

Greener, Smarter, More Efficient: COMPETENCY FRAMEWORK FOR OFFSITE AND MODULAR CONSTRUCTION

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1. Introduction

1.1. The European market and its need for a new offsite and modular construction Competency Framework

The construction industry is experiencing an unprecedented period of rapid change across Europe, enabled by technological advances and socio-economic drivers. As the industry responds to emergent challenges including labour skills gaps, improving energy consumption and resource efficiency, digitising and modernising processes, and improving productivity; the need for a paradigm shift from traditional to modern methods of construction has been never been greater.

A report by the Construction Industry Training Board (CITB) in the UK proposed that the successful integration of OSM construction was highly reliant on the rapid upskilling of educators within existing education networks[1]. The researchers specifically acknowledged the 'shortage of tutors and assessors skilled in offsite'. Whilst the CITB report was specific to the UK, similar reports have emerged from partner nations. The European Builders Confederation reported in 2018 that 'The construction sector is faced with an ageing workforce and skills shortage, while youth unemployment remains high across the EU' [2] and a recent report on the construction industry in Germany found that 'the lack of skilled labour impairs the construction of new houses' [3]

Researchers in the field have called for a 'shared understanding between industry and training/education institutions to enable an...(OSM)... knowledgeable industry' [4] and recent EU focused report(s) have identified 'In most cases, the main reason explaining skills shortages is the inadequacy of educational programmes and vocational training' [5]. The resultant impact of the lack of appropriately skilled labour is a significant under-delivery of affordable and energy efficient housing stock across Europe.

Offsite and modular methods of construction (OSM) have been utilised in different ways across Europe and have proven to be cleaner, safer and more productive than traditional building methodologies. Recent advances in technological processes have brought offsite methodologies into the mainstream, with the associated benefits of addressing the key issues identified above as well as providing a route to lower cost, affordable housing stock.

Investment in a transnational collaboration presents an opportunity to accelerate the pan-European response to the education and skilling needs of the construction industry. The

[1]https://www.citb.co.uk/documents/research/offsite_construction/offsite_construction_full_report_20170410.pdf

[2]<https://www.kfw.de/PDF/Download-Center/Konzernthemen/Research/PDF-Dokumente-Fokus-Volkswirtschaft/Fokus-2018/Fokus-Nr.-221-August-2018-Fachkraefteengpaesse-im-Bauhandwerk.pdf>

[3]https://ebc-construction.eu/wp-content/uploads/EBC-RA2017-2018-EN_BD.pdf

[4]<https://www.emeraldinsight.com/doi/pdfplus/10.1108/09699981111098702>

[5]<https://ec.europa.eu/docsroom/documents/26206/attachments/1/translations/en/renditions/native>

project is predicated on the sharing of best practice, commonality in benchmarking and standardising educator training, sharing of effective pedagogical approaches and resources, and the development of a European network of professionals working and teaching within the field of OSM education.

The project is positioned within the field of higher education with a focus on developing advanced-level technical skills, thus our references to advanced vocational education and training (AVET) is synonymous with higher education.

The project aims to modernise the delivery of off-site and modular (OSM) construction advanced vocational education & training (AVET) by developing an innovative training model and joint curriculum that provides a framework to benchmark the quality of delivery within the partner nations. Specific emphasis will be placed upon the digitisation of key processes as well as key agendas including decarbonising activity and improving energy efficiency, workplace safety practices and supporting a diverse and equal workforce.

1.2. Aims and objectives of this research

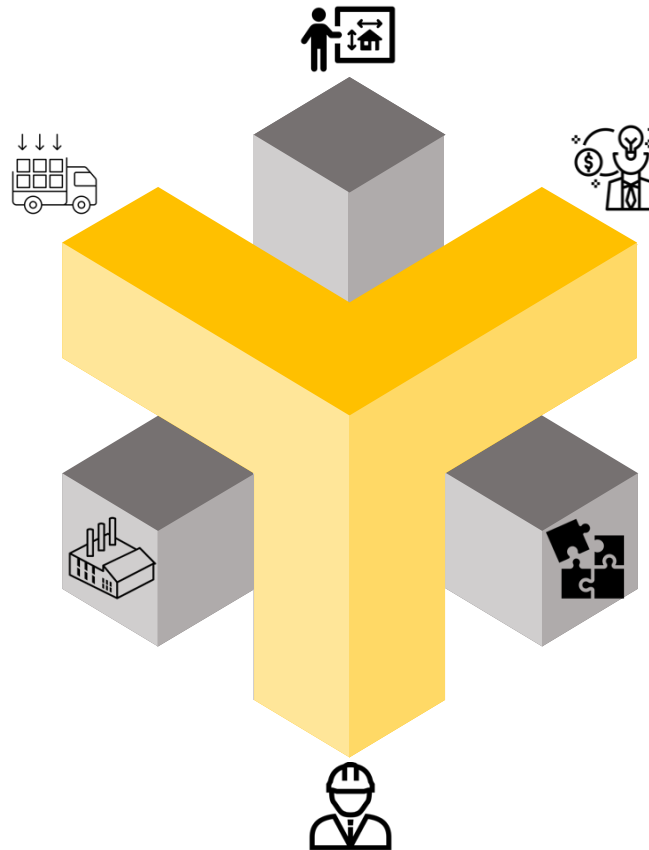
The main aim of this research was to provide a robust evidence base of the likely nature of industry demand for skills in offsite and modular construction in Europe.

1.3. Research methodology

1.3.1. Desk-based research

Desk-based research was used to identify key offsite functions and personas on which to focus the research as well as to map existing national competency frameworks to design a survey and prepare for depth interviews. Desk-based research also provided industry data from existing research to assess likely future demand for offsite and modular construction.

Key personas (job-functions) identified in the desk-based research are:



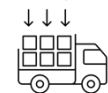
Digital design persona



Estimating / commercial persona



Offsite manufacturing persona



Logistics persona



Onsite placement and assembly persona



Site management and integration persona

Key job roles identified in the desk-based research are:

Job roles	European Qualification Framework
Skilled worker	Level 3 to 4
Manager	Level 5
Supervisor	Level 5 to 6
Senior Manager	Level 6 to 7

Key type of skills identified in the desk-based research are:



During our research, we have identified various entries for each of the three categories of skills identified above. We asked our survey participants to rate their importance for each different job role. Their combined responses are reported as an average for each role. These results can for example be found in 2.3 for the Digital Design Persona.

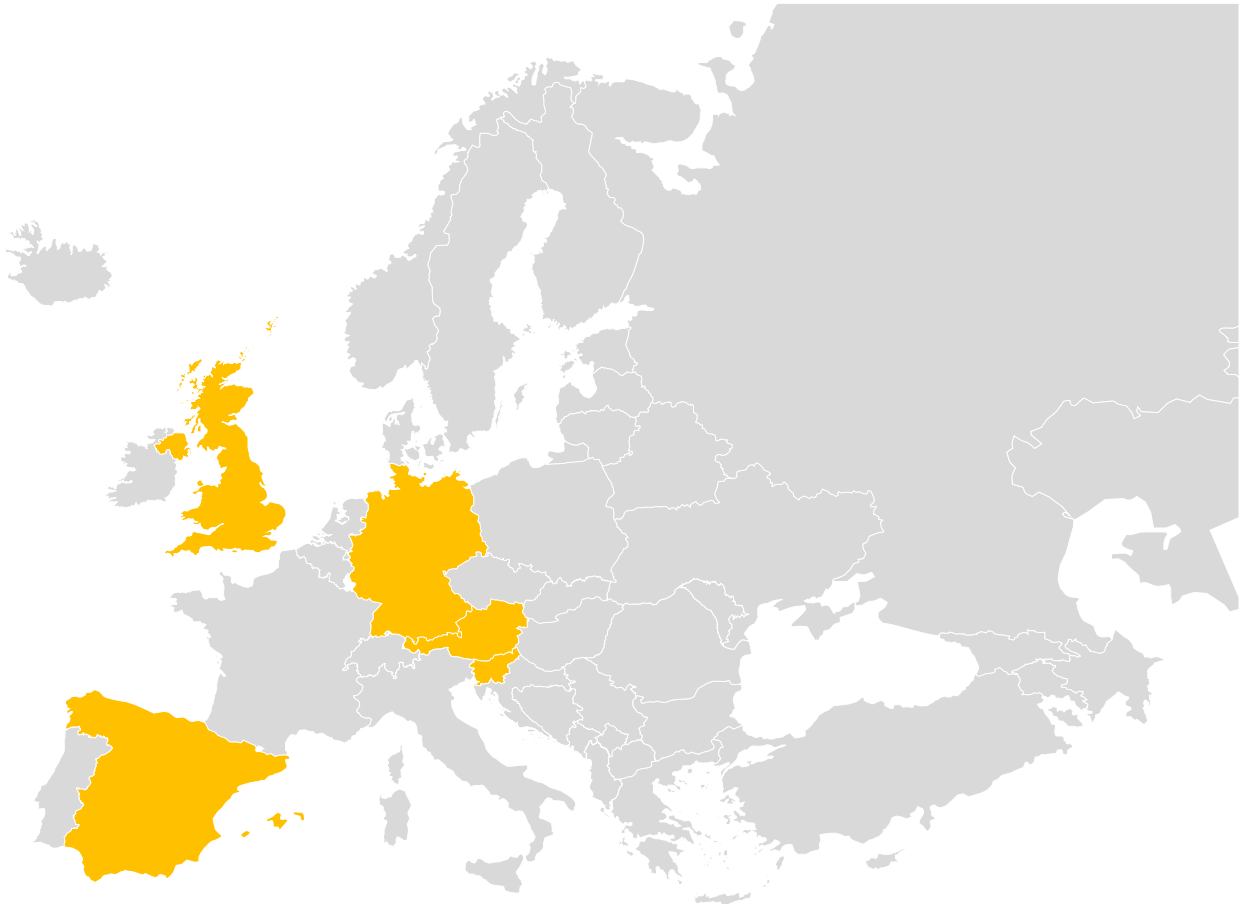
Furthermore, we asked several additional questions relating to the view on each persona (e.g. 2.1), Training and Qualification Needs (e.g. 2.4) and further Key Issues (e.g. 2.6). Answers to these questions are listed as given on the surveys without any further editing.

Key sub-sectors identified in the desk based research are:



1.3.2. Survey and Depth interviews

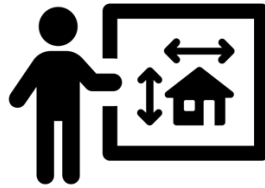
Depth interviews were conducted with a sample of employers, manufactures, training providers and stakeholders in each partner country: Austria, Germany, Slovenia, Spain and the United Kingdom (Scotland).



Summary of research methodology

The working group has surveyed and interviewed companies already involved in offsite and modular construction across European Union. Research has shown that demand for skills differ among job-roles and different personas. There is a major need for new trainings and qualifications. Classroom delivery and work-based learning is preferred over full online delivery, i.e. blended learning is preferred.

2. Digital Design



2.1. Digital Design Persona

In the opinion of the Industry critical difference between design for traditional construction and design for offsite construction are:



2.2. Overview of the digital design function

Digital Design is the thread that runs through Offsite Construction. It is a process that begins at concept design through to detailed design, procurement, health and safety, management and planning, factory operations and site operations, maintenance, disposal and reuse.

A core understanding of digital design is needed for all parties involved in offsite construction with varying level of knowledge, however the designer/architect design needs to be translated to the manufacture and operative in a way to ensure to project is designed and constructed without errors.

This can be where the gaps in the translation when using a software appear. The parties need to work collaboratively and the project needs to be digital design lead.

Skills gaps have been identified not only in the application of software and BIM knowledge but also in in use and demolition and reuse:

1. Building Design
2. Maintenance and managed
3. After use (circular)

2.3. Skills and knowledge needs – digital design

Technical Skills Required

Technical skills	Job roles	Degree of importance
BIM-enabled design	Skilled worker	3.8
	Supervisor	4.0
	Manager	4.0
	Senior Manager – Professional	4.2
Creating 3D models	Skilled worker	4.2
	Supervisor	3.6
	Manager	3.5
	Senior Manager – Professional	3.5
Developing a value proposition (cost, durability, low carbon, aesthetic)	Skilled worker	2.7
	Supervisor	3.5
	Manager	4.2
	Senior Manager – Professional	4.1
Digital design software use e.g. AutoCAD, Revit, BIM360?	Skilled worker	4.3
	Supervisor	4.1
	Manager	3.8
	Senior Manager – Professional	3.7
Digital skills (e.g. scheduling and specific IT)	Skilled worker	4.1
	Supervisor	4.2
	Manager	4.2

	Senior Manager – Professional	4.2
Generating 2D fabrication drawing and site drawings	Skilled worker	4.4
	Supervisor	4.3
	Manager	3.1
	Senior Manager – Professional	3.3
Obtaining prices and dealing with variations	Skilled worker	2.7
	Supervisor	3.9
	Manager	4.6
	Senior Manager – Professional	4.3
Producing product/service specialisations	Skilled worker	3.7
	Supervisor	3.7
	Manager	3.8
	Senior Manager – Professional	4.0
Reading technical drawings	Skilled worker	4.6
	Supervisor	4.8
	Manager	4.5
	Senior Manager – Professional	4.4
Risk assessment	Skilled worker	3.2
	Supervisor	4.2
	Manager	4.7
	Senior Manager – Professional	4.4
Other 1 (please specify): <i>On site construction experience</i>	Skilled worker	4.0
	Supervisor	4.5
	Manager	4.5
	Senior Manager – Professional	4.5
Other 2 (please specify): <i>Understanding of processes and procedures both onsite and offsite to provide final product</i>	Skilled worker	4.0
	Supervisor	4.5
	Manager	4.5
	Senior Manager – Professional	4.5

Knowledge required

Knowledge	Job roles	Degree of importance
Appreciation of how buildings are constructed	Skilled worker	4.4
	Supervisor	4.6
	Manager	4.6
	Senior Manager – Professional	4.5
Current and emerging technologies	Skilled worker	3.4
	Supervisor	3.7
	Manager	4.5
	Senior Manager – Professional	4.5
Degrees of tolerance/accuracy	Skilled worker	4.6
	Supervisor	4.7
	Manager	4.3
	Senior Manager – Professional	4.1
IT tools	Skilled worker	4.3
	Supervisor	4.1
	Manager	4
	Senior Manager – Professional	4
Lean methodologies	Skilled worker	3.6
	Supervisor	4.3
	Manager	4.2
	Senior Manager – Professional	3.9
New technologies e.g. 3D printing	Skilled worker	3.1
	Supervisor	3.3
	Manager	3.0
	Senior Manager – Professional	3.4
Order of sequence	Skilled worker	3.7
	Supervisor	4.1
	Manager	4.3
	Senior Manager – Professional	4.5
Processes used to assemble buildings	Skilled worker	4.3
	Supervisor	4.0
	Manager	4.7
	Senior Manager – Professional	4.6
Quality assurance	Skilled worker	3.9
	Supervisor	4.5
	Manager	4.5
	Senior Manager – Professional	4.5

Relevant design codes and standards	Skilled worker	3.5
	Supervisor	4.3
	Manager	4.1
	Senior Manager – Professional	4.4
Understanding of full range of materials and products used (weights, volumes, dimensions, etc.)	Skilled worker	3.9
	Supervisor	4.2
	Manager	4.0
	Senior Manager – Professional	4.0
Understanding of relevant products and systems	Skilled worker	3.9
	Supervisor	4.2
	Manager	4.6
	Senior Manager – Professional	4.4
Understanding of the materials being produced and energy efficiency ratings, U-values, etc.	Skilled worker	3.3
	Supervisor	4.1
	Manager	4.1
	Senior Manager – Professional	4.4
Waste management	Skilled worker	3.4
	Supervisor	4.2
	Manager	3.9
	Senior Manager – Professional	4.2
Weight and robustness of materials	Skilled worker	3.6
	Supervisor	4.2
	Manager	4
	Senior Manager – Professional	4
Other 1 (please specify): How systems interface on site	Skilled worker	4
	Supervisor	5
	Manager	5
	Senior Manager – Professional	4

Meta Skills Required

Meta skills	Job roles	Degree of importance
Accuracy	Skilled worker	4.5
	Supervisor	4.6
	Manager	4.2
	Senior Manager – Professional	4.0
Attention to detail	Skilled worker	4.4
	Supervisor	4.6
	Manager	4.4
	Senior Manager – Professional	4.2

Business case for offsite and modular	Skilled worker	2.6
	Supervisor	3.4
	Manager	4.4
	Senior Manager – Professional	4.6
Effective and on-going communication	Skilled worker	4.5
	Supervisor	4.6
	Manager	4.8
	Senior Manager – Professional	4.8
Problem-solving	Skilled worker	4.4
	Supervisor	4.9
	Manager	4.8
	Senior Manager – Professional	4.8
Team-working	Skilled worker	4.8
	Supervisor	4.7
	Manager	4.8
	Senior Manager – Professional	4.5
Working to tight deadlines	Skilled worker	4.1
	Supervisor	4.2
	Manager	4.5
	Senior Manager – Professional	4.3

2.4. Training and qualification needs – digital design

Main gaps and issues in training and qualifications for Digital design persona in the context of offsite and modular construction as viewed by the industry

“Correct, training doesn't exist” “expensive courses; hard to reach”

“Offsite is never really 100% offsite design and construction. All the offsite designed and built constructions are in the end somehow attached to the building site.”

“too few companies are currently engaged in digital design” “Lack of practical relevance.”

“Lack of motivation of workers and managers.” “Nothing.” “Speed of change.”

“Being open to change of design software /processes in an evolving industry.”

“Lack of access to new technologies”

“Specific training and qualifications for timber frame designers/ technicians as well as for architects etc. Building services is a big issue with offsite construction and more training is required for the people within this sector.”

“The lack of knowing for the systems, the construction details and the interaction between offsite and onsite.”

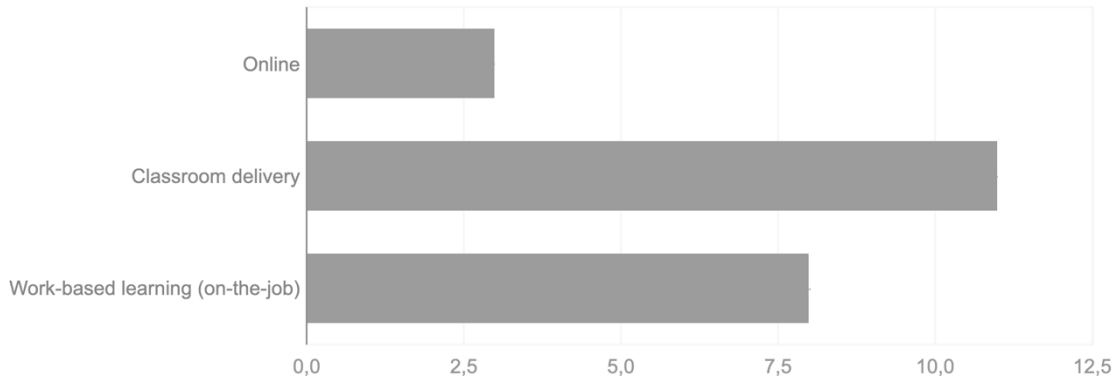
“One of the biggest deficits is the lack of knowledge of offsite construction by Architects. One of the jobs we make is to disseminate this knowledge in order to show them how to design. Projects have to be created from the beginning thinking about their industrialization and it means that designers must know the requirements of the system: how to divide the building in components, how big they have to be, how many of the building will be done at the company, logistic law, materials...”

“Specific training and qualifications for timber frame designers/technicians as well as for Architects etc. Building services is a big issue with offsite construction and more training is required for the people within this sector.”

Preferred training delivery method

What in your view would be a preferred training delivery method? (Please choose one or more)

17 responses



2.5. Job roles and career pathways – digital design

Skilled worker	Supervisor	Manager	Senior Manager – Professional
3D Visualizer CAD Modeller	Architectural Technician BIM Technician Pre-Construction Designer Building Services Engineer	Electrical Engineer	Architect Design Engineer Structural Engineer

2.6. Key issues for consideration – digital design

Sub-sector specific regarding technical skills, knowledge and soft skills required

Housing	Technical compliance, Practical relevance, Construction integrity and coherence, Three-dimensional Construction System (PPVC), with steel structure and concrete floors,
Commercial	Circular economy and decommissioning, Construction integrity and coherence
Infrastructure	With offsite specific knowledge is needed to ensure the infrastructure is in the correct place in a timeous manner, Getting services on site early, Onsite adaptation possibilities.
Industrial	Circular economy and decommissioning, Three-dimensional Construction System (PPVC), with steel structure and concrete floors

Country (national) specifics

Slovenia	Climate (Mediterranean / central / northern Europe).
	Different legislation in the federal states, Climate, Quantity of snow.
United Kingdom	Buildings standards for minimum thermal performance and airtightness are poor – this results in variance in specification requests from clients, which leads to the inability to standardise the build system and optimise the design of standardised parts.
	Building regulations
	Social and, consequently, economical
Spain	The current law doesn't facilitate the implementation of the industrial construction. At the political level, there is an absolute ignorance about what means an industrial construction. The culture of heavy construction in Spain is so strong, with big lobbies (cement, bricks), but, anyway, at the social level, barriers are being broken thanks to big Promoters which are supporting its dissemination.

3. Estimating/Commercial



3.1. Estimating/Commercial Persona

In the opinion of the Industry estimating is a crucial element in offsite construction in comparison with traditional construction because of:

Because modular construction is quick and one-off, facilities can be built in a few weeks, rapid financing is required.

To have a cost advantage over traditional construction methods in economic competition.

Prefabrication causes a high Quality in planning and costing calculation.

More barriers to get innovation in traditional.

The objects are ordered and sold well in advance, because they are also drawn through computers (eg BIM), the project inventory / project estimate is more accurate and faster.

“In wooden, prefabricated construction, wood is the basic construction material and the essential thing is that the building is assembled from construction elements that have been prefabricated. The construction elements are manufactured in an indoor environment and in a controlled atmosphere. Therefore the works are independent of the weather and subject to appropriate control systems which enables a very accurate manufacture. Regular production controls are carried out by independent experts of internationally recognized institutions, which, due to fulfilment of internationally comparable requirements regarding the quality, award certificates of conformity and quality marks. All materials used in the production as well as the entire Marles construction system and technology process are in accordance with the international standards.”

Much greater accuracy in planning; prefabricated parts must match.

Offsite construction is closer to "selling a known product" than to "building the known product", so the product is a better defined unity than the onsite buildings.

For the sake of spending the funds, for the sake of a proper estimate of spending.

Because of their main difference, meaning transportation of modular element and manipulating them on-site

3.2. Overview of the estimating/commercial function

Similar to digital design, offsite manufacturing is front loaded. There is a firm cost. The project needs to be designed and costed before manufacturing begins.

Estimating and commercial covers all the key stages of the offsite process. BIM should/will play a large role. As it allows for monitoring of design cost, design changes, change control procedures, design freeze, manufacture, on site assembly and placement, monitoring maintenance and demolition and reuse.

3.3. Skills and knowledge needs – estimating/commercial

Technical skills required

Technical skills	Job roles	Degree of importance
Analysis of tender documents/contract terms and conditions	Manager	4.3
	Senior Manager – Professional	4.6
BIM-enabled design	Manager	3.9
	Senior Manager – Professional	4.3
Costing/developing whole life cycle costs	Manager	4.4
	Senior Manager – Professional	4.4
Developing sub-contract terms and conditions	Manager	3.9
	Senior Manager – Professional	4.1
Developing a value proposition (cost, durability, low carbon, aesthetic)	Manager	4.1
	Senior Manager – Professional	4.2
Developing tenders	Manager	3.8
	Senior Manager – Professional	4.3
Obtaining prices and dealing with variations	Manager	4.0
	Senior Manager – Professional	4.5
Planning	Manager	4.2
	Senior Manager – Professional	4.5
Producing product/service specifications	Manager	3.9
	Senior Manager – Professional	3.9
Reading technical drawings	Manager	4.2
	Senior Manager – Professional	4.3
Risk assessment	Manager	4.5
	Senior Manager – Professional	4.6

Knowledge required

Knowledge	Job roles	Degree of importance
Appreciation of how buildings are constructed	Manager	4.0
	Senior Manager – Professional	4.6
Contract law	Manager	3.9
	Senior Manager – Professional	4.5
Current and emerging technologies	Manager	4.1
	Senior Manager – Professional	4.5
IT tools	Manager	4.0
	Senior Manager – Professional	4.4
Lean methodologies	Manager	3.9
	Senior Manager – Professional	4.0
Quality assurance	Skilled worker	4.1
	Supervisor	4.7
	Manager	4.5
	Senior Manager – Professional	4.6
Typical associate costs	Manager	4.2
	Senior Manager – Professional	4.5
Understanding of full range of materials and products used (weights, volumes, dimensions, etc.)	Manager	3.7
	Senior Manager – Professional	4.5
Waste management	Manager	4.5
	Senior Manager – Professional	4.4

Meta skills required

Meta skills	Job roles	Degree of importance
Accuracy	Manager	4.2
	Senior Manager – Professional	4.7
Attention to detail	Manager	4.0
	Senior Manager – Professional	4.5
Business case for offsite and modular	Manager	4.1
	Senior Manager – Professional	4.4
Commercial awareness	Manager	4.1
	Senior Manager – Professional	4.1
Effective and on-going communication	Manager	4.5
	Senior Manager – Professional	4.5

Problem-solving	Manager	4.7
	Senior Manager – Professional	4.6
Team-working	Manager	4.5
	Senior Manager – Professional	4.5
Working to tight deadlines	Manager	4.5
	Senior Manager – Professional	4.7

3.4. Training and qualification needs – estimating/commercial

Main gaps and issues in training and qualifications for Estimating/Commercial persona in the context of offsite and modular construction as viewed by the industry

“Knowledge of sales techniques. Contact and follow up with buyers / clients.”

“The market sets its rules for offsite buildings as an answer to onsite building procedures.”

“Not so many literature available in schools, probably due to an minor small share/ratio of prefabricated and modular buildings in construction industry.”

“gap - in knowledge of all the advantages of materials, soil geology, urbanism, etc., broad knowledge required”

“too few companies”

“lack of motivation”

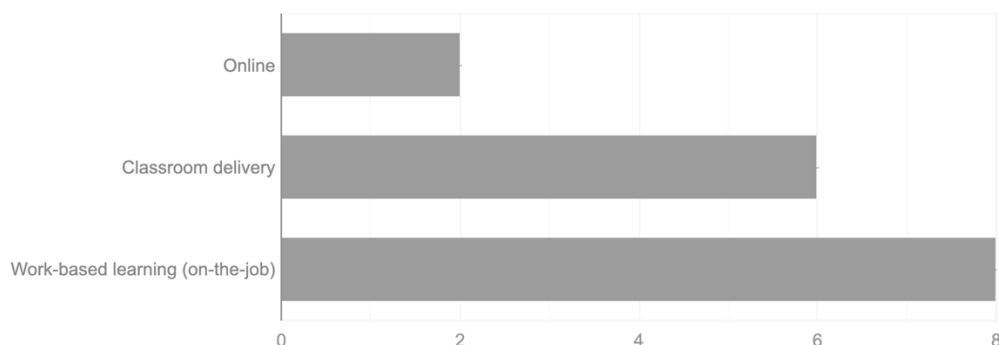
“Usually too little previous practical knowledge or approaches.”

“Use of BIM to derive cost information directly from the 3D model. PDF / 2D CAD drawings are often used to measure from, which gives inaccurate information that takes longer to quantify.”

Preferred training delivery method

What in your view would be a preferred training delivery method? (Please choose one or more)

11 responses



3.5. Job roles and career pathways – estimating / commercial

Skilled worker	Supervisor	Manager	Senior Manager – Professional
Not applicable	Not applicable	Contracts Manager Commercial Manager Risk Manager Business Development Manager Sales Manager	Estimator Quantity Surveyor Planner

3.6. Key issues for consideration – estimating / commercial

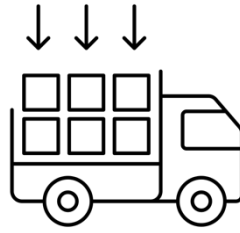
Sub-sector specific regarding technical skills, knowledge and soft skills required

Housing	Urban planning / housing technologies, Yes. Architecture and technical workers who make workshop and construction plans., yes, for documentation advice
Commercial	Urban planning / market analysis., Yes. They should in preliminary phase with customers know what are they selling and if it's possible to make that kind of a building (we sell individual houses)., yes, sales consultancy.
Infrastructure	Understanding of infrastructural conditions. yes, to provide construction / site infrastructure. Yes - costing / planning for infrastructure to be in place prior to module delivery.
Industrial	Urban planning. yes, because of the materials

Country (national) specifics

Slovenia	In the design phase we are using Eurocodes (EN), which are specifying how structural design should be conducted in the European Union.
	Different legislation in the federal states, Climate, Quantity of snow.
Austria	Different geographical conditions, legal requirements
Slovenia	Yes, public tender laws impact estimating/commercial work

4. Logistics



4.1. Logistics Persona

In the opinion of the construction industry, the task of the logistics persona includes:

coordination of connections between elements (mechanical work, electrical work, statics, ...)

arranging transportation of a modular object from production to a specific location a way of building in the future

The chronologically correct and damage-free delivery of the components to the construction site.

Logistics in my opinion is one of the most important context in modular construction, as element can be heavy and long. Manipulating them and transporting is one of the most important aspects.

Big Elements

The chronologically correct and damage-free delivery of the components to the construction site.

4.2. Overview of the logistics function

Within a factory it is important that everything moves smoothly and units can move down the line from workplace to workplace as the whole production line will move at the speed of its slowest task. Teamwork and good coordination is vital. Size of units & transportation of units from factories to site can be challenging (factories can adapt by breaking the elements down to a size that logistics aren't a problem anymore). Logistic personnel has to deal with any challenges, regulations and other restrictions.

Sourcing of material and considering aspects like decarbonisation by for example using local sources is an important aspect considering existing worldwide challenges. Logistics could also benefit from the use of flying-factories if the project was of a sufficient size to warrant a temporary facility onsite though this currently is not common practice.

4.3. Skills and knowledge needs – logistics

Technical skills required

Technical skills	Job roles	Degree of importance
Budget and financial management	Skilled worker	2.6
	Supervisor	3.2
	Manager	4.4
Control and management of inventory	Skilled worker	3.7
	Supervisor	4.1
	Manager	3.9
Digital skills (e.g. scheduling and specific IT)	Skilled worker	3.1
	Supervisor	4.0
	Manager	3.8
Health & Safety	Skilled worker	4.1
	Supervisor	4.0
	Manager	4.0
Lifting and handling	Skilled worker	4.0
	Supervisor	4.1
	Manager	3.4
Planning	Skilled worker	3.8
	Supervisor	4.1
	Manager	4.1
Process management	Skilled worker	4.0
	Supervisor	4.1
	Manager	4.6
Quality control	Skilled worker	3.7
	Supervisor	4.6
	Manager	3.7

Reading technical drawings	Skilled worker	3.8
	Supervisor	4.1
	Manager	4.0
Risk assessment	Skilled worker	3.6
	Supervisor	4.1
	Manager	4.6
Supply chain management (“re-engineering supply chain”)	Skilled worker	3.2
	Supervisor	4.0
	Manager	4.1
Time management	Skilled worker	4.0
	Supervisor	4.3
	Manager	3.9
Working at heights	Skilled worker	4.1
	Supervisor	3.3
	Manager	3.1

Knowledge required

Knowledge	Job roles	Degree of Importance
Appreciation of how buildings are constructed	Skilled worker	3.4
	Supervisor	4.2
	Manager	4.4
Degrees of tolerance/accuracy	Skilled worker	3.6
	Supervisor	4.1
	Manager	3.8
Integrating onsite and offsite	Skilled worker	3.8
	Supervisor	4.0
	Manager	4.1
IT tools	Skilled worker	3.0
	Supervisor	3.7
	Manager	3.7
Lean methodologies	Skilled worker	3.6
	Supervisor	4.0
	Manager	4.0
Low carbon agenda	Skilled worker	2.8
	Supervisor	3.9
	Manager	4.0
Order of sequence	Skilled worker	4.2
	Supervisor	4.7

	Manager	4.1
Processes used to assemble buildings	Skilled worker	3.8
	Supervisor	4.5
	Manager	3.8
Quality assurance	Skilled worker	3.6
	Supervisor	4.1
	Manager	3.8
Safe lifting and handling	Skilled worker	4.4
	Supervisor	4.5
	Manager	3.4
Scheduling	Skilled worker	3.4
	Supervisor	4.2
	Manager	4.1
Site specifics	Skilled worker	3.9
	Supervisor	4.1
	Manager	3.7
Understanding of the materials being produced and energy efficiency ratings, U-values, etc.	Skilled worker	2.7
	Supervisor	3.3
	Manager	3.8
Waste management	Skilled worker	3.3
	Supervisor	4.1
	Manager	4.0
Weight and robustness of materials	Skilled worker	3.8
	Supervisor	3.9
	Manager	3.4

Meta Skills Required

Meta skills	Job roles	Degree of importance
Accuracy	Skilled worker	4.0
	Supervisor	4.3
	Manager	3.8
Attention to detail	Skilled worker	3.3
	Supervisor	3.6
	Manager	3.6
Business case for offsite and modular	Skilled worker	3.3
	Supervisor	3.6
	Manager	3.8
Customer awareness	Skilled worker	3.6
	Supervisor	3.8

	Manager	4.3
Customer service	Skilled worker	3.2
	Supervisor	3.8
	Manager	4.2
Effective and on-going communication	Skilled worker	4.1
	Supervisor	4.3
	Manager	3.9
Negotiation	Skilled worker	3.0
	Supervisor	4.0
	Manager	4.9
Problem-solving	Skilled worker	3.1
	Supervisor	4.4
	Manager	4.8
Process improvement	Skilled worker	3.8
	Supervisor	4.4
	Manager	4.1
Team-working	Skilled worker	4.4
	Supervisor	4.7
	Manager	4.3
Working to tight deadlines	Skilled worker	4.0
	Supervisor	4.3
	Manager	4.3

4.4. Training and qualification needs – logistics

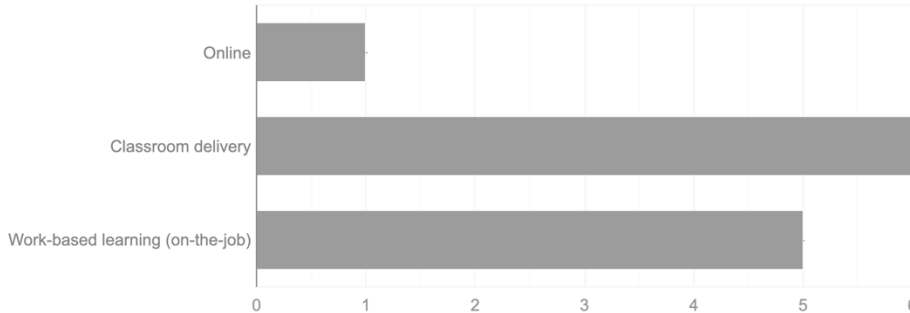
The training materials need to reflect the upskilling of the current workforce and the training of the future workforce. This provides a challenge as to the wider meta skills required to understand whole building systems and the move to offsite manufacture. The difference between a skills gap and a skills shortage, is that a skills gap refers to qualitative skills deficiencies within companies and can be overcome by further training of the existing workforce. On the other hand, a skills shortage refers to quantitative shortages in the labour markets and requires the recruitment of more people into the industry, the construction industry faces both. Trainings should include modern technology, including using Internet of Things, use of BOTs, CO-BOTS, Augmented and Virtual Reality as well as emphasise green materials and resources.

Main gaps and issues in training and qualifications for Logistics persona in the context of offsite and modular construction as viewed by the industry

*“there are none.” “Digital skills to log / record / track stock, orders and deliveries.”
 “Lack of motivation and lack of technical knowledge.”*

Preferred training delivery method

What in your view would be a preferred training delivery method? (Please choose one or more)
 9 responses



4.5. Job roles and career pathways – logistics

Skilled worker	Supervisor	Manager	Senior Manager – Professional
Administrator Banksman/Signaller	Dispatch Leader Crane Specialist Plant Support Services Coordinator Site Supervisor	Logistics/Plant Manager Dispatch Manager Transport Manager Construction Manger Sales Manager HR/Training Manager	Not applicable

4.6. Key issues for consideration – logistics

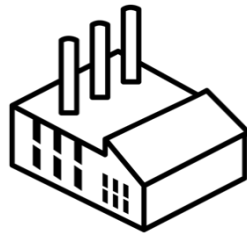
Sub-sector specific regarding technical skills, knowledge and soft skills required

Housing	/
Commercial	/
Infrastructure	Geographical knowledge. Ensuring services are in place on site ahead of module delivery.
Industrial	/

Country (national) specifics

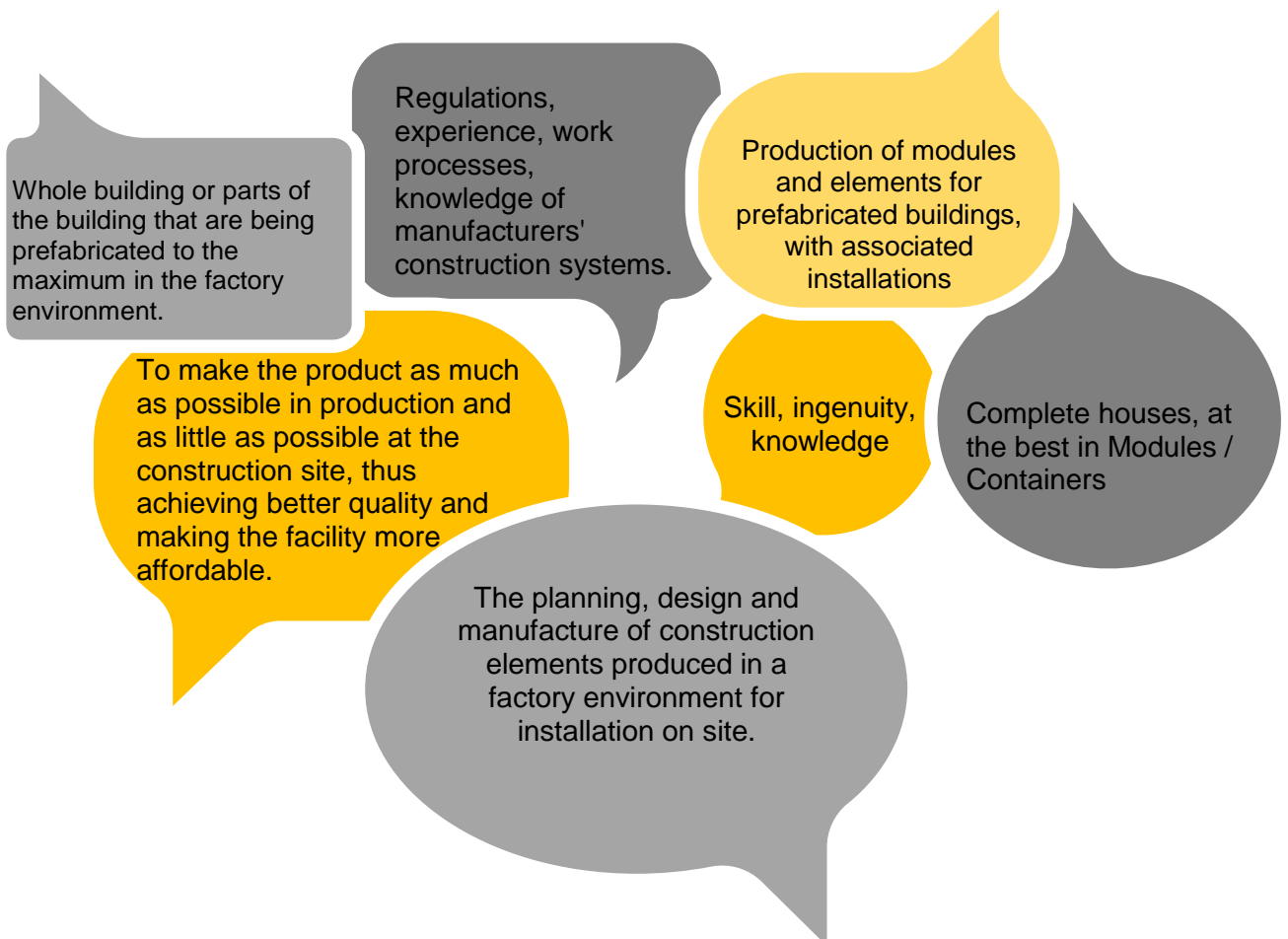
Slovenia	Slovenia - earthquake safety of facilities
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5. Offsite manufacture



5.1. Offsite manufacture persona

In the opinion of the construction Industry the Offsite Manufacture Persona refers to the following tasks:



5.2. Overview of the offsite manufacture function

Manufacturing is still based on traditional methods however by moving construction off-site workers have a more structured, safer and more productive work environment. By working in an factory environment less waste is produced and work can be done in shifts around the clock if demand requires it. This role is rich on skilled workers all different trades are involved in the construction of off-site panels and other components. Furthermore there is a need for supervisors and managers in this area who can observe and implement the required procedures to meet quality assurance criteria.

5.3. Skills and knowledge needs – offsite manufacture

Technical skills required

Technical skills	Job roles	Degree of importance
BIM-enabled design	Skilled worker	3.9
	Supervisor	3.9
	Manager	4.1
Health & safety	Skilled worker	4.7
	Supervisor	4.6
	Manager	4.3
Relevant trade skills (joinery, plastering, operating site machinery, welding)	Skilled worker	4.6
	Supervisor	3.9
	Manager	2.9
Lifting and handling	Skilled worker	4.8
	Supervisor	4.0
	Manager	2.8
Machine plant operation	Skilled worker	4.7
	Supervisor	4.2
	Manager	2.9
Measuring to precise specifications	Skilled worker	4.5
	Supervisor	4.5
	Manager	3.2
Multiskilling (e.g. combination of various technical skills)	Skilled worker	4.2
	Supervisor	4.1
	Manager	3.3
Process management	Skilled worker	3.4
	Supervisor	4.1
	Manager	4.6

Project management	Skilled worker	2.8
	Supervisor	4.2
	Manager	4.9
Quality control	Skilled worker	4.2
	Supervisor	4.8
	Manager	4.2
Reading technical drawings	Skilled worker	4.9
	Supervisor	4.7
	Manager	4.1
Risk assessment	Skilled worker	3.8
	Supervisor	4.6
	Manager	4.7
Supply chain management (“re-engineering the supply chain”)	Skilled worker	2.5
	Supervisor	3.6
	Manager	4.8
Time management	Skilled worker	3.8
	Supervisor	4.5
	Manager	4.7
Use of hand tools	Skilled worker	4.6
	Supervisor	3.6
	Manager	2.6
Working at heights	Skilled worker	4.6
	Supervisor	3.4
	Manager	2.4

Knowledge required

Knowledge	Job roles	Degree of importance
Appreciation of how buildings are constructed	Skilled worker	4.4
	Supervisor	4.4
	Manager	4.2
Basic Design	Skilled worker	2.9
	Supervisor	3.5
	Manager	3.6
Degrees of tolerance/accuracy	Skilled worker	4.8
	Supervisor	4.6
	Manager	3.8
Impacts for site if manufacture is at fault	Skilled worker	4.5
	Supervisor	4.5
	Manager	3.6

Lean methodologies	Skilled worker	3.1
	Supervisor	4.0
	Manager	4.5
New technologies e.g. 3D printing	Skilled worker	2.8
	Supervisor	3.4
	Manager	3.9
Offsite manufacturing processes	Skilled worker	3.6
	Supervisor	4.4
	Manager	4.4
Order of sequence	Skilled worker	4.0
	Supervisor	4.4
	Manager	3.9
Processes used to assemble buildings	Skilled worker	3.9
	Supervisor	4.3
	Manager	3.9
Quality assurance	Skilled worker	4.3
	Supervisor	4.8
	Manager	4.4
Relevant design codes and standards	Skilled worker	3.2
	Supervisor	4.2
	Manager	4.7
Safe lifting and handling	Skilled worker	4.8
	Supervisor	4.4
	Manager	3.4
Scheduling	Skilled worker	3.5
	Supervisor	4.4
	Manager	4.6
Understanding of full range of materials and products used (weights, volumes, dimensions, etc.)	Skilled worker	4.0
	Supervisor	4.6
	Manager	4.2
Understanding of relevant products and systems	Skilled worker	4.1
	Supervisor	4.6
	Manager	4.3
Waste management	Skilled worker	4.6
	Supervisor	4.3
	Manager	4.2
Wight and robustness of materials	Skilled worker	4.2
	Supervisor	4.3
	Manager	3.9

Meta skills required

Meta skills	Job roles	Degree of importance
Accuracy	Skilled worker	4.8
	Supervisor	4.6
	Manager	4.0
Adaptability	Skilled worker	4.5
	Supervisor	4.4
	Manager	4.2
Attention to detail	Skilled worker	4.5
	Supervisor	4.5
	Manager	4.2
Process improvement	Skilled worker	4.0
	Supervisor	4.5
	Manager	4.4
Effective and on-going communication	Skilled worker	4.4
	Supervisor	4.5
	Manager	4.6
Problem-solving	Skilled worker	4.2
	Supervisor	4.5
	Manager	4.5
Team-working	Skilled worker	4.7
	Supervisor	4.6
	Manager	4.7
Working to tight deadlines	Skilled worker	4.2
	Supervisor	4.6
	Manager	4.2

5.4. Training and qualification needs – offsite manufacture

Main gaps and issues in training and qualifications for Offsite Manufacture persona in the context of offsite and modular construction as viewed by the industry

“The lack of combined technical and commercial training.”

“The employees have to know and adapt themselves to the way of manufacturing an offsite construction. They need to know about time scheduling, risks,...”

“Digitalization, made the job more attractive.”

“in-depth knowledge of the construction industry and related experience. Impact on the environment, e.g. demographic changes, construction impacts on infrastructure (roads, schools, shops ...).”

“The main gaps are in training and qualification of manufacturers personnel and erectors as well as their supervisors.”

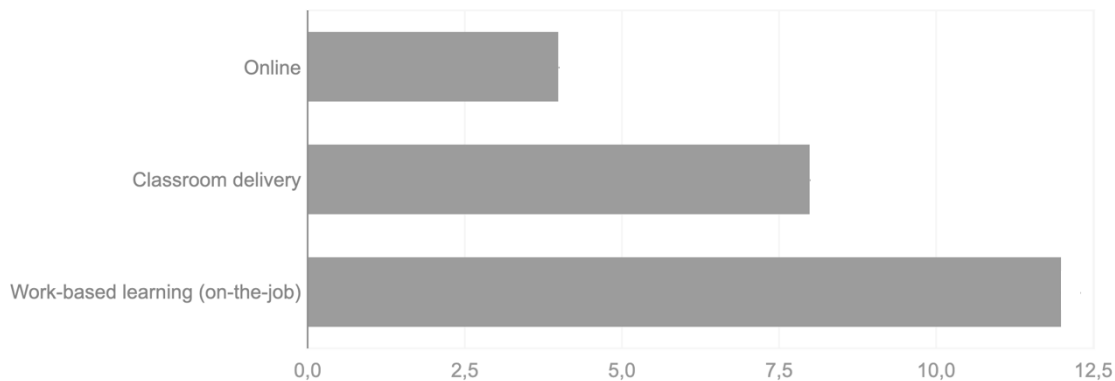
“missing Know How, Communication with Sub companies.”

“The systems are new on a market and are not well accepted from workers”

Preferred training delivery method

What in your view would be a preferred training delivery method? (Please choose one or more)

17 responses



5.5. Job roles and career pathways – Offsite manufacture

Skilled worker	Supervisor	Manager	Senior Manager – Professional
Timber operative / fabricator Multi-Skilled Operative Steel Fixer Welding Fabricator Trades: Joiner; Kitchen Fitter Forklift driver Trades: Plumber, Electrician, Painter & Decorator; Floor layer/Tiler, Cavity Insulation Installer	Factory Supervisor	Project Manager Factory Manager Plant Manager	

5.6. Key issues for consideration – offsite manufacture

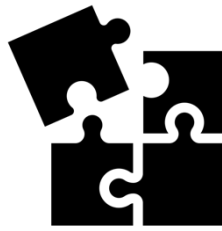
Sub-sector specific regarding technical skills, knowledge and soft skills required

Housing	Yes, prefabrication of Modules (Containers). Understanding the process and speed of construction. BIM / VR (virtual reality). Yes - understanding the process and speed of construction.
Commercial	Understanding the process and speed of construction.
Infrastructure	The need to ensure the infrastructure is in place in time and accurately as generally in offsite construction it needs to be in place before construction starts on site. Yes - the need to ensure the infrastructure is in place in time and accurately, as generally in offsite construction it needs to be in place before construction starts on site.
Industrial	/

Country (national) specifics

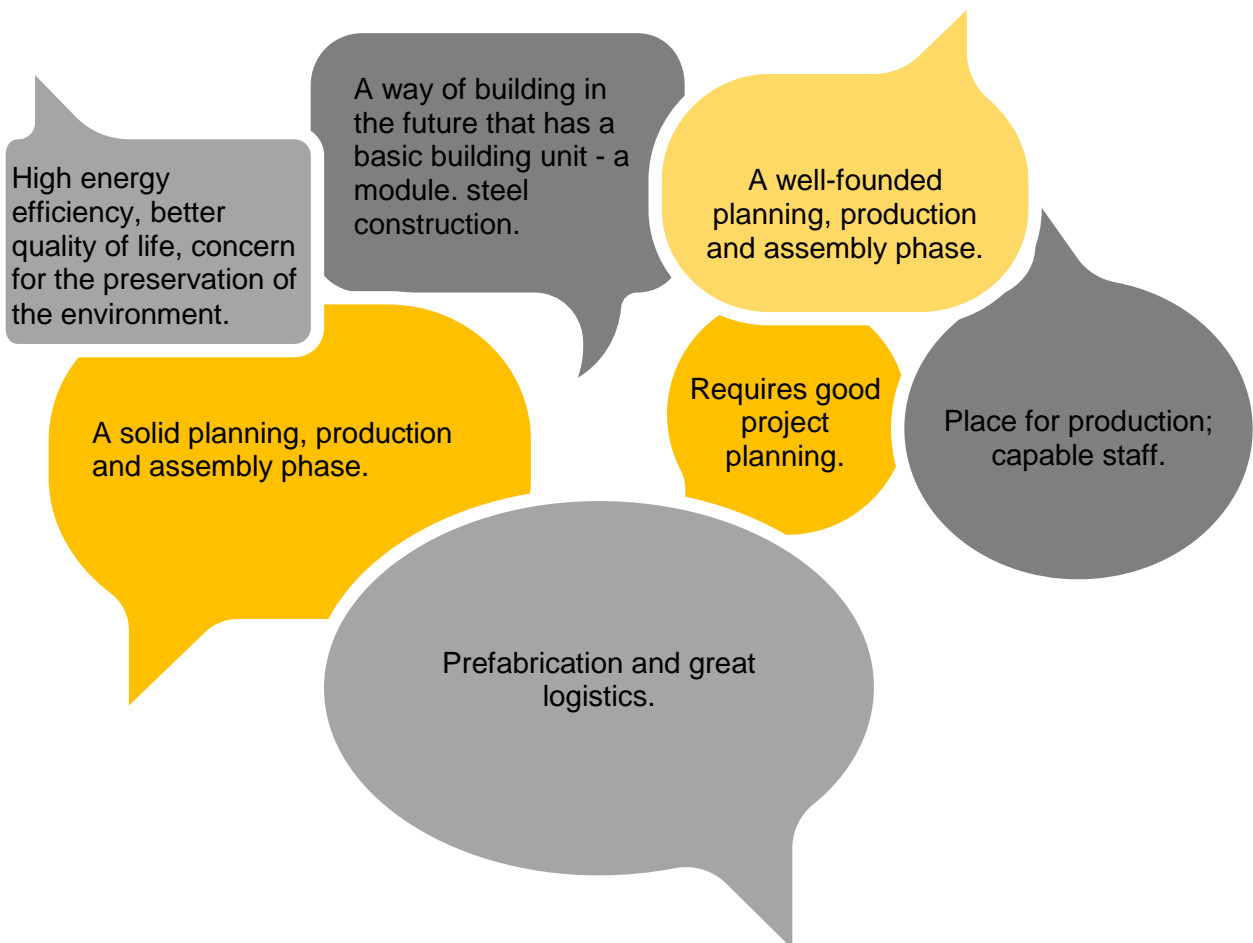
Slovenia	Earthquake safety of facilities
Germany	Multi Story houses should easier to build.
Austria	Refugees because of the climate change Politics, culture and climate EU, yes, quality of construction, regulations and climate greatly influence the style of construction in our country

6. Onsite placement and assembly



6.1. Onsite placement and assembly persona

In the opinion of the industry the onsite placement and assembly aspects of modular construction requires:



6.2. Overview of the onsite manufacture and assembly function

Onsite placement and assembly relates to the process of assembling a building by connecting modular parts of the building that have been produced offsite and then transferred to the planned location of the building. For workers and supervisors working in onsite placement and assembly, many technical / physical skills are required, including relevant trade skills (joinery, plastering, operating site machinery, welding); however, as technologies adapt and processes become increasingly automated, the focus will shift toward upskilling of existing trades and also new and emerging skilled worker roles. As IoT/ 4.0 technologies are increasingly adopted, the skillsets required from workers and supervisors within the realm of onsite placement and assembly must include more meta skills such as accuracy and adaptability.

6.3. Skills and knowledge needs – onsite manufacture

Technical skills required

Technical skills	Job roles	Degree of importance
Health & safety	Skilled worker	4.5
	Supervisor	4.5
	Manager	4.2
Relevant trade skills (joinery, plastering, operating site machinery, welding)	Skilled worker	4.6
	Supervisor	4.0
	Manager	3.1
Laying groundworks	Skilled worker	4.2
	Supervisor	4.4
	Manager	3.4
Lifting and handling	Skilled worker	4.7
	Supervisor	4.4
	Manager	3.7
Machine plant operation	Skilled worker	4.3
	Supervisor	3.9
	Manager	3.2
Measuring to precise specifications	Skilled worker	4.5
	Supervisor	4.5
	Manager	3.9
Multiskilling (e.g. combination of various technical skills)	Skilled worker	3.9
	Supervisor	4.2
	Manager	3.8

Process management	Skilled worker	3.5
	Supervisor	4.3
	Manager	4.6
Project management	Skilled worker	3.7
	Supervisor	4.1
	Manager	4.6
Quality control	Skilled worker	4.0
	Supervisor	4.5
	Manager	4.2
Reading technical drawings	Skilled worker	4.6
	Supervisor	4.8
	Manager	4.3
Risk assessment	Skilled worker	4.1
	Supervisor	4.5
	Manager	4.6
Time management	Skilled worker	3.9
	Supervisor	4.4
	Manager	4.4
Use of hand tools	Skilled worker	4.4
	Supervisor	3.7
	Manager	3.3
Working at heights	Skilled worker	4.6
	Supervisor	3.6
	Manager	3.0

Knowledge required

Knowledge	Job roles	Degree of importance
Degrees of tolerance/accuracy	Skilled worker	4.3
	Supervisor	4.2
	Manager	3.7
Impacts for site if manufacture is at fault	Skilled worker	4.1
	Supervisor	4.6
	Manager	3.9
Integrating onsite and offsite	Skilled worker	3.7
	Supervisor	4.1
	Manager	3.9
Lean methodologies	Skilled worker	3.4
	Supervisor	4.0
	Manager	4.0

Processes used to assemble buildings	Skilled worker	4.3
	Supervisor	4.7
	Manager	4.0
Quality assurance	Skilled worker	4.2
	Supervisor	4.8
	Manager	4.8
Site specifics	Skilled worker	3.7
	Supervisor	4.5
	Manager	4.3
Safe lifting and handling	Skilled worker	4.7
	Supervisor	4.3
	Manager	3.9
Scheduling	Skilled worker	3.7
	Supervisor	4.6
	Manager	4.7
Understanding of full range of materials and products used (weights, volumes, dimensions, etc.)	Skilled worker	4.0
	Supervisor	4.5
	Manager	3.8
Waste Management	Skilled worker	4.2
	Supervisor	4.6
	Manager	4.3
Wight and robustness of materials	Skilled worker	3.8
	Supervisor	4.1
	Manager	3.9

Meta skills required

Meta skills	Job roles	Degree of importance
Accuracy	Skilled worker	4.4
	Supervisor	4.6
	Manager	4.0
Adaptability	Skilled worker	3.9
	Supervisor	4.2
	Manager	4.3
Attention to detail	Skilled worker	4.2
	Supervisor	4.5
	Manager	3.6
Negotiation	Skilled worker	3.1
	Supervisor	4.3
	Manager	4.7

Effective and on-going communication	Skilled worker	3.5
	Supervisor	4.5
	Manager	4.6
Problem-solving	Skilled worker	3.9
	Supervisor	4.4
	Manager	4.6
Team-working	Skilled worker	4.5
	Supervisor	4.4
	Manager	4.2
Working to tight deadlines	Skilled worker	4.4
	Supervisor	4.5
	Manager	4.4

6.4. Training and qualification needs – onsite placement and assembly persona

Main gaps and issues in training and qualifications for Onsite Placement and Assembly persona in the context of offsite and modular construction as viewed by the industry

“no problem, as with any job, you have to come up with a problem and you have to solve it, that's how you learn.”

“Create valuable, goal-oriented support (training) with regard to the readiness to take on responsibility (character building, etc.). Today there is a lack of people who are willing to take on responsibility.”

“Understanding of benefits offsite can deliver, including delivering projects on-time and to the level of quality expected.”

“Creating valuable, goal-oriented support (training) with regard to the willingness to take on responsibility (character building, etc.). Today there is a lack of people who are willing to take on responsibility.”

“More specific learning.”

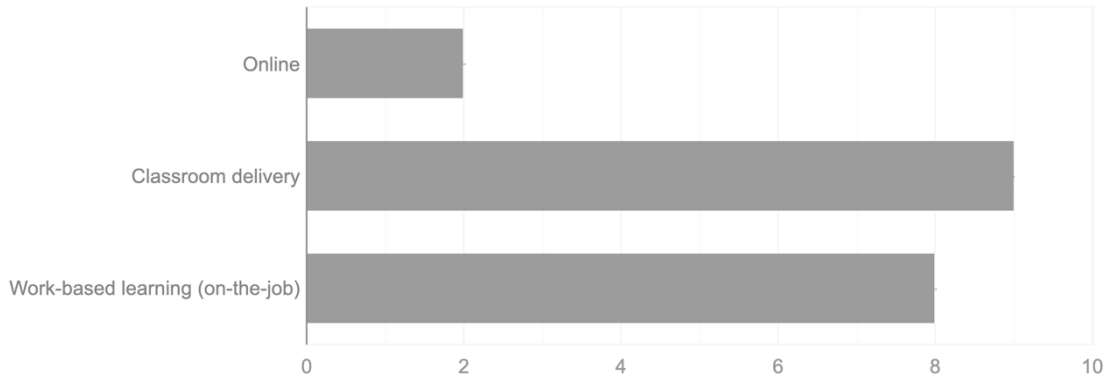
“There is no place to study this kind of construction.”

“The ensemble of three-dimensional modules demands an specialization not comprehensible in any other sectors (perhaps the naval one). It means an special training in Risks, fixing systems, schedules...”

Preferred method of delivery

What in your view would be a preferred training delivery method? (Please choose one or more)

13 responses



6.5. Job roles and career pathways – Onsite placement and assembly persona

Skilled worker	Supervisor	Manager	Senior Manager – Professional
Timber operative / fabricator Assembly Technician Erectors: Steel; Precast concrete Operatives: Groundworks; Roofing Banksman/Signaller Crane Operator Forklift Driver Trades: Plumber, Electrician, Painter/Decorator, Joiner Tunnelling Operative	Chargehand Site supervisor	Project Manager Site Manager Site Inspector	Not applicable

6.6. Key issues for consideration – onsite placement and assembly

Sub-sector specific regarding technical skills, knowledge and soft skills required

Housing	Mix system steel-concrete. GRC and Concrete panels. Three-dimensional construction system (PPVC) with steel-structure and concrete floors.
Commercial	Mix system steel-concrete. Three-dimensional construction system (PPVC) with steel-structure and concrete floors.
Infrastructure	/
Industrial	Mix system steel-concrete. Three-dimensional construction system (PPVC) with steel-structure and concrete floors. The society joins modular construction with lower quality and price.

Country (national) specifics

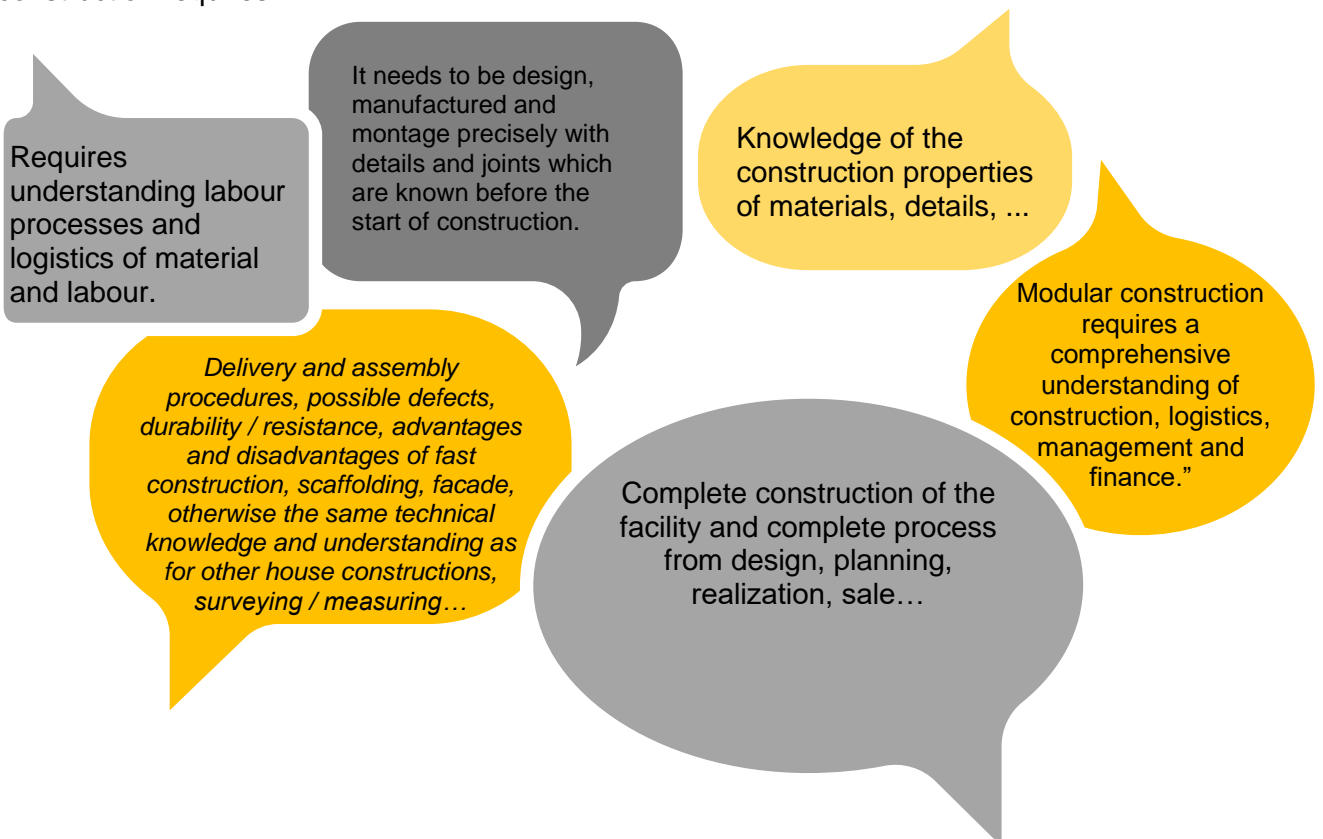
Slovenia	The society joins modular construction with lower quality and price.
Spain	The first condition is the lack of offsite culture and the lack of offer
United Kingdom	The current law doesn't facilitate the implementation of industrial systems in construction.

7. Site management and integration



7.1. Site Management and Integration Persona

In the opinion of the industry comprehensive understanding of site management in offsite construction requires:



7.2. Overview of the Site management and Integration function

For workers and supervisors working in site management and integration, many technical skills are required. Digital skills are also very relevant within site management and integration, including scheduling, specific IT and information management (project delivery and design management). However, as technologies adapt and processes become increasingly automated, the focus will shift toward upskilling of existing trades and also new and emerging skilled worker roles. As IoT/ 4.0 technologies are increasingly adopted, the skillsets required from workers and supervisors within the realm of site management and integration must include more meta skills such as accuracy and adaptability. In addition, there will be a major increase in the need for green skills, within the entire offsite construction sector, as skillsets must adjust to the demand for environmental / waste management, resource efficiency and circular economy as a whole.

7.3. Skills and knowledge needs – site management

Technical skills required

Technical skills	Job roles	Degree of importance
Health & safety	Manager	4.4
	Senior Manager – Professional	4.3
Budget and financial management	Manager	4.4
	Senior Manager – Professional	3.1
Digital skills (e.g. scheduling and specific IT)	Manager	3.8
	Senior Manager – Professional	3.6
Information management (project delivery and design management)	Manager	4.5
	Senior Manager – Professional	3.3
Measuring to precise specifications	Manager	4.0
	Senior Manager – Professional	3.4
Multiskilling (e.g. combination of various technical skills)	Manager	4.0
	Senior Manager – Professional	3.8
Process management	Manager	4.2
	Senior Manager – Professional	3.1
Project management	Manager	4.5
	Senior Manager – Professional	3.5
Quality control	Manager	4.3
	Senior Manager – Professional	3.8

Reading technical drawings	Manager	4.4
	Senior Manager – Professional	4.1
Risk assessment	Manager	4.4
	Senior Manager – Professional	4.2
Supply chain management	Manager	4.0
	Senior Manager – Professional	3.5
Time management	Manager	4.5
	Senior Manager – Professional	4.1

Knowledge required

Knowledge	Job roles	Degree of importance
Degrees of tolerance/accuracy	Manager	3.9
	Senior Manager – Professional	3.6
Impacts for site if manufacture is at fault	Manager	4.3
	Senior Manager – Professional	3.6
Integrating onsite and offsite	Manager	4.2
	Senior Manager – Professional	4.0
IT tools	Manager	3.9
	Senior Manager – Professional	3.9
Lean methodologies	Manager	4.2
	Senior Manager – Professional	3.3
Order of sequence	Manager	4.3
	Senior Manager – Professional	3.4
Processes used to assemble buildings	Manager	4.2
	Senior Manager – Professional	4.1
Quality assurance	Manager	4.3
	Senior Manager – Professional	3.8
Safe lifting and handling	Manager	4.4
	Senior Manager – Professional	3.5
Site specifics	Manager	3.8
	Senior Manager – Professional	3.5
Understanding of relevant products and systems	Manager	4.2
	Senior Manager – Professional	3.9
Waste management	Manager	4.2
	Senior Manager – Professional	4.0

Wight and robustness of materials	Manager	3.6
	Senior Manager – Professional	3.5

Meta Skills Required

Meta skills	Job roles	Degree of importance
Accuracy	Manager	4.3
	Senior Manager – Professional	3.9
Adaptability	Manager	4.2
	Senior Manager – Professional	3.7
Attention to detail	Manager	3.9
	Senior Manager – Professional	4.1
Negotiation	Manager	4.5
	Senior Manager – Professional	4.0
Effective and on-going communication	Manager	4.5
	Senior Manager – Professional	4.1
Problem-solving	Manager	4.6
	Senior Manager – Professional	4.0
Process improvement	Manager	4.1
	Senior Manager – Professional	3.4
Team-working	Manager	4.7
	Senior Manager – Professional	4.0
Working to tight deadlines	Manager	4.5
	Senior Manager – Professional	3.9
Other 1 (please specify): Precision	Manager	4.0
	Senior Manager – Professional	4.0
Other 2 (please specify): Mentoring	Manager	4.0
	Senior Manager – Professional	4.0

7.4. Training and qualification needs – site management and integration persona

Main gaps and issues in training and qualifications for Site Management persona in the context of offsite and modular construction as viewed by the industry

“No experiences. You need experiences at working on a site construction. No school and education can't prepare you for that job, only experiences are important.

“Contractors do not place sufficient emphasis on training, so errors in performance occur. I believe that multiple training or periodic training would be required.”

“Time and conflict management, Lack of practical experience.”

“interoperability and processing of all construction conditionalities.”

“Understanding of need to store panels/modules safely and securely on site (if required before assembly).”

“Time and conflict management”

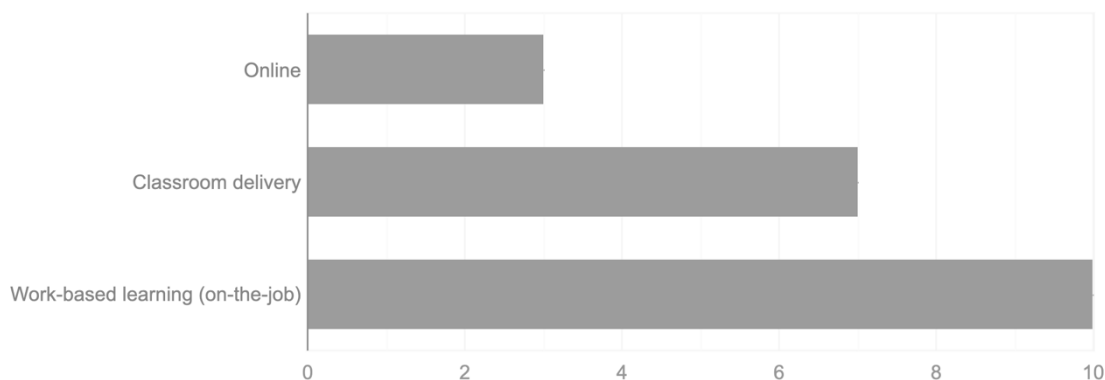
“There is no specific training in this kind of construction”

“The technical staff in the sites need training about this kind of construction.”

Preferred method of delivery

What in your view would be a preferred training delivery method? (Please choose one or more)

13 responses



7.5. Job roles and career pathways – Site management persona

Skilled worker	Supervisor	Manager	Senior Manager – Professional
Not applicable	Not applicable	Site Manager Project Manager Construction Manager Logistics Manager Compliance Manager	Site Inspector

7.6. Key issues for consideration – site management and integration

Sub-sector specific regarding technical skills, knowledge and soft skills required

Housing	Communication with investors and subcontractors. Façades, service work or adjustment work (smart front door with fingerprint, face recognition etc, smart home), repair / polishing of scratches Time and conflict management. Time and conflict management
Commercial	Mix system steel structure and concrete floors
Infrastructure	/
Industrial	Mix system steel structure and concrete floors

Country (national) specifics

Austria	Climate
Spain	Lack of culture in offsite and modular construction
Spain, Slovenia	The law, Climate, Salary differences comparison Austria - Slovenia, motivation / accuracy of employees in Austria noticeably higher

8. Acknowledgements

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