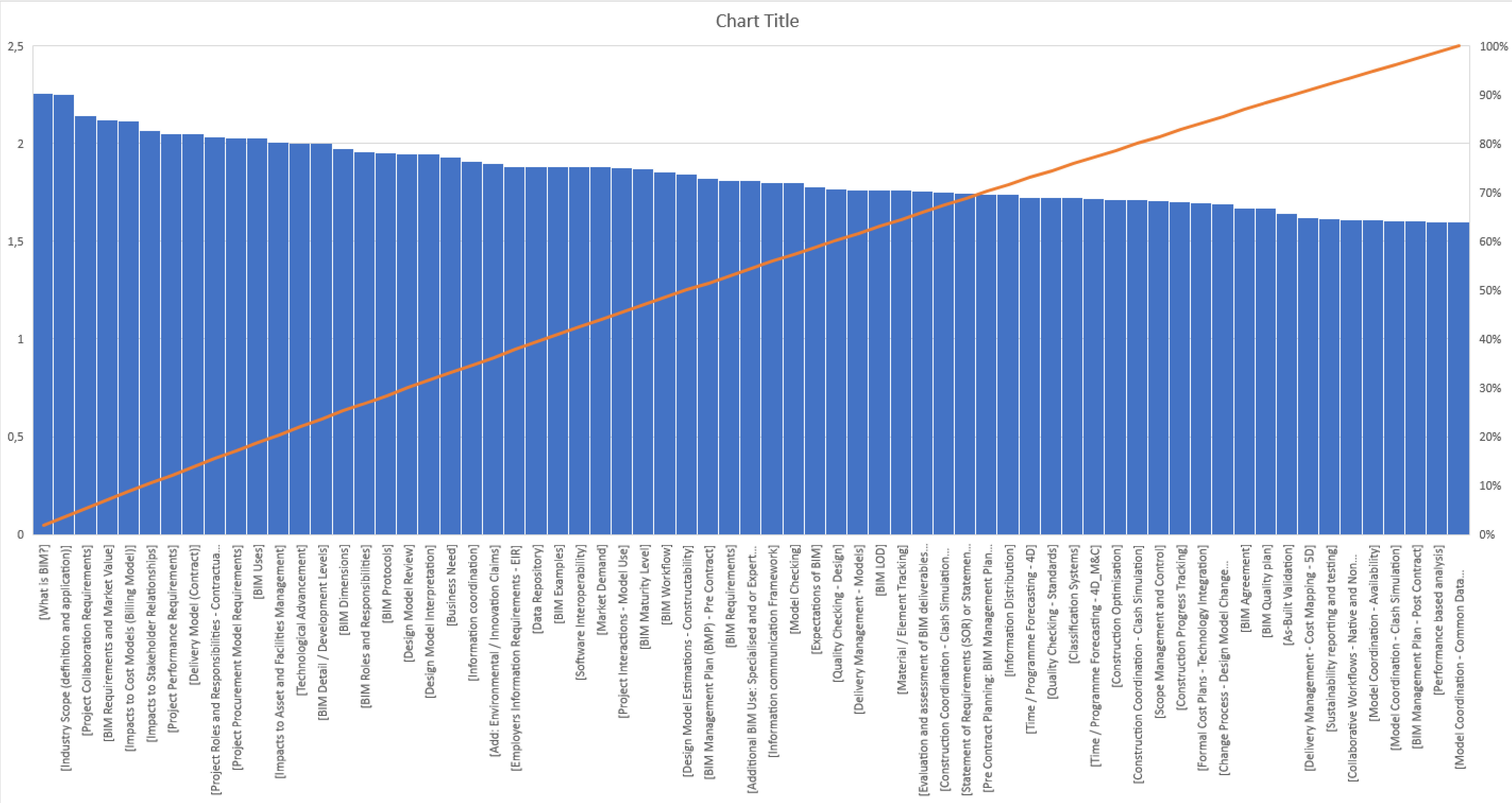


Chart Title
2,5
2
1,5
1
0,5
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
[What is BIM?]
[Industry Scope (definition and application)]
[Project Collaboration Requirements]
[BIM Requirements and Market Value]
[Impacts to Cost Models (Billing Model)]
[Impacts to Stakeholder Relationships]
[Project Performance Requirements]
[Delivery Model (Contract)]
[Project Roles and Responsibilities - Contractua...
[Project Procurement Model Requirements]
[BIM Uses]
[Impacts to Asset and Facilities Management]
[Technological Advancement]
[BIM Detail / Development Levels]
[BIM Dimensions]
[BIM Roles and Responsibilities]
[BIM Protocols]
[Design Model Review]
[Design Model Interpretation]
[Business Need]
[Information coordination]
[Add: Environmental / Innovation Claims]
[Employers Information Requirements - EIR]
[Data Repository]
[BIM Examples]
[Software Interoperability]
[Market Demand]
[Project Interactions - Model Use]
[BIM Maturity Level]
[BIM Workflow]
[Design Model Estimations - Constructability]
[BIM Management Plan (BMP) - Pre Contract]
[BIM Requirements]
[Additional BIM Use: Specialised and or Expert...
[Information communication Framework]
[Model Checking]
[Expectations of BIM]
[Quality Checking - Design]
[Delivery Management - Models]
[BIM LOD]
[Material / Element Tracking]
[Evaluation and assessment of BIM deliverables...
[Construction Coordination - Clash Simulation...
[Statement of Requirements (SOR) or Statemen...
[Pre Contract Planning: BIM Management Plan...
[Information Distribution]
[Time / Programme Forecasting - 4D]
[Quality Checking - Standards]
[Classification Systems]
[Time / Programme Forecasting - 4D_M&C]
[Construction Optimisation]
[Construction Coordination - Clash Simulation]
[Scope Management and Control]
[Construction Progress Tracking]
[Formal Cost Plans - Technology Integration]
[Change Process - Design Model Change...
[BIM Agreement]
[BIM Quality plan]
[As-Built Validation]
[Delivery Management - Cost Mapping - 5D]
[Sustainability reporting and testing]
[Collaborative Workflows - Native and Non...
[Model Coordination - Availability]
[Model Coordination - Clash Simulation]
[BIM Management Plan - Post Contract]
[Performance based analysis]
[Model Coordination - Common Data...

6 Conclusions

In this report we analysed the existing qualifications, educational background, specialisation, experience as well as skills assessment of construction industry with emphasis on BIM and nZEB,

We used standardized questionnaire with self-assessment of selected nZEB and BIM knowledge and skills which supporting their advancement.

Based on this evaluation and previous literature review, we can conclude level implementation in both fields are very low. One of the main reasons is that skills and knowledge is at very low level, therefore there is need for. improving knowledge and skills in nZEB and BIM field in order to raise lever of implementation of nZEB in projects.

The result of self-assessment part of questionnaire is that average grade for **nZEB is 2,62** and for **BIM is 1,93. With this project we need to rise average grades to at least to the 3 Intermediate (practical application/Proficient) level in order to bring the nZEB and BIM into practice.**

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