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Behavioural attitudes to modern methods of construction



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1 Executive summary

The primary objective of this report is to investigate the psychology of change inherent in the broader acceptance and adoption of modern methods of construction (MMC) within the realm of housing delivery. Understanding the underlying factors that influence this transformation is important in shaping the future of the housing industry.

As the residential construction industry undergoes transformation, it is important to foster trust and faith in compliant modern building techniques that supersede traditional methodologies. By identifying and addressing any potential barriers to acceptance of MMC, the report aims to provide insight from both the construction sector and wider public.

To fulfil these objectives, an in-depth analysis was undertaken, incorporating both quantitative and qualitative approaches. Through semi-structured interviews with construction sector stakeholders two sets of surveys were designed, one for the public and the other for the construction sector. The surveys provided valuable data was gathered from the public and construction industry sector. This dual approach not only ensures the depth of understanding but also provides a holistic view of the challenges, perceptions, and expectations of the construction sector and public towards MMC.

Some of the main findings indicate that in Ireland there is limited experience within the construction sector working on MMC projects, with Category 2 MMC emerging as the most prevalent. Public perception of MMC varies, with positive perceptions around terms like *modular house* and *offsite house* contrasting with negative perceptions related to *rapid-build house* and *pre-fabricated house*. The factors influencing the public's decision relating to residential property purchase are primarily related to considerations of *Location, Price* and *Quality*.

The barriers to wider MMC adoption in the construction industry are identified as a *lack of industry knowledge, difficulties changing from traditional construction, and lack of pipeline of MMC*. Government involvement is deemed crucial, emphasising the need for *guaranteeing project pipeline, supporting public procurement, and showcasing successful MMC projects*.

2 Introduction and background

2.1 Overview of modern methods of construction

MMC is used in this report to define a variety of offsite manufacturing and onsite procedures that offer alternatives to traditional house building. Following the MMC introductory guide, prepared by the Department of Housing, Local Government and Heritage (DHLGH) 7 MMC categories are defined as follows (DHLGH, 2023):

Category 1. Pre-manufacturing – 3D primary structural systems (volumetric) – See Figure 1

Category 2. Pre-manufacturing – 2D primary structural systems (panelised) – See Figure 2

Category 3. Pre-manufacturing components – non systemised primary structure

Category 4. Additive manufacturing – structural and non-structural

Category 5. Pre-manufacturing – non-structural assemblies & sub-assemblies, for example pods

Category 6. Traditional building product led site labour reduction/productivity improvements

Category 7. Site process led site labour reduction/productivity/assurance improvements (innovative processes and approaches)



Figure 1. 3D Volumetric unit (BuildOffsite, 2023)

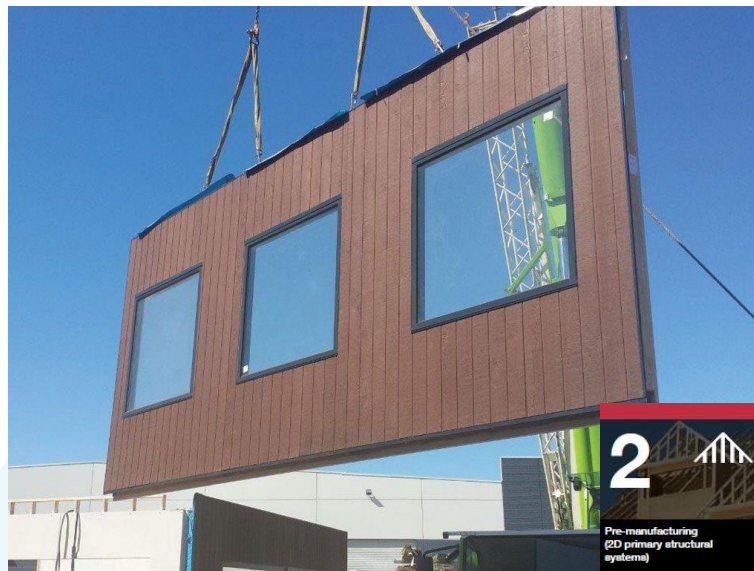


Figure 2. 2D panelised wall (Edwards-Clarke, 2023)

The following descriptions of each category of MMC are summarised from DHLGH (2023) and Buildoffsite (2023):

Category 1 is a systemised approach based on volumetric construction. The volumetric units can be brought to site with the basic structure with/without all internal and external finishes and services installed. For apartment buildings, full volumetric units can include apartments and common area space.

Category 2 refers to approaches using flat panel units for floor, wall and roof structure of varying materials which are manufactured in a factory environment and assembled on site to create the final three-dimensional structure. More complex panels may also include services, windows, doors, internal wall finishes and external cladding. This category can include materials such as light-gauged steel, cross-laminated timber, structurally insulated panels, etc.

Category 3 refers to pre-manufactured structural elements, which include: load bearing beams, columns, walls, core structures and slabs that are not substantially in-situ workforce constructed. These items are not part of a systemised design (Category 1 & 2).



Category 4 is remote or site based printing of parts of buildings based on digital design and manufacturing techniques.

Category 5 are pre-manufacturing approaches including: non-structural volumetric assemblies (known as pods), partition wall systems, weatherproofing, mechanical & electrical equipment assemblies, façade assemblies, etc. These are non-structural assemblies and sub-assemblies.

Category 6 includes traditional building products manufactured to reduce the extent of site labour required. Examples include pre-cut configurations, large format walling products, easy jointing features, etc.

Category 7 'is intended to encompass approaches utilising innovative site based construction techniques that harness site process improvements falling outside the five main pre-manufacturing categories 1-5 or materials innovation in Category 6' (MHCLG Working Group (2019)). Examples include insulated concrete formwork, augmented & virtual reality, drones, etc.

In this framework, Categories 1-5 refers to offsite pre-manufacturing and Categories 6-7 refers to site-based process improvement. This framework enables clients, advisors, lenders and investors, warranty providers, insurers and valuers to all have a common understanding of the terminology of MMC.

2.2 Current situation in Irish context

Ireland's national 'Housing for all (HfA)' strategy states that 'everyone in the State should have access to a home to purchase or rent at an affordable price, built to a high standard and in the right place, offering a high quality of life' (DHLGH (2021)). The HfA 2021 Strategy Action Plan aims to have 33,000 residential units being built each year by 2030. Furthermore, the 2030 targets of the Climate Action and Low Carbon Development (Amendment) Act 2021 (Department of Environment, Climate and Communications (2021)) requires a 51% reduction in the embodied carbon for all buildings. Additionally, with an aging workforce and reducing workforce (Conefrey and McIndoe-Calder (2018)), efficiencies in the construction process of delivering housing needs to change. It will most likely not be possible to use traditional construction methods and meet these climate action and housing unit goals. MMC could help to achieve these targets by accelerating housing delivery and effectively reducing carbon emission (Kechidi and Banks (2023)).

A survey conducted by Linesight (2021) including designers, contractors, developers and end users in Ireland showed that the 73% of designers / contractors surveyed estimate that offsite manufacturing (OSM) is still at early stages of development as it represents only 10% of current turnover. Offsite construction accounts for less than 1% of total new residential units in Ireland, whereas it is 10% in the UK market (EI & DETE (2022)). A CIF MMC report in 2020 detailed the number of existing Irish MMC providers according to the MMC category framework (CIF (2020)). The number of companies is summarised in Table 1. It shows the number of providers was 87 up to 2020 (some companies produce more than one category of MMC, so the exact number of providers would be slightly lower than 87). The report 'Modern method of construction: defining MMC business' (CPS (2022)) noted that there were approximately 100 OSM companies with facilities in Ireland. However, just 27 of these 100 MMC companies provide complete housing solutions to the Irish construction sector. The analysis by CIF (2020) indicated a good regional distribution in Ireland. These firms have a wide distribution network and are typically based close to larger cities or the motorway network. A presentation given by NSAI (2023) indicates there are 160 MMC companies in Ireland in 2023 Ireland, showing a growing activity in MMC. This number is expected to reach 180 by 2024. Of these MMC companies, 22 have Agrément certificates (NSAI (2023)). Globally, offsite construction generated €110 billion in 2020 and at the time of reporting expected a 5.9% increase rate each year in the future (Allied Market Research, 2021).



Table 1. Number of Irish MMC providers in 2020 (CIF (2020))

Category	Number of providers
Category 1	13
Category 2	33
Category 3	13
Category 4	1
Category 5	14
Category 6	5
Category 7	8
Total	87

2.3 Construction sector perception of MMC

This section presents a literature review of the construction sector's perspective of MMC in Ireland and around the world. Various benefits of MMC have been observed in different studies and reports such as: reducing handover time, reducing waste and increasing sustainability, increasing productivity, improving quality, improving certainty of project (Blismas and Wakefield (2009), Reddy (2020)). Despite the recognition of these benefits in the construction sector, the adoption of MMC is still at a low level in Ireland. Some recent research has attempted to investigate the current industry perception of MMC and the barriers of adoption in both the Irish and international context. Reddy (2020) used online questionnaires and interviews with Irish MMC stakeholders to identify market constraints. The five most important barriers were concluded as: unsuitability for smaller projects due to personalized design requirements, inflexibility to adapt to late design changes, competitive market favouring traditional-build suppliers, and limited availability of design options. This result is slightly biased as the respondents were mainly architects (53%) with only 23% of respondents from contractors. Focusing on the small and medium enterprises in Ireland, Carmody et al., (2022) conduct six interviews with one company that had provided volumetric (Category 1) service for more than twelve months. The most significant constraints highlighted by the Category 1 MMC company were 'lack of knowledge' and 'keeping a continuous schedule of projects'. As only one firm was studied, the authors state that the barriers could vary with different companies.

The 'RIAI design for manufacture and assembly / DMFA report' (RIAI (2022)) is aimed at practicing architects to show how good design can be used to facilitate MMC, whilst not losing design quality. RIAI (2022) also presents the perception and actual conditions of MMC in Ireland from 13 different aspects such as quality, design flexibility, manufacturing capacity, etc (shown in Appendix 1). The report highlights the following challenges that slow the development of MMC innovation: client risk aversion, existing system and regulations that limit innovation, lack of funding, the fragmented nature of industry, lack of dissemination of what has been done, industry culture that discourages innovation, and insurance. The main barriers to adoption of MMC were highlighted as: skills needs, manufacturing capabilities (the implementation of MMC requires both a different business model and a different skill set to traditional construction), procurement process, clear requirements, insurance (obtaining building insurance cover post-completion), certification

(time and money), building control regulation and planning.

CIF (2020) reported key issues from different MMC categories and summarised barriers to MMC implementation. These aspects cover areas such as finance, construction, regulation, strategy, standard, project management, risk assessment and technical innovation. The report presents detailed drivers and barriers for MMC related to industry, but not the general public. Mourao (2021) identified seven barriers to MMC adoption by industry. *Skill & Knowledge* was identified as having the greatest level of impact on adoption of offsite construction with the current education and training system’s focus on traditional construction being the main reason for this. *Skill & Knowledge* was followed very closely by *Process & Programme and Industry & Market Culture* as having the next highest impact on adoption of offsite construction.

Outside of Ireland research has also investigated barriers of MMC adoption. Table 2 summarises barriers of MMC adoption in different countries and regions.

Table 2. Barriers of MMC adoption in different countries and areas

Country/Region	Top 5 Barriers identified	Literature
U.S.A.	Lack of contractor experience, inflexible to design changes, lack of familiarity, higher initial construction cost, logistics of offsite assembly, technical challenges, regulations, characteristics of sites, challenge of off-site financing and business model.	Razkenari et al., (2020)
Bangladesh	High initial cost, Inadequacy of local R&D institutes and services, lack of skilled contractors, unawareness of MMC by the market and public, uncertainty of market demand.	Datta and Assafi (2022)
Saudi Arabia	High initial cost, customer resistance to adopt MMC, improper marketing plan, the dominance of the traditional, construction method, lack of professionals.	Shash and Alawad (2020)
UK	Upfront design timescale, commercial competitiveness, education of project managers, upfront costs, design flexibility.	Williamson et al., (2019)
England	Inability to achieve economies of scale, Increased project cost, increased capital cost, the capacity of suppliers, End-user prefer to traditional method.	Agapiou (2022)
Australia	Lack of awareness / training / experience of builders, policies of finance industry / banks, perception issues in the society, lack of awareness / training / experience of designer, architecture.	Dave et al., (2017)
China	High cost pressure without economic sales effect, uncertainty of market demand, legal issues, lack of practices and experience, fragmented industry structure.	Mao et al., (2015)
New Zealand	Financial constraints, lack of knowledge and information, regulatory requirements and standard, lack of inflow and demand.	Darlow et al., (2022)

From Table 2, some common barriers can be recognised internationally: high advanced cost, lack of knowledge and experience, standards/regulation, market demand and public perceptions. It can be seen from Table 2 that some barriers depend on the country. This is due to countries having different maturity of adoption and implementation of MMC. Within the Irish context, there is a no comprehensive quantitative study showing



the current industry perception of MMC. This gap will be filled in the report.

2.4 Public perception of MMC

Currently, little research has been conducted on the public perception of MMC around the world. Most of the research has focused on the construction sector's perception of MMC. According to the survey conducted by the HOME group in UK (HOME (2018)) on members of the public, 52% of respondents (a weighted sample of 2,076 persons) would be hesitant to live in a modular home, and 41% believe modular homes are less durable than traditional built homes. Additionally, 70% of people connected the term 'modular' with shipping container residences. However, when respondents were asked to identify a modular residential property when provided with several images of modular and non-modular residential properties, 90% of respondents were unable to identify a specific MMC home. This demonstrates that the current visual/aesthetic view of MMC products can be very similar to traditional properties. Shah et al., (2020) conducted a questionnaire survey of the general public's perceptions of MMC in UK with 195 respondents. Shah et al. (2020) reported that the majority of respondents are unsure or do not want to buy a prefabricated house. Their findings also showed that there is little generational bias in MMC perception i.e., both young and older respondents had similar perceptions. Shah et al. (2020) observed that the most appealing aspect of prefabricated products was the low price. There is no study that shows the attitudes of the Irish public towards MMC.

3 Research objectives and methodology

3.1 Research objectives

There are three main objectives of this study as follow,

- Objective 1: Understanding current situation of MMC adoption and perception within the general public and construction industry.
- Objective 2: Identify drivers and barriers of MMC and possible ways to improve adoption of MMC in the Irish context.
- Objective 3: Identify approaches that could broaden the understanding of MMC and its benefits.

To achieve these objectives, a quantitative and qualitative analysis was conducted, based on construction industry semi-structured interviews and subsequent questionnaires collected from both the public and construction industry.

3.2 Research methodology

This section describes the methodology employed to accomplish the objectives, which involved a four-step approach.

Step 1: The first step consists of an extensive literature review to gain insights into the development of MMC both in the Irish and international context (Sections 2.2-2.4).

Step 2: Using the knowledge derived from the literature review, several key questions were formulated to conduct semi-structured interviews with MMC stakeholders from both Ireland and the UK. These interviews aimed to capture the construction industry perspectives of both the public and the industry regarding MMC.

Step 3: Drawing from the responses gathered during the interviews, two questionnaires were designed to investigate the behavioural attitudes towards MMC in Ireland. The interview responses were used to design the two separate public and construction industry questionnaires.

Step 4: The survey results provided insights into both the construction industry and public perceptions of MMC and possible ways to build confidence in more innovative residential property building approaches such as MMC.

Based on the findings from the literature review and objectives of this research, several questions were designed for the construction industry stakeholder semi-structured interviews, as shown in Table 3.

Table 3. Relation between the objectives and semi-structured interview questions

Objective	Interview questions
Objective 1	What do you believe the current perceptions of MMC by industry are? What do you believe the current perceptions of MMC by the general public/end users are?
Objective 2	How important do you believe the type of house construction is to the general public/end users that are buying a new home?
Objective 3	How do you think government could help change any negative perceptions? How do you think the construction industry could help change any negative perceptions? How do you think your organisation could help change any negative perceptions?

According to the objectives and semi-structured interview results, the questionnaire was divided into two sections, one for the general public (Questions 3-20) and the other for construction industry professionals (Questions 21-38). The categories and aim of each group of questions in each questionnaire is shown in Table 4. A list of the survey questions is provided in Appendix 2. The rationale for choosing the survey questions is expressed in next section, along with the interview results. To facilitate the survey process, the questionnaire was created using the SurveyMonkey platform and subsequently distributed through social media platforms and emails.

Table 4. Summary of categories of questionnaire questions

Information summary	Questions
Survey of the general public	
Demographic information	Questions 3-5
Attitudes towards property purchase	Questions 6-12
Public perception of MMC/traditional construction	Questions 13-20
Survey of construction industry	
Demographic information	Questions 21-27
MMC adoption in the industry	Questions 28-32
Barriers and drivers of MMC	Questions 33-34
Potential suggestions	Questions 35-38

4 Research results

4.1 Semi-structured interview results

A total of 19 construction sector stakeholders were contacted, of which 13 agreed to participate in the semi-structured interviews. The interviewees were from the following backgrounds: architects, contractors, industry representative bodies, MMC manufacturers, MMC designers, testing/certification organisations, standards/building control, and government agencies. The interview questions were designed to explore various aspects, including industry perception of MMC, the public perception of MMC from the industry's viewpoint, and potential ways to improve MMC adoption. The construction sector presented diverse views concerning MMC. Table 5 summarises how interview results help the design of the survey questions for general public.

Table 5. Relationship between interview question and questionnaire questions for the general public

Interview question	Results from interview	Collected information
What do you believe the current perceptions of MMC by the general public/end users are?	Public's view depends on their knowledge, age...	Q3: location, Q4: age group, Q5: education background, Q14,15: awareness of MMC, Q16: experience of MMC.
	Depends on terminology used to describe.	Q13: Perception of MMC terms,
		Q17: Willing to buy MMC.
How important do you believe the type of house construction is to the general public/end users that are buying a new home?	Care more factors rather than type of construction	Q6-12: factors affect new property purchasing. Q18-20: Comparison between MMC and traditional construction product.

Similar to the industry perception from previous research summarised in Table 2, 61.5% of those interviewed noted that the public's view depends on different factors, including the terminologies used, their knowledge about MMC, and their age. The survey Questions 3-5 were designed to collect this demographic information. When asking whether they believe if the public care about the type of construction if they are buying a newly built residential property, all interviewees think people care more about other factors rather than type of construction. Those answers help build Questions 6-12.

Regarding the public perception, 76.9% of interviewees believe that there is a negative correlation between the public's perception and the terms used to describe the MMC. Specific terms like 'prefab' 'volumetric,' and 'rapid construction' seem to be the biggest sources of negative perception. On a positive note, about 37.5% of those interviewed believe that the public's perception of MMC is favourable, considering that it is a manufactured product and is already being used by the industry. It is worth mentioning that there were three interviewees who highlighted a lack of knowledge about MMC within the general public. To understand public perception towards MMC, Questions 13-20 were designed.

The design of the construction industry survey questions was based on both literature review and interview results. Based on the knowledge gained from the literature review, it was necessary to understand the current level of MMC adoption in the industry. Hence, Questions 28-32 were designed to understand the extent of MMC adoption in Irish construction. From Table 2, several overlapping factors contribute to barriers to MMC adoption across the world. Therefore, Questions 33 & 34 in the industry survey were designed to identify drivers and barriers in the Irish context. The remainder of the industry questions were designed based on interview results and the logic of their selection is summarised in Table 6.

Table 6. Relationship between construction industry interview question and questionnaire questions

Interview question	Results from interview	Collect information
What do you believe the current perceptions of MMC by industry are?	Depends on natural of their organisation	Q21: organisation type Q24: organisation location Q25: organisation size
	Depends on their work experience, role...	Q22: Years of experience in construction Q23: Role in organisation Q27: Years of experience working in MMC
		Q35: Do you believe of MMC will be widely used in Ireland
How do you think the construction industry could help change any negative perceptions?	Show benefit of MMC	Q36: Industry ways to improve public understanding of MMC
How do you think government could help change any negative perceptions?	Help wider adoption of MMC	Q37: Industry ways to improve adoption of MMC Q38: Government ways to improve public understanding of MMC

When asking about industry perception of MMC, 53.8% of the interviewees hold the belief that the perception of the construction industry varies depending on factors like the company's type, size, and location. To explore this further, survey Questions 21-27 aim to collect demographic information. It was observed that 69.2% of interviewees expressed a positive view of MMC within the industry. This positive perception is mainly attributed to the numerous advantages of MMC, such as faster construction, improved quality, and enhanced working conditions for labourers. Those factors help to design Question 33 to understand drivers of MMC. The interviewees mostly (69.2%) believed MMC is still in its early stages of adoption, which aligns with the literature indicating a small market share in Ireland. Question 28-32 are designed to observe the level of MMC adoption within Ireland. On the other hand, the remainder of interviewees (30.8%) stated a negative attitude towards MMC, citing concerns about the existing issues in the Irish MMC market. These responses are instrumental in formulating Question 34. Interestingly, 23% of interviewees considered resistance to change away from traditional construction as a significant challenge in adopting MMC.

The interviewees were queried about potential strategies to enhance the public perception of MMC, and their responses were used to formulate Questions 36-38. When addressing how the industry could mitigate negative perceptions of MMC among the public, 92.3% of participants suggested that showcasing the benefits of MMC to the public is crucial. Some interviewees recommended approaches including employing case studies, utilising online magazines, and leveraging social media platforms. Additionally, 69.2% of interviewees expressed the view that the industry should focus more on improving the MMC product itself. Suggestions in this regard encompass delivering higher-quality products and ensuring product quality (53.8%), reducing prices (7.7%), and innovating further in MMC product development (7.7%).

In the context of how government could alter the public's potential negative perception of MMC, 84.6% of interviewees believed that a broader adoption of MMC within the construction sector could be instrumental. Consequently, Questions 37 & 38 were designed to understand the potential solutions for fostering wider adoption of MMC from both industry and government perspectives. Concerning strategies to promote the adoption of MMC, 38.5% of interviewees thought that increased public procurement could be beneficial, while 46.2% highlighted the importance of implementing policies and improving the project pipeline as potential

solutions.

4.2 Survey results

A total of 146 survey responses were reviewed, with 114 valid responses (recovery efficiency rate of 78% (114/146)). The survey Figure 3 illustrates that 36.8% (42 out of 114) of participants belong to the general public, while the remaining respondents are from the construction sector.

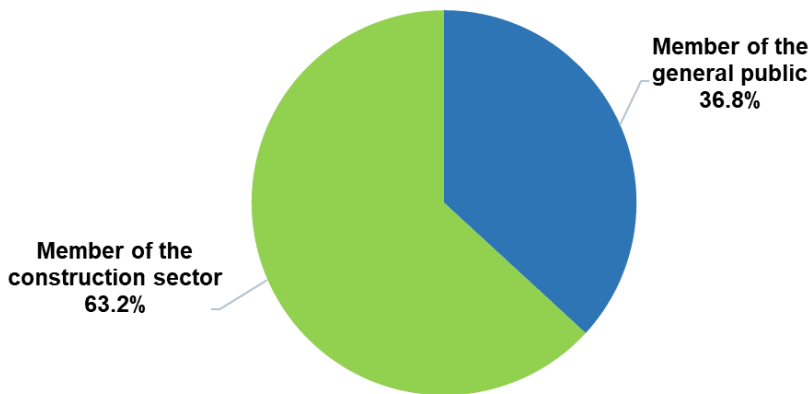


Figure 3. Background of all respondents (114 valid responses).

General public survey results

Within the general public group (42 respondents), participants were well-distributed across 13 counties (see Figure 4). Dublin accounted for the largest portion with 45.2% (19 out of 42) of participants, followed by Wicklow (9.5% - 4 out of 42), Kildare (9.5% - 4 out of 42), and Galway (7.1% - 3 out of 42). As shown in Figure 5, the majority of respondents belonged to the 31-40 age group (52.4% - 22 out of 42), followed by 41-50 (19.1% - 8 out of 42), and 18-24 (16.7% - 7 out of 42). With respect to educational background, 71.4% (30 out of 42) of the public participants held a master's degree or postgraduate diploma, while 21% (9 out of 42) had a bachelor's degree or equivalent (see Figure 6). No participants with lower levels of education were observed, indicating a well-educated background among the public respondents.

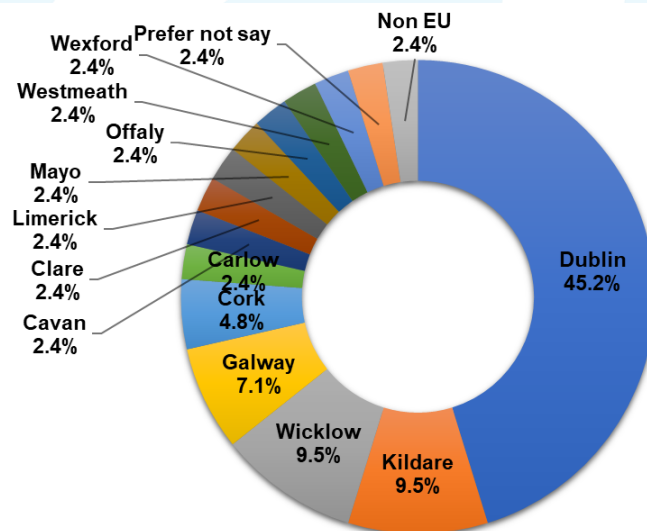


Figure 4. Geographical distribution of general public respondents (42 respondents).

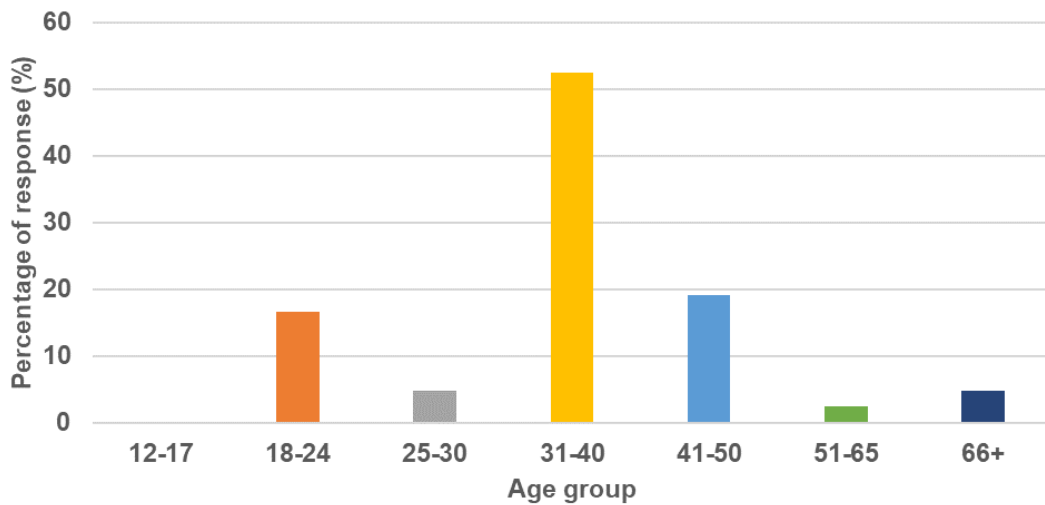


Figure 5. Age distribution of general public respondents (42 respondents).

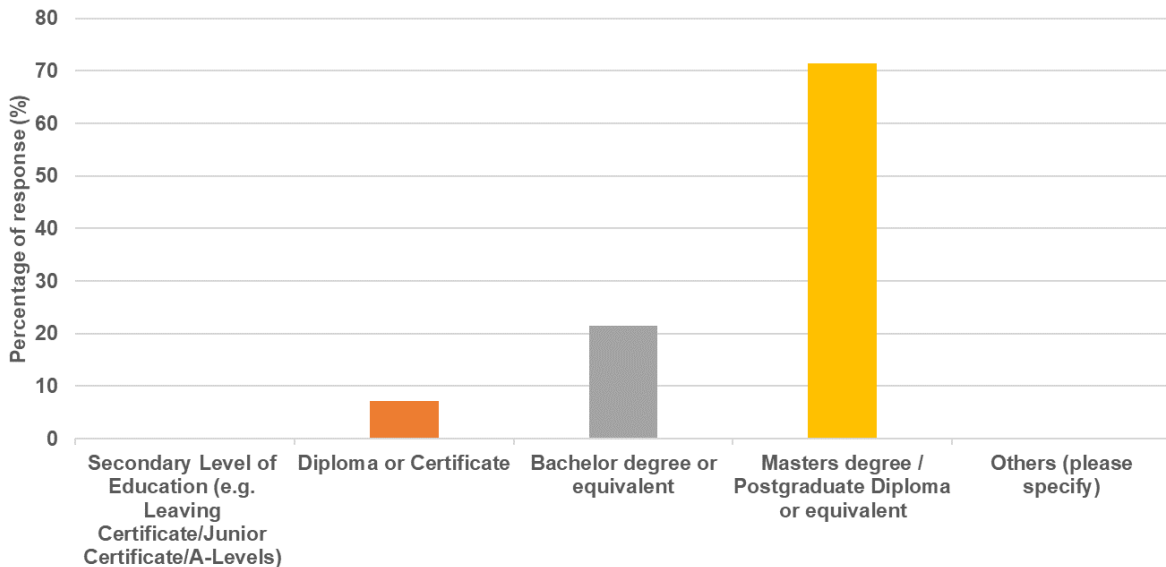


Figure 6. Educational background of the general public respondents (42 respondents).

To understand how different factors affect the purchase of a new build residential property, a rank-order approach to questions was used. From Figure 7, the top two factors considered most important when members of the public consider purchasing a new residential property were identified as *Price* and *Location*. However, it is difficult to identify the importance of the rest factors directly from Figure 5. To quantify the significance of these factors, each one was scored based on their ranking results using Borda's aggregates with a weighted average value, as described in the study conducted by Lin (2010). Details of the scoring method are supplied in Appendix 3.

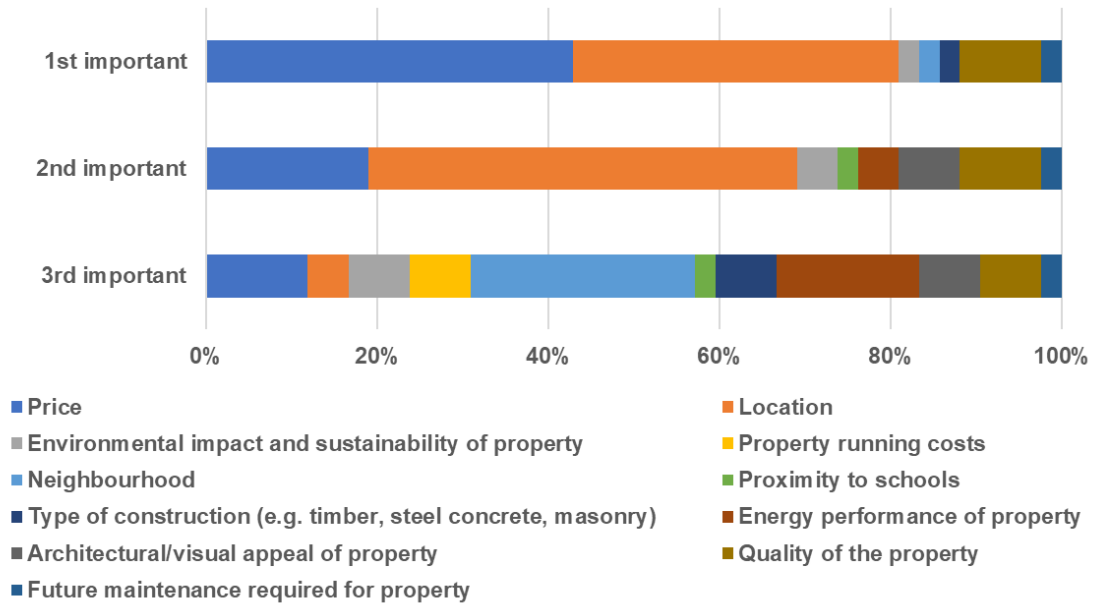


Figure 7. The three most important factors when buying a new build residential property for the general public respondents (42 respondents).

By using this method, a high score represents the factor is important. A score of 100 means all participants select the factor as the 1st important. If a factor has a score of 0, it means no one selected this factor as important. Upon calculation, the scores of each factor were obtained and are presented in Figure 8. Location emerged as the most important factor, surpassing Price in importance. The third most important factor was the Quality of the property. All other factors exhibited no significant difference, with scores all below 8, signifying their relatively minimal importance compared to Location, Price and Quality of the property.

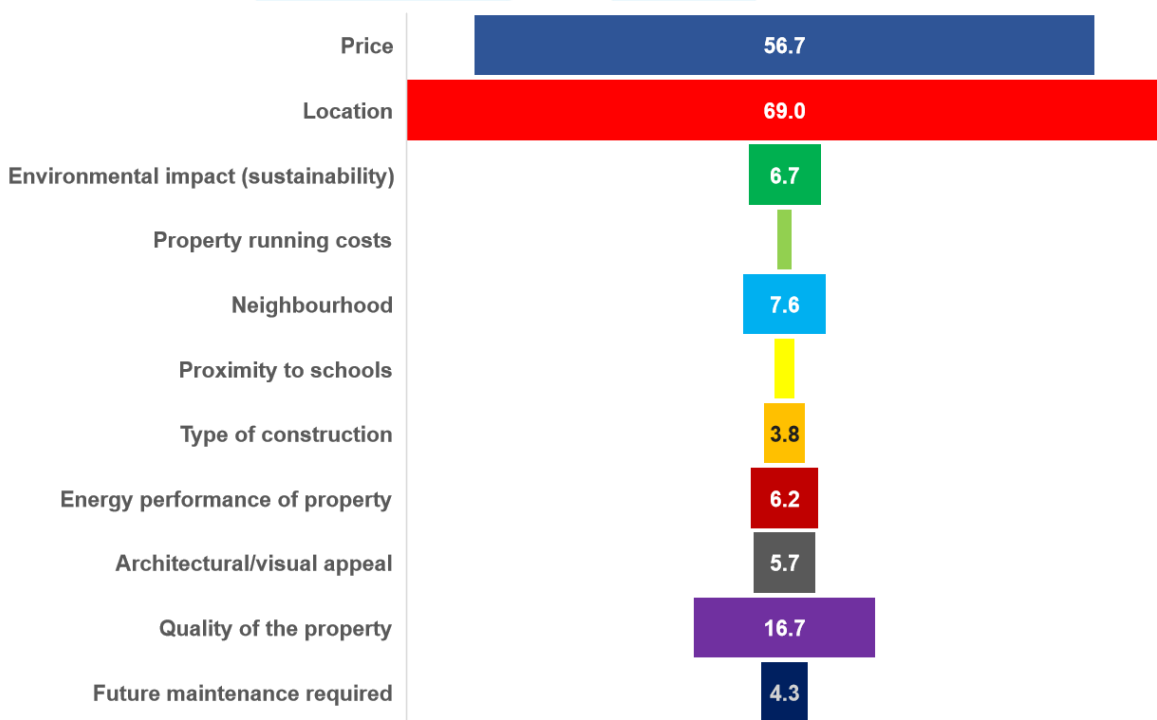


Figure 8. General public respondents score of factors when buying a new build residential property (42 respondents).

An interesting observation is the higher score attributed to *Price* than *Location* from respondents in Dublin (see Figure 9), a phenomenon possibly influenced by the comparatively elevated property prices in this area compared to the rest of the country.



Figure 9. General public respondents score of factors when buying a new build property: Dublin vs non-Dublin (42 respondents).

To identify potential benefits of MMC that could impact the purchase of a new build residential property, scoring questions were used to ask general public respondents to identify their importance. The selected factors are related to some potential drivers of MMC identified during the semi-structured interviews. Table 7 displays the weighted average score for each factor. *Price* received the highest score among these factors, followed closely by *Build quality*, which held the same rank as in the previous analysis. Notably, the scores for these two factors were very close, suggesting their near equal importance to the general public. The *Cost of running a home* was scored highly, surpassing *Sustainability*. *Type of construction* received the lowest score among these five factors, indicating that the general public respondents place less emphasis on the construction method when compared to the other factors.

Table 7. General public respondents weighted average score when buying a new build residential property (42 respondents).

Potential benefits of MMC	Not at all important (1)	(2)	(3)	(4)	Very important (5)	No opinion	Total	Weighted Average
Price	0	0	1	10	31	0	42	4.71
Build quality	0	0	1	12	29	0	42	4.67
Cost of running a home	0	0	5	11	26	0	42	4.50
Sustainability	2	4	8	19	9	1	42	3.68
Type of construction	1	8	18	8	6	1	42	3.24

When participants were queried about their willingness to customise a property, 81% (34 out of 42) responded ‘Yes’, whereas only 4.8% (2 out of 42) said ‘No’ (see Figure 10). This implies that the ability to customise a newly built residential property can serve as a potential driver for selling MMC products in the future.

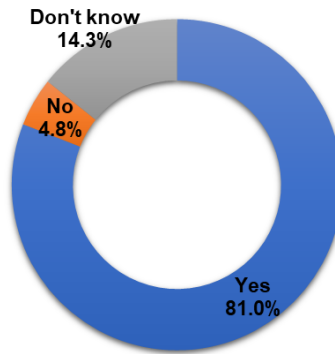


Figure 10. General public respondents' willingness to customise the property (42 respondents).

Question 13 inquired about participants' perceptions related to specific terms associated with MMC. The responses in Figure 11 indicated a positive perception towards 'modular house' and 'off-site house' and a more negative perception to 'prefabricated house' and 'rapid-build house'. There was a consistent level (above 30%) of respondents who had a neutral/not good or bad perception of all MMC terms. However, contrary to the semi-structured interview results with industry stakeholders who thought prefabricated, rapid construction and modular had negative perceptions, there was no clear negative perception observed regarding 'prefabricated house' and 'rapid-build house' (see Figure 11) i.e. positive and negative perceptions were about the same. This discrepancy suggests a potential misunderstanding within the industry about public perception to specific MMC terms. However, a distinct negative perception was noted concerning 'rapid-build house' among residents of Dublin. In this subgroup, 42.1% of respondents expressed a negative perception about this term (see Figure 12).

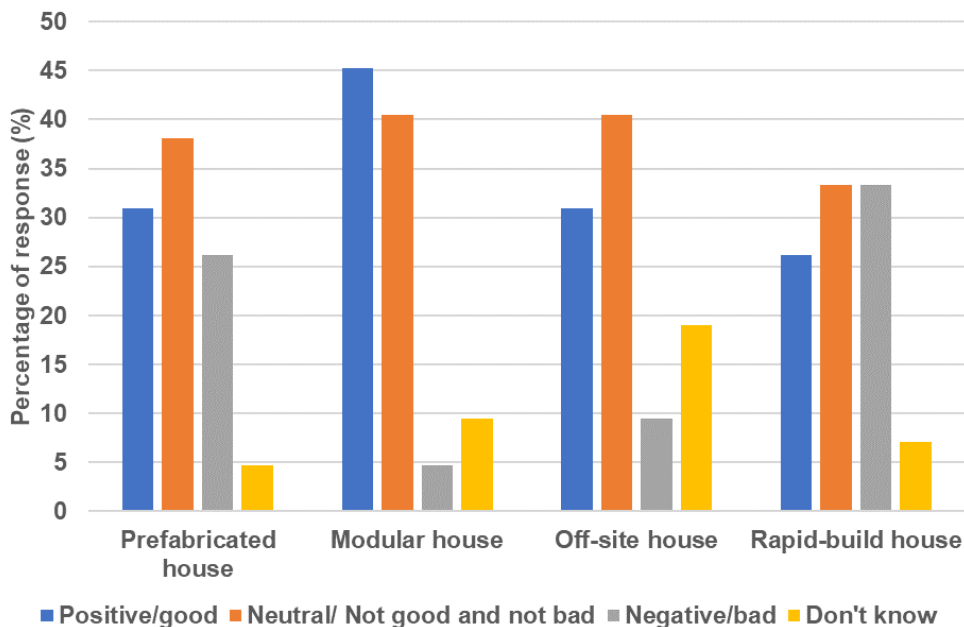


Figure 11. General public respondents' perception relating to different MMC terms (42 respondents).

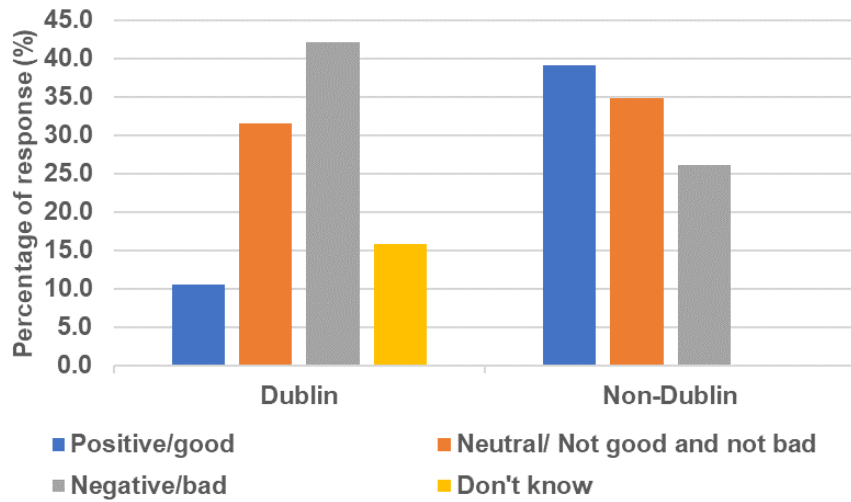


Figure 12. General public respondents' perception around term 'rapid-build house' from different areas (42 respondents).

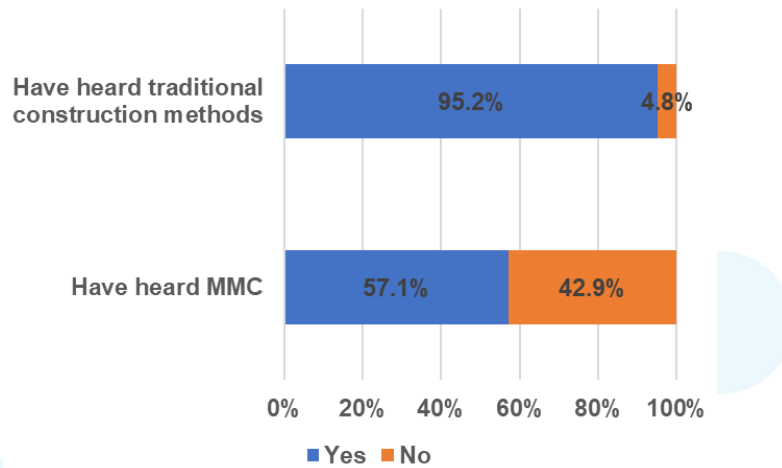


Figure 13. General public respondents' knowledge about different construction methods (42 respondents).

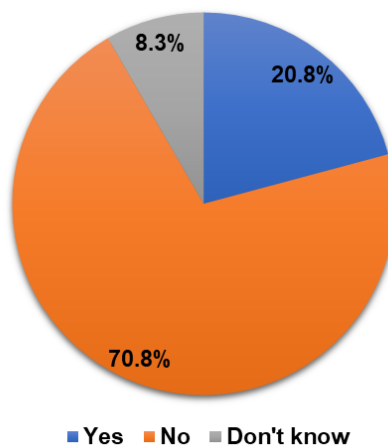


Figure 14. General public respondents that have lived in an MMC constructed property (42 respondents).

Figure 13 shows that the general public were highly aware of traditional construction methods (95.2% - 40 out of 42), but less so for MMC methods (57.1% - 24 out of 42). Only 20.8% (9 out of 42) have identified that they have lived in MMC built homes (see Figure 14). These findings align with existing literature indicating that MMC is still in its early stages (Linesight (2021) & CIF (2020)), with a moderate level of understanding in the general public.

At this point of the survey, the general public participants were asked if they had prior knowledge of MMC (Question 14). Consequently, only participants who had prior knowledge of MMC were asked subsequent questions. Those members of the general public who had not heard of MMC finished the survey at this point. This resulted in 24 respondents out of initial 42 participants (57% had heard of MMC). When asked about their willingness to purchase an MMC property instead of a traditional one (see Figure 15), only 16.7% (4 out of 24) of participants who had previous awareness of MMC stated they would not buy an MMC property, while 41.7% (10 out of 24) expressed interest in buying an MMC residential property. Interestingly, the same number of respondents said they did not know if they would buy an MMC property.

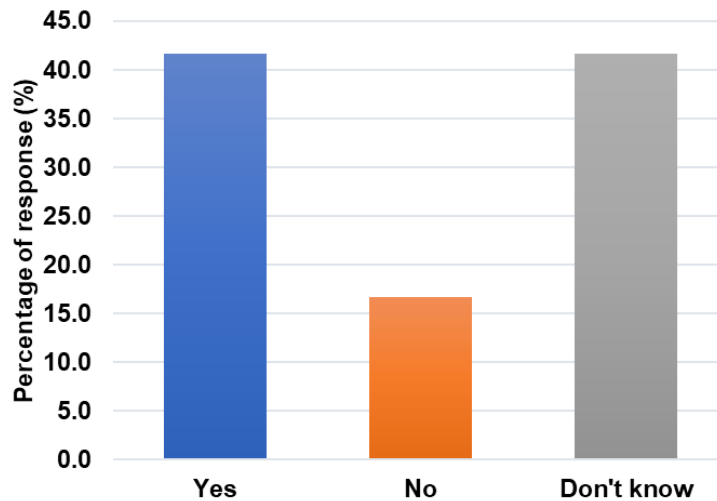


Figure 15. Willingness of general public respondents who had previous awareness of MMC to buy a new build MMC residential property (24 respondents).

The general public respondents who had previous awareness of MMC were asked about their perception regarding how MMC properties compare to traditional build properties in three distinct aspects: *Quality*, *Energy performance*, and *Sustainability* (which were the main MMC drivers for the public identified from the literature review and semi-structured interviews). Figure 16 demonstrates that only 16.7% (4 out of 24) of respondents who had previous awareness of MMC believed MMC properties have lower quality than traditionally built residential properties. More than half of the respondents who had previous awareness of MMC believed MMC built properties either matched or exceeded the quality of traditional builds (33.3% + 20.8% = 54.1% (13 out of 24)). These responses suggest a positive perception from the general public who had already heard of MMC built properties.

From Figure 16 it can be seen that there is a positive perception among the general public participants who had previous awareness of MMC regarding the *Energy performance* and *Sustainability* of MMC properties. With 54.2% (13 out of 24) of participants considering MMC properties to be more energy-efficient than traditional ones and 70.8% (17 out of 24) believing MMC properties are more sustainable. These responses demonstrate an awareness and acknowledgment of the environmental credentials associated with MMC from the public that have heard of MMC.

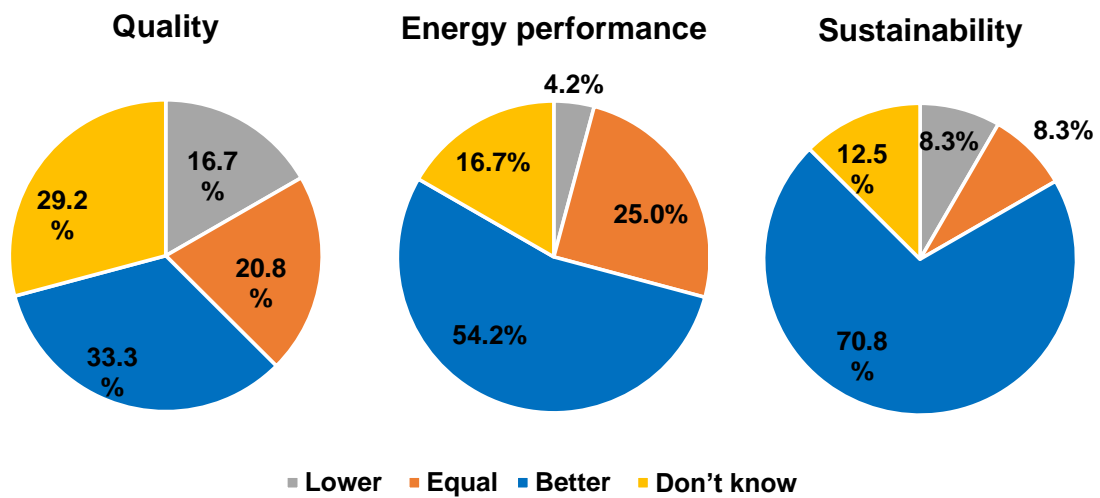


Figure 16. General public respondents who had previous awareness of MMC perception about how MMC properties performance compared to traditional built properties (24 respondents).

Construction industry survey results

In this section, the survey results from the construction sectors are presented. The construction industry survey respondents exhibited a well-distributed representation from various organisations within the construction sector, totalling 72 respondents across 13 different organization sectors (see Figure 17). The three largest sectors were architecture (19.4% - 14 out of 72), government (19.4% - 14 out of 72), and engineering (13.9% - 10 out of 72).

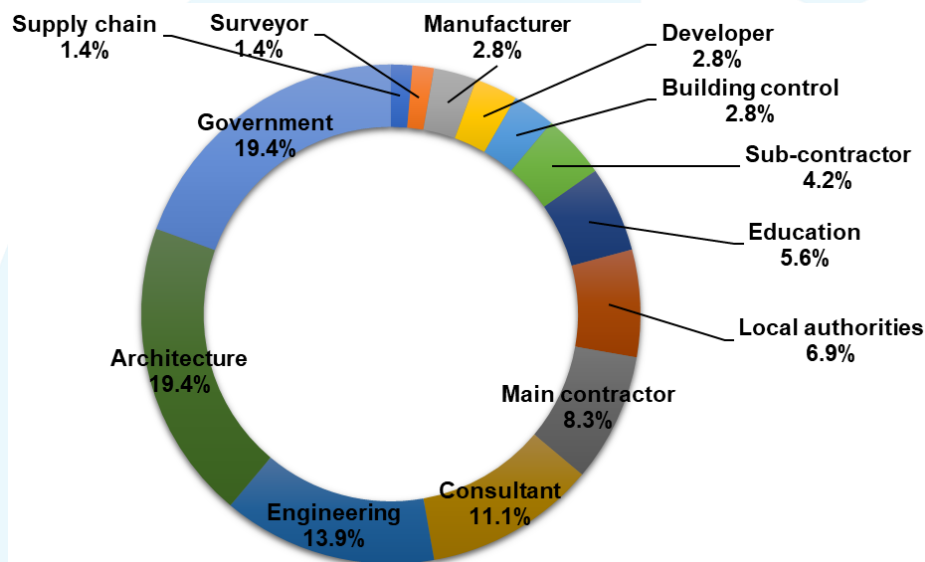


Figure 17. Construction industry organisation respondent distribution across the construction sector (72 respondents).

The construction industry respondents years of experience within the construction sector are provided in Figure 18. In general, there was an even distribution in all experience levels ranging from 20% to 30%, with the exception for the 5-10 years' experience group, which comprised only 6.9% (5 out of 72) of respondents. In terms of levels of seniority in Figure 19, 40.3% (29 out of 72) of participants are senior managers or directors, while 27.8% (20 out of 72) held first-level management positions and the rests are entry level or intermediate level.

A notable observation in Figure 20 was the geographic distribution of the construction industry respondents, where only 9.7% (7 out of 72) worked outside of Dublin in areas such as Clare, Limerick, Longford, Louth, Mayo, Meath and Wicklow. This has skewed the geographic distribution, with 90.3% (65 out of 72) of participants based in Dublin. Survey respondents in the construction sector worked in organizations of varying sizes, with the majority (31.9% - 23 out of 72) employed in companies or organizations with more than 249 employees (see Figure 21). Medium-sized companies/organizations followed closely, employing 30.6% (22 out of 72) of respondents, while only 16.7% (12 out of 72) worked in smaller companies with fewer than 9 employees.

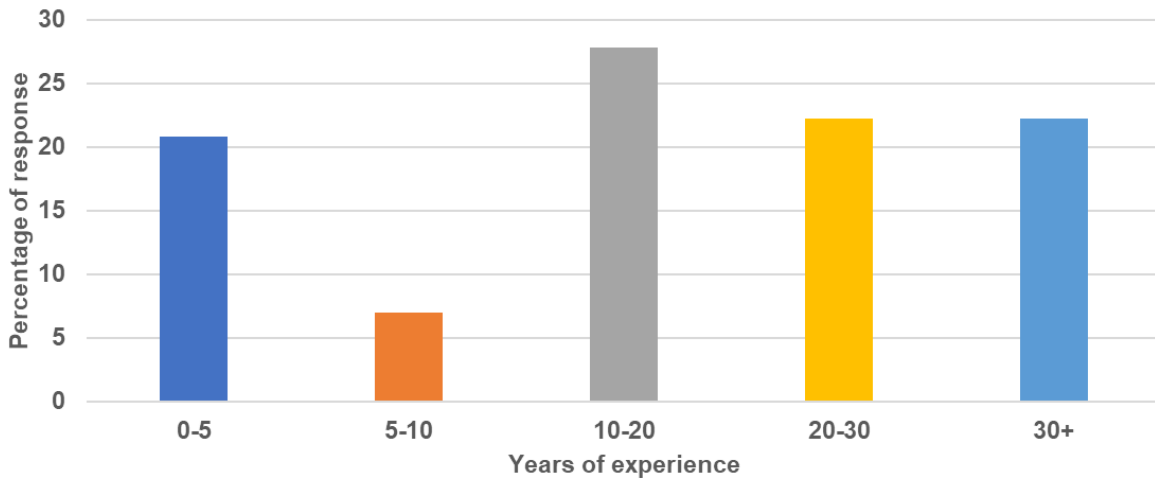


Figure 18. Construction industry respondents' years of experience in the construction sector (72 respondents).

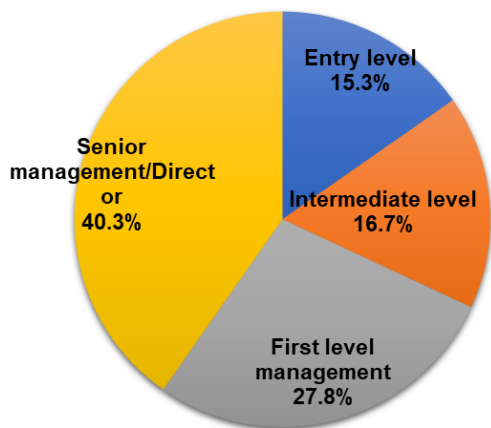


Figure 19. Construction industry respondents' distribution of roles within their organisation (72 respondents).

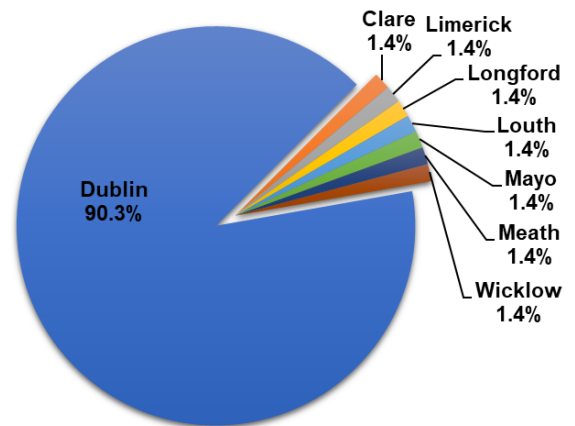


Figure 20. Construction industry respondents' geographical distribution (72 respondents).

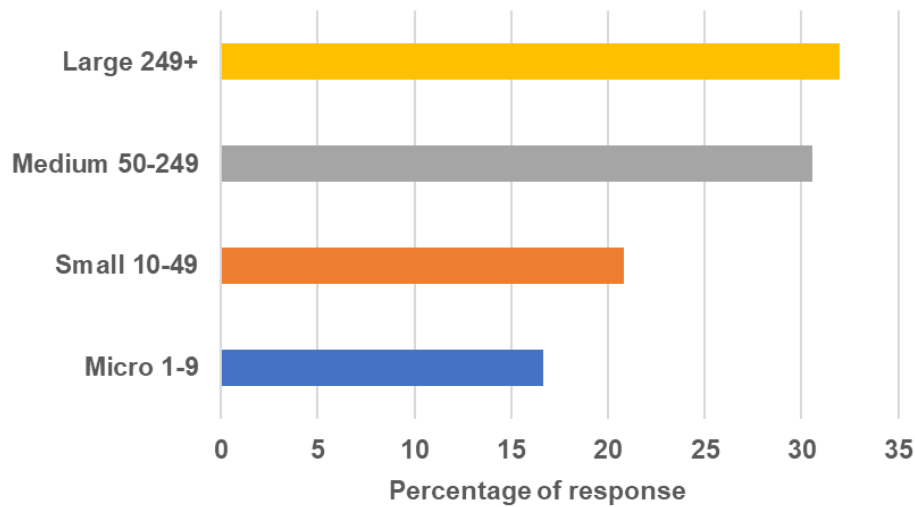


Figure 21. Construction industry respondents’ organisational size distribution (72 respondents).

Compared to the general public respondents, a significant 91.7% (66 out of 72) of construction sector participants had heard of MMC. This indicates significant knowledge of MMC within the construction industry. Figure 22 shows the construction industry respondents experience working in MMC projects. However, it is worth noting that 33.3% (24 out of 72) of participants had never worked on MMC projects, and only 7% (5 out of 72) had more than 20 years of experience in this domain. Additionally, only 19.5% (14 out of 72) of respondents have 10 or more years of experience working on projects with MMC. These responses would align with the relatively recent adoption of MMC within the Irish construction sector.

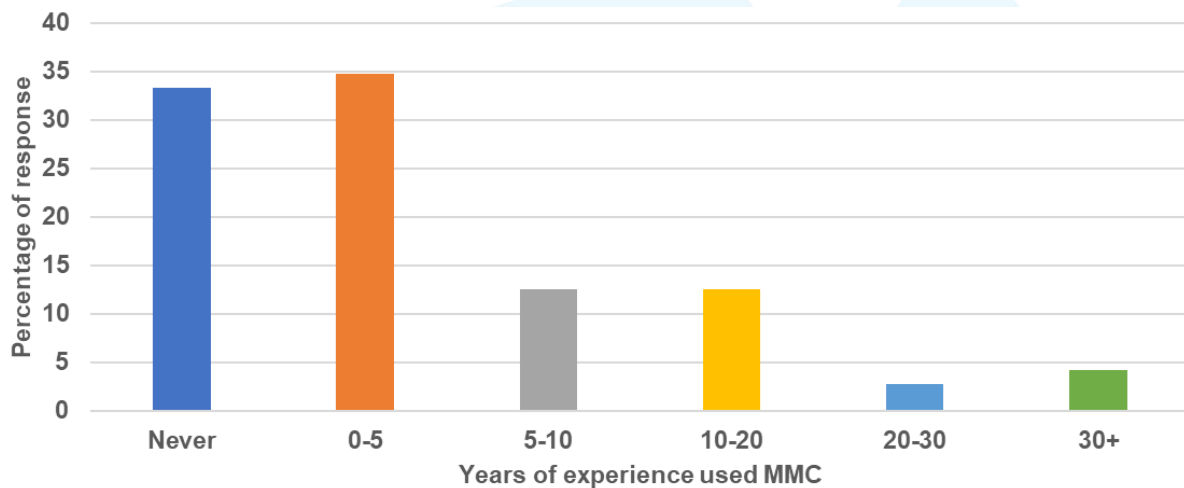


Figure 22. Construction industry respondents’ years of experience working in MMC projects (72 respondents).

As some participants lacked experience with MMC, only 47 respondents answered the remaining questions (down from 72 respondents for the previous questions). Among the various MMC categories, Category 2 was the most commonly used in projects, with 74.5% (35 out of 47) of participants having worked on projects within this category (Figure 23). Following closely was Category 5, utilized by 61% (29 out of 47) of respondents. Categories 1 and 7 had lower adoption rates, with 36.2% (17 out of 47) and 29.8% (14 out of 47) usage, respectively.

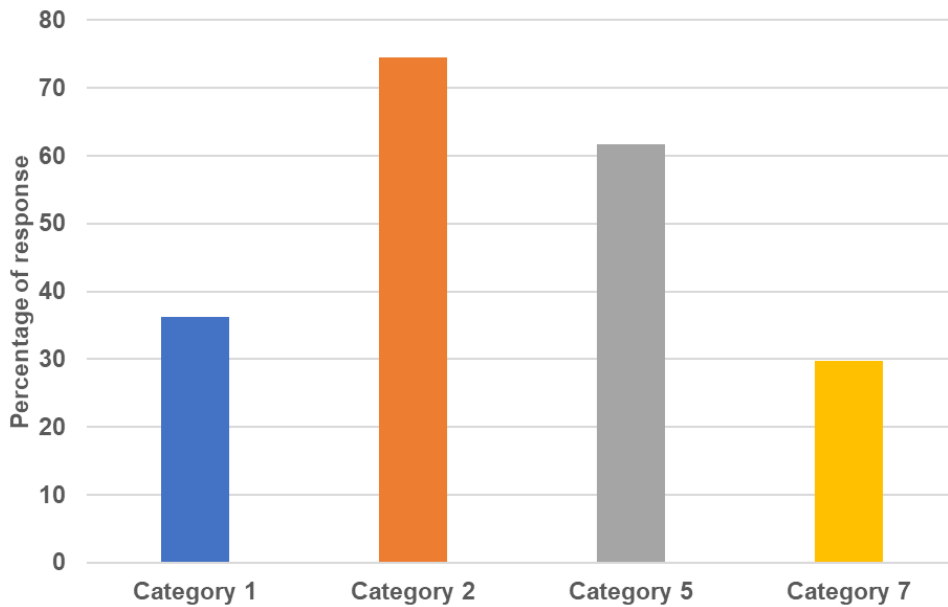


Figure 23. Construction industry respondents with MMC experience distribution of projects worked on each category of MMC (47 respondents).

Figure 24 shows the extent of MMC used in residential projects by construction industry respondents with MMC experience. It can be seen from Figure 24 that 68.1% (32 out of 47) of respondents stated that they used Category 1 in less than 10% of their projects. Only 8.7% (4 out of 47) reported using Category 1 in over 30% of their projects. Category 2, on the other hand, saw wider adoption, with 26% (12 out of 47) of respondents using it in over half of their projects. Despite being recognized as the second most widely used category (see Figure 23), 42% (20 out of 47) of respondents stated that Category 5 constituted less than 10% of their projects. Interestingly, 27.7% (13 out of 47) of participants were uncertain about the extent of Category 5 involvement in their projects. This could point to a lack of clarity in the construction industry relating to the description of Category 5, rather than it not being used. When asked about the future development of MMC in Ireland, 84.8% (40 out of 47) of construction sector respondents with MMC experience expressed their belief that MMC would be widely used in Ireland. Only 8.7% (4 out of 47) held the opposite view, indicating a positive perception of MMC within the Irish construction industry that have experience of MMC.

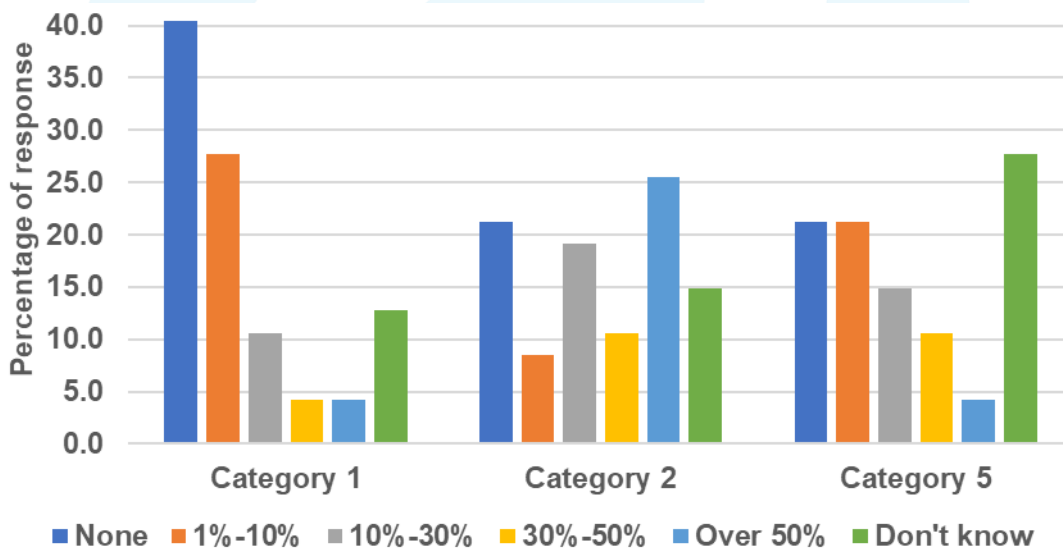


Figure 24. Construction industry respondents with MMC experience percentage of projects they currently work on that are MMC in Categories 1, 2 & 5 (47 respondents).

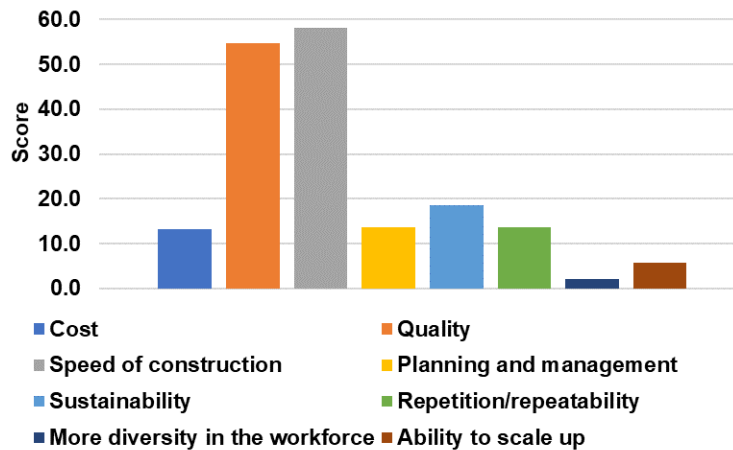


Figure 25. Construction industry respondents with MMC experience scoring of the benefits of MMC (47 respondents).

As can be seen in Figure 25, *speed of construction* (score of 54.6) and *quality* (score of 58.1) were the top two benefits of MMC identified by the construction industry respondents with MMC experience (details of the scoring method for ranked response questions are supplied in Appendix 3). *Sustainability* followed closely behind these with a score of 18.6 highlighting this benefit in MMC. In order to explore potential differences in viewpoints between the government and local authority respondents and the others construction industry respondents with MMC experience regarding these benefits, scores were calculated separately for ‘government and local authorities’ and the ‘other construction industry’ respondents, as shown in Figure 26.

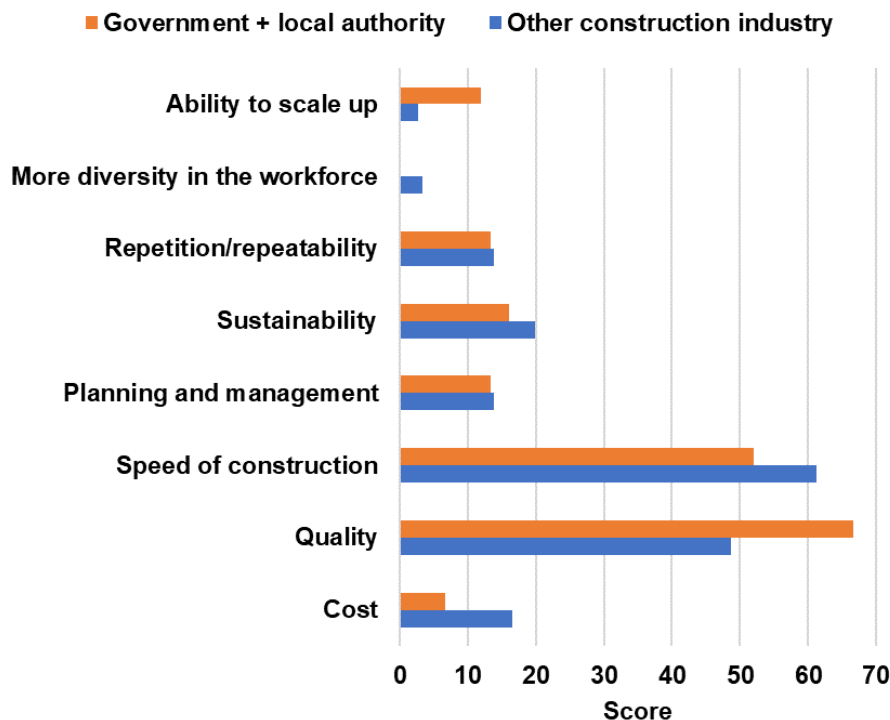


Figure 26. Government + local authority respondents and other construction industry respondents with MMC experience scoring of the benefits of MMC (47 respondents).

From the responses in Figure 26, it can be seen that both groups with MMC experience identified *Quality* and *Speed of construction* as the top two benefits of MMC. However, there were notable differences in their other perspectives. The ‘government and local authorities’ with MMC experience emphasised *Quality* as the most significant benefit (score of 66.7), whereas ‘other construction industry’ respondents with MMC experience rated *Speed of construction* as highest at a score of 61.2. Also, the ‘other construction industry’ respondents

with MMC experience scored *Cost* more than twice as important than that of the ‘government and local authorities’. Additionally, the *Ability to scale up* was recognised by the ‘government and local authority’ respondents but was not acknowledged by the ‘other construction industry’ respondents.

The construction industry respondents with MMC experience were then asked about barriers to wider adoption of MMC in Ireland as can be seen in Figure 27. The responses show that *Lack of industry knowledge* and *Difficult to change from tradition* were perceived as the top two barriers by all respondents, as shown in Figure 27. The subsequent factors, *Lack of pipeline* and *Immaturity of the supply chain*, had very close scores, indicating their comparable significance as barriers. Interestingly, these findings diverged from a previous study conducted by Reddy (2020), which identified *Unsuitability for small projects* and *Inflexibility to adapt late design changes* as the top barriers. However, this difference can be attributed to the participants of their study primarily being architects.

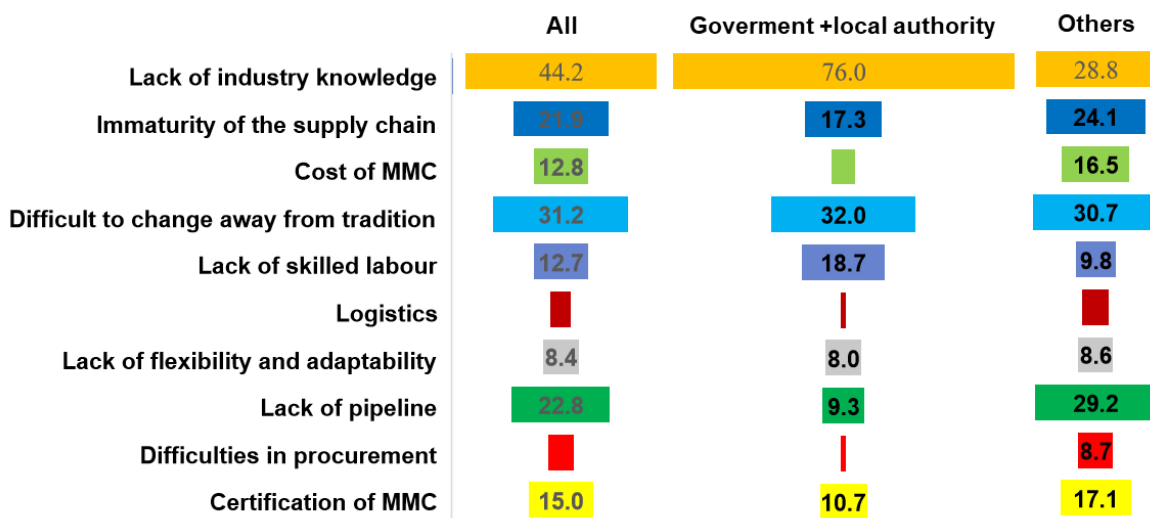


Figure 27. Construction industry respondents with MMC experience scoring of barriers to wider adoption of MMC from different groups (47 respondents).

When analysing the results in Figure 27 from different respondent groups with MMC experience, distinctions emerged. For the 'government and local authority' group, *Lack of industry knowledge* was the most significant barrier, scoring notably high at 76. The following barriers identified were by this group in order of highest score as; *Difficult to change away from tradition*, *Immaturity of the supply chain*, and *Lack of skilled labour*. In contrast, the 'Others' group (the remaining non-government and local authority construction industry organisations with MMC experience) considered *Difficult to change from tradition*, *Lack of pipeline*, and *Lack of industry knowledge* as the top three barriers, all with very similar scores. Following closely were *Immaturity of the supply chain* and *Certification of MMC*, indicating their comparable importance as barriers within this group's perspective. These insights underline the complexity of challenges faced by different sectors in the adoption of MMC.

The construction industry that have MMC experience was then asked to rank possible ways to enhance the understanding of MMC within the general public. The options provided in Figure 28 were defined based on the semi-structured interviews. The survey responses suggest that *Creating case studies as examples* could be the most effective approach (refer to Figure 28). Additionally, *Demonstrating benefits via different platforms* and *Ensure quality of MMC* were identified as equally viable methods. For the construction industry with MMC experience, there were three key strategies identified to promote the wider adoption of MMC, as shown in Figure 29. Each of the strategies had similar levels of importance: *Sharing knowledge of MMC practice*, *Ensure consistent high quality product* (i.e. MMC as a product) and *Help sector understand current developments*. From Figure 30, the top strategy for the government sector to facilitate broader MMC adoption was *Guarantee project pipeline*. This was followed closely by *Show successful implementation in Ireland* and

Align procurement process.

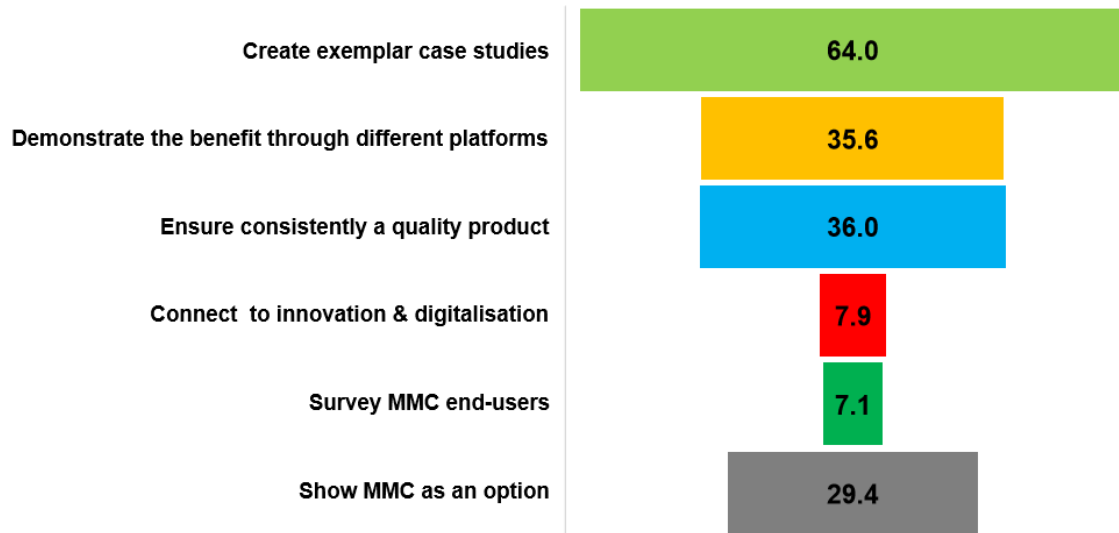


Figure 28. Construction industry respondents with MMC experience scoring of ways to improve the general public's understanding of MMC (47 respondents).

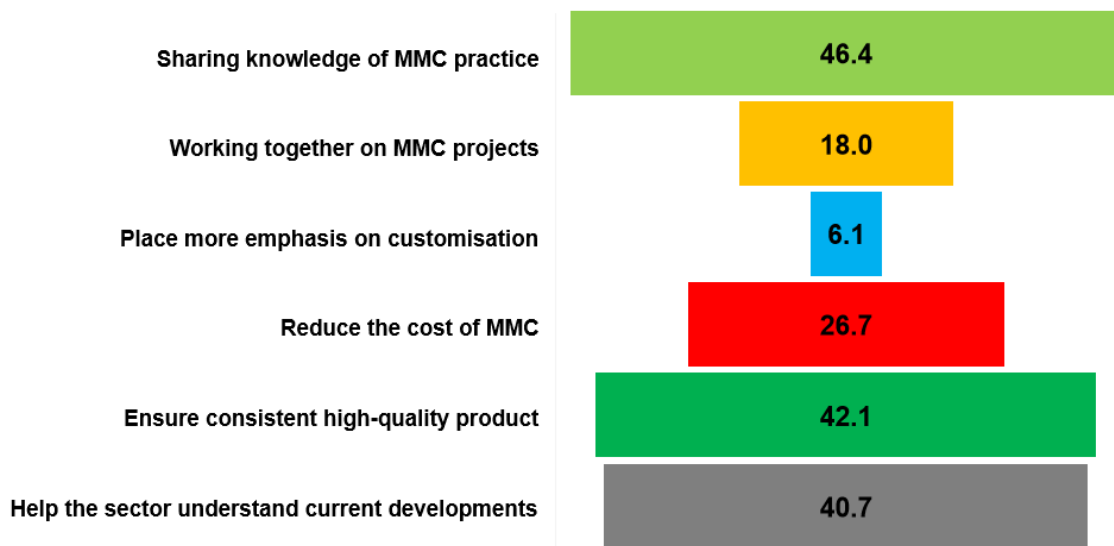


Figure 29. Construction industry respondents with MMC experience scoring of ways that industry could improve the adoption of MMC (47 respondents).

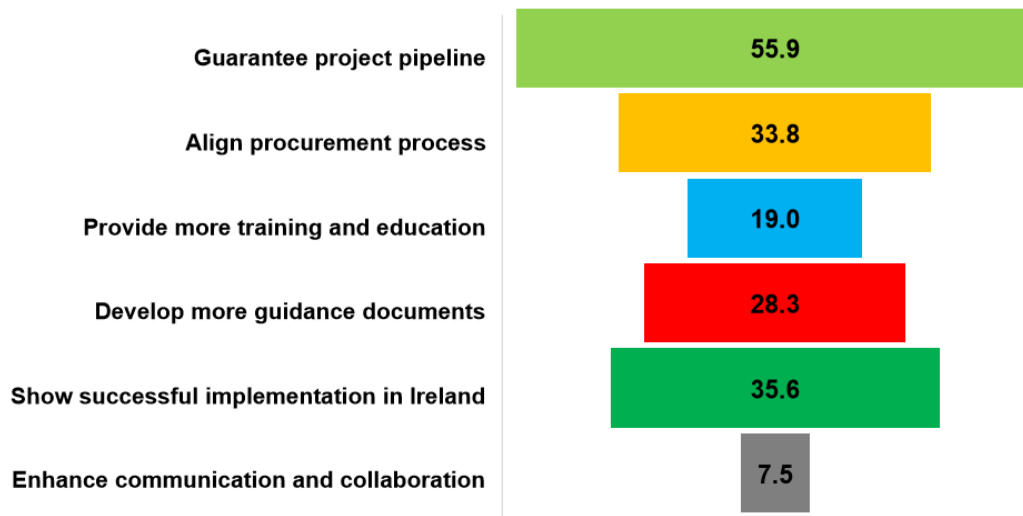


Figure 30. Construction industry respondents with MMC experience scoring of ways that government could improve the adoption of MMC (47 respondents).

The survey results in Figures 28 to 30 emphasise the significance of consistent quality, knowledge sharing, and clear demonstrations of MMC benefits in promoting its widespread acceptance and use in both the general public and the construction sector.

5 Research findings and recommendations

This research employs a four-step methodology to accomplish its objectives. Initially, a comprehensive literature review is conducted to gain insights into MMC adoption within both the Irish and international contexts. Following this, a semi-structured interview format is developed based on the knowledge acquired from the literature review. Interviews are then conducted across 13 construction sectors. Subsequently, a survey is designed based on the results from the interviews, aiming to address all identified objectives. Finally, the survey results are meticulously analysed and summarised, leading to the derivation of key findings and the formulation of relevant recommendations.

5.1 Findings

This section presents the findings from the study related to the three research objectives.

5.1.1 Findings related to Objective 1: Understanding current situation of MMC adoption and perception within the general public and construction industry

MMC adoption in Irish context

- Only 19.5% (14 out of 72) of construction sector participants had greater than 10 years' experience working on projects with MMC and 33.3% (24 out of 72) have never used MMC in projects, which indicates that lack of experience in MMC within construction sector.
- Category 2 is the most used MMC type in Ireland, with 74.5% (35 out of 47) of construction industry respondents with experience of MMC having used it. Additionally, construction industry respondents with experience of MMC stated Category 2 as the 'most used category' on current projects.

Public perception of MMC:



- Mixed perception of MMC terms exist within the general public respondents. Positive perceptions around 'Modular house', 'Offsite house' exists, but notably more negative perceptions exist around the terms 'Prefabricated house' and 'Rapid-build house'.
- 57.1% (24 out of 42) of the general public respondents had already heard of MMC before starting the survey. In this subgroup (people who had heard of MMC), 54.2% (13 out of 24) believe MMC performs better in terms of energy performance and 70.8% (17 out of 24) in terms of sustainability compared to traditional construction.
- Of those general public respondents who had heard of MMC, 54.2% (13 out of 24) believe MMC performs equally or better in terms of quality when compared to traditional construction methods.

Factors Influencing residential property purchase:

- Location and price are recognised as the most important factors when the general public considers buying a new residential property.
- Quality, a key benefit of MMC according to the construction industry respondents with MMC experience, is identified as the third most important factor when the general public considers buying a new residential property.

5.1.2 Findings related to Objective 2: Identify drivers and barriers of MMC and possible ways to improve adoption of MMC in the Irish context

Barriers to wider MMC adoption:

- Identified barriers to adoption of MMC by the construction industry with MMC experience include; lack of industry knowledge, difficulties changing from traditional construction, lack of pipeline, and immaturity of the supply chain.
- Improving the industry's knowledge in MMC and helping industry move away from traditional residential construction practices are seen as important for broader adoption.

Potential ways Government could improve wider MMC adoption

- Guaranteeing project pipelines and improving public procurement were highlighted as ways government could encourage wider MMC adoption.
- Government could help to highlight successful MMC projects to build industry confidence about MMC.

Importance of Quality and Customisation:

- The construction sector consistently identified quality as important. The general public identified quality as the most important issue after price and location (factors not influenced by type of construction). Therefore, quality appears overall to be the issue that influences MMC adoption and perception. Maintaining and improving quality of MMC is within the construction industry control, whereas other important factors, such as price and location are not.
- The customisability of MMC is valued by general public survey respondents. 81% (34 out of 42) of the general public respondents would be willing to customise their residential property, making it a potential avenue for MMC promotion.

Need for Education and Clear Communication:

- A substantial portion of both the general public and the construction industry lacks in-depth knowledge about MMC, highlighting the need for educational initiatives.



- Clear communication and showcasing successful MMC implementations have been highlighted by respondents to help with public awareness and acceptance of MMC.
- There were some mixed responses observed by the general public, such as they did not believe the type of construction was important when purchasing a new residential property. However, the general public that were aware of MMC already thought MMC was more sustainable and energy efficient, and about the same in terms of quality as traditional construction.

5.1.3 Findings related to Objective 3: Identify approaches that could broaden the understanding of MMC and its benefits

Public understanding and willingness to adopt MMC:

- There is a limited awareness of MMC within the general public, 42.9% (18 out of 42) of the general public respondents have never heard of MMC.
- 16.7% (4 out of 24) of the general public that are aware of MMC do not want to buy an MMC residential property and 41.7% (10 out of 24) don't know if they are willing to buy an MMC residential property, indicating a lack of comprehensive understanding.
- 81% (34 out of 42) of the general public respondents are willing to customise a residential property, potentially offering MMC with a differentiator to traditional construction.

Ways to improve public understanding and adoption:

- The construction industry respondents with MMC experience suggest demonstrating MMC benefits through case studies to enhance public understanding.
- Ensuring consistent high-quality MMC product, sharing MMC knowledge, and helping sectors understand current developments are identified as the three main actions the construction industry could take to improve perceptions and adoption of MMC.

5.2 Recommendations

By considering all results and findings from this report, some overall recommendations are listed as follows:

1. The construction industry could focus on improving MMC knowledge within the construction sector to help wider adoption of MMC. The expertise in MMC is growing (approximately 87 companies working in MMC in 2020 to 160 in 2023), however, there is a lack of experience of working in MMC in the industry. This lack of skills and knowledge is also identified in the literature. Construct Innovate will need to work with other stakeholders to improve MMC knowledge within the construction sector. Future Construct Innovate projects will need to help provide industry with the appropriate MMC knowledge to increase adoption.
2. The construction industry could also focus on ensuring consistent high-quality MMC product and showcasing successful case studies to widen adoption of MMC and improve the perception of MMC. Such a showcasing could form the basis for a future project in Construct Innovate to help widen adoption and improve the perception of MMC in the construction sector.
3. Government agencies could attempt to guarantee MMC project pipelines, align procurement processes, and support educational initiatives about MMC benefits to improve the perception and understanding of MMC. Government has already started to address some of these issues, but Construct Innovate could also help disseminate some of the work being done.



4. The perception of MMC, in the sample size of the general public respondents that already knew about MMC, depended on the terms used to describe MMC e.g. *prefabricated* and *rapid-build* had more negative connotations, whereas *modular* and *offsite* had more positive connotations. A wider communications exercise is needed to encompass the wider public who may not have heard about MMC. Those that have heard about MMC are more positive about it. The wider communication approach could emphasize the quality and sustainability of MMC, its potential for customization, and showcase real-life success stories to enhance public understanding and acceptance. This would help improve the general public's understanding and perception of MMC. Construct Innovate could undertake a project to develop a targeted communication/dissemination strategy to enhance understanding and perception.

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Appendices

Appendix 1. Table of Benefits and Barriers of MMC from RIAI (2022)

Table 1 - Benefits and Barriers of MMC Summarised

Issue	Perception	Actual	Enablers	Measures Underway
Quality of Finished Buildings	Poor quality, 'prefabs' not durable.	High quality, durable, manufactured in controlled environment.	Specifications, standards, quality control, early engagement with clients, designers, and contractors.	CSG Innovation and Digital Adoption Sub-Group. Engagement of the RIAI with bodies such as Enterprise Ireland, OGP, etc. to develop a greater awareness of improved quality through the use of MMC.
Quality of Built Environment	Standardisation of components and building assemblies and repetition of elements leads to poor quality, poorly articulated buildings and built environment.	This is a critical issue and requires ongoing vigilance on the part of the architectural profession, clients, and planning authorities. Historic poor precedents means that this critical issue must always be at the forefront in using a DfMA approach.	Skilled architectural design from initial concept through to all RIAI stages.	Need for specific training at third level as well as CPD training for the architectural profession.
Design Inflexibility	Changes are difficult to make, suitable only for high volume.	Customisation is possible, but after placing the order change is not possible.	Greater level of planning, use of BIM, build general awareness of DfMA in the design profession.	Development of RIAI DfMA overlay for design development. Review of DHLGH's Design Manual for Quality Housing (Jan, 2022) standard dwelling layouts for MMC and DfMA suitability.



Issue	Perception	Actual	Enablers	Measures Underway
Interfaces	Specific MMC requirements need to be carefully planned.	Design development should be undertaken incorporating the categories of MMC amenable to the design and project constraints.	Adopting a DfMA approach to design development.	Development of RIAI DfMA guide and design overlay. Build Digital Project to transition the industry to increased levels of digital delivery. Development of an Enterprise Ireland Construction Technology Centre.
Manufacturing Capacity	Low number of manufacturers, limited capacity.	Perceptions are accurate.	Increase demand, identify investors, support the establishment of MMC focused manufacturing facilities.	Enterprise Ireland Centre of Excellence. Need for initiatives from public and large private sector clients to encourage MMC through quotas thus promoting market confidence.
Industry	Fragmented, limited R&D capacity.	With some exceptions, the perceptions are accurate.	Increased Governmental Support for R+D in the Construction Industry.	CIRI, Enterprise Ireland Centre of Excellence, Construction Technology Centre (NUIG), Department of Further and Higher Education, Research, Innovation and Science.
Regulation/standards	Certification and approval by Local Authorities and Fire Officers can be difficult to achieve for innovative products.	Limited guidance on and certification schemes for various categories of MMC.	Increased guidance for local authorities and fire officers, designers and manufacturers on certification for MMC, development of new testing and research facilities for MMC Manufacturers.	Enterprise Ireland Centre of Excellence, NSAI, RIAI, Engineers Ireland and other professional bodies.



Issue	Perception	Actual	Enablers	Measures Underway
Risk aversion	Clients unwilling to consider MMC.	Combination of risk aversion and lack of awareness.	New and improved procurement methodologies that encourages collaboration and the development of an increased MMC manufacturing supply chain.	RIAI, The Office of Government Procurement (OGP), Enterprise Ireland.
Procurement	Inflexible public procurement processes. Needs client engagement with the modular manufacturer.	True to some degree but experienced clients can use the tools provided. Contractor could engage depending on stage of development of design.	Understanding of the market and opportunities. Introduce contracts that promote greater levels of collaboration.	Review of the Capital Works Management Framework, Demonstration Park, Enterprise Ireland Centre of Excellence, RIAI, The Office of Government Procurement (OGP).
Contracts	Standard contracts don't cater for MMC.	Not entirely true. Experienced clients can use the standard forms, but they may require amendment. Early contractor involvement can be challenging for public sector bodies.	Detailed consideration and planning, commercial aspects considered early on.	RIAI, The Office of Government Procurement (OGP).
Finance	Greater upfront costs, MMC are more expensive.	Incorporating MMC may lead to more upfront construction costs occurring offsite, capital cost of MMC may be higher than traditional methods however the lifecycle cost of MMC should be determined i.e. what impact does increased productivity have on the construction programme.	Develop a greater awareness of lifecycle costs, programme and quality improvements of DfMA and MMC.	SCSI, CIF, RIAI, Property Industry Ireland, LDA.



Issue	Perception	Actual	Enablers	Measures Underway
Liability	Design responsibility at interfaces is challenging warranties.	Typically, no clear design responsibilities are developed when developing a design with MMC adoption.	Development of a project set of roles and responsibilities for projects incorporating MMC from concept to project completion stages".	RIAI, SCSl, Engineers Ireland, CIF, manufacturers' representative bodies, insurers.
Insurance	Products are not available to cover new and emerging risks. Too great a reliance on professional indemnity insurance.	Insurance companies may not understand what the categories of MMC are and the risks associated with each which may lead to increased premiums or underwriting refusals.	Engagement with stakeholders including insurers and representative bodies (e.g., Insurance Ireland, Brokers Ireland).	RIAI, SCSl, Engineers Ireland, CIF, NSAI, manufacturers' representative bodies, insurers.





Appendix 2. Survey questions

Q1. Are you happy to proceed with this survey?

Q2. Which group best describes you?

Public survey questions

Q3. Which area do you live in in Ireland?

Q4. What age group do you belong to?

Q5. Which of the following describes the highest level of education you have received?

Q6. If you were purchasing a new build residential property (e.g. house or apartment) please list in order the 3 most important factors affecting your purchasing decision (1st is the most important)?

Q7. Please rank how important price is to you if you were to buy a newly built property.

Q8. Please rank how important the sustainability (environmental impact) of a property is to you if you were to buy a newly built property.

Q9. Please rank how important the cost of running a home (e.g. electricity bills) is to you if you were to buy a newly built property.

Q10. Please rank how important build quality is to you if you were to buy a newly built property.

Q11. Please rank how important the type of construction (e.g. brick/masonry, timber frame, concrete, steel) is to you if you were to buy a newly built property.

Q12. Would you like to be able to customise certain aspects of your property if you were to buy a newly built home (e.g. window type, facade type, internal room layout)?

Q13. What perception do you have related to the following terms?

Prefabricated house, Modular house, Off-site house, Rapid-build house

Q14. Have you heard of offsite modern methods of construction?

Q15. Have you heard of traditional residential construction methods (e.g. brick/masonry block walls, timber floors, trussed roof)?

Q16. Have you ever lived in a residential property constructed using modern methods of construction (e.g. timber frame, modular construction)?

Q17. If you were to buy a newly built residential property would you like to buy a property that is built through these modern methods of construction (e.g. timber frame, modular construction) rather than traditional construction (e.g. brick/masonry block walls, timber floors, trussed roof)?

Q18. How would you rate the quality of a residential property built by a modern method of construction (e.g. timber frame, modular construction) compared with traditional methods (e.g. brick/masonry block walls, timber floors, trussed roof)?

Q19. How would you rate the energy performance of a residential property built by these modern method of construction (e.g. timber frame, modular construction) compared with traditional methods (e.g. masonry block walls)?

Q20. How would you rate the sustainability of a residential property built by these modern method of construction (e.g. timber frame, modular construction) compared with traditional methods (e.g. masonry block walls)?



Industry survey questions

Q21. What type of construction sector organisation do you work for?

Q22. How many years of experience do you have working in the construction sector?

Q23. How would you describe your role within your organization?

Q24. Where is your company/organisation located?

Q25. How many employees does your company/organisation have?

Q26. Have you heard of modern methods of construction?

Q27. How many years experience do you have working on projects that have used MMC?

Q28. Which categories of MMC have you used in projects you have worked on?

Q29. Which category of MMC do you use most often in your housing related projects?

Q30. In your current projects, could you estimate how much Category 1 MMC (3D structural volumetric) are being used in your housing related projects?

Q31. In your current housing related projects, could you estimate how much Category 2 MMC (2D structural panels) are being used?

Q32. In your current housing related projects, could you estimate how much Category 5 MMC (pre-manufacturer assemblies and sub-assemblies) are being used?

Q33. Please rank 3 aspects you believe are the main benefit of MMC when compared to traditional methods of construction.

Q34. Please rank 3 aspects you believe to be the main barriers to the wider adoption of MMC within the construction sector.

Q35. Do you believe MMC will be widely used in the construction of housing in the future in Ireland?

Q36. Please select 2 ways you think the construction sector could improve the understanding of MMC in the general public.

Q37. Please select 2 ways you think the construction sector could improve the adoption of MMC within the construction sector.

Q38. Please select 2 ways you think the government could improve the adoption of MMC within the construction sector.

Q39. If you have any other comments or advice related to this survey, please specify.



Appendix 3. Borda's aggregates with a weighted average value

Equation 1 was employed to calculate the score of these factors:

$$\text{score of factor } X = \frac{X^{1st} \times a + X^{2nd} \times b + X^{3rd} \times c}{\text{Total participates}} \times 100 \quad (1)$$

In the scoring process, X^{1st} represents the number of participants selecting 'X' as the first important factor, and similar rules apply to 2nd and 3rd. The symbols a, b, c are scale factors used to weigh the importance of the factors. In this report, the values of a, b, and c are set as 1, 0.6, and 0.2 respectively. Consequently, the maximum score in this scenario is 100 when every participant selects the same factor as their 1st important factor. A lower score for a factor indicates its lesser importance.

