Pop-up Earthquake Architecture for Integrating Practical Experience and Social Responsibility into Architectural Education

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ABSTRACT: The last major earthquakes that struck extended urban and rural areas in Southeast Türkiye left thousands of buildings demolished or uninhabitable. After the urgent demand for temporary housing is resolved, there will be a need to provide quick solutions for adequate social spaces for the affected communities. Additionally, considering the large number of collapsed or heavily damaged buildings in past earthquakes in Türkiye, schools of architecture should prepare architects capable of understanding and applying the basic principles of seismic design for buildings. Moreover, given the social responsibilities that the profession entails, future architects should also be able to engage with the communities they serve, thus providing spaces that are not only safe but also suitable for their needs. This paper describes an architectural studio with a twofold aim: firstly, making a meaningful contribution to a small community living in the earthquake zone by identifying their post-disaster needs for spaces of social interaction; and secondly, providing undergraduate students with applied knowledge and skills in conceiving, designing, planning, producing, assembling, disassembling, transporting, and installing a pop-up structure. The design-build studio was organized through a reductive selection of design proposals, where ultimately one project was selected for actual construction and another for further construction detailing. The proposed approach of using a hands-on and embedded teaching format to explore pop-up architectural design responses, following design-for-disassembly principles, ensured students' in-depth learning of construction techniques and the associated important roles of detailing and drawings for materializing a project. Due to time and material limitations, however, not all students benefited from the possibility of building their own designs, leading to a sometimes-estranged studio environment.

KEYWORDS: Post-disaster recovery, design-build studio, timber construction, active learning, hands-on teaching

INTRODUCTION

The two major earthquakes that struck extended urban and rural areas in Southeast Türkiye on February 6, 2023, caused more than 50,000 casualties and left over 200,000 buildings either collapsed or severely damaged (Mertol et al. 2023). During the months that followed that disaster, the main recovery efforts focused on providing emergency housing (e.g., (Florian 2023)), with the most common solution coming in the form of 'container cities.' Although containers and other unit-based solutions provided a quick, easy-to-transport, and easy-to-install solution, the result was extended residential areas without spaces for social engagement for the people. Moreover, in villages and small towns around the major cities, communities were left to their own devices to find quick alternatives to housing, leading to much less attention paid to providing any sort of social space solutions.

The short-term need for providing quick solutions for adequate social spaces for the affected communities entangles itself with a long-term one: rising earthquake awareness among the professionals involved in building construction. The majority of the building stock that has been destroyed or severely damaged during earthquakes in Türkiye lacks code compliance and adequate structural detailing, displaying poor construction quality and architectural design faults (Cogurcu 2015). This evidence highlights the failure of all building-related professions to provide citizens with safe spaces to live and demands a rethinking of the way we are forming those professionals. Schools of architecture should prepare architects capable of understanding and applying the basic principles of seismic design for buildings. Moreover, given the social responsibilities that the profession entails, future architects should also be able to engage with the communities they serve, thus providing spaces that are not only safe but also suitable for their needs.

This paper describes an architectural design-build studio with a twofold aim: firstly, making a meaningful contribution to a small community living in the earthquake zone by identifying their post-disaster needs for spaces of social interactions; and secondly, providing undergraduate students with applied knowledge and skills in conceiving, designing, planning, producing, assembling, disassembling, transporting, and installing a pop-up structure. The main challenge, therefore, is how to set up a studio where students can produce an architectural project according to their level of design, knowledge, and skills within 15 weeks, and, more importantly, ensuring that this project fits the needs of a community affected by a major disaster.

1.0 METHOD

1.1 Teaching strategy

The challenge posed by the aforementioned aim led to three main studio targets:

- Balancing project size versus complexity: The social gathering project should be small enough for the studio to cover the entire design-to-production process in 15 weeks. Simultaneously, it should be complex enough to fulfil the learning requirements of a 3rd Year Architecture Studio, as defined by the school's curriculum.
- Revising the students' role in the process: Unlike traditional forms of architectural studios, the intention of building one proposal (due to logistic and economic constraints) necessitates rethinking the self-assumed designer's role of each team in all steps of the design-to-production process.
- Including the transportation variable: Given the lack of public facilities and proper infrastructure in the disaster areas and the impossibility of students staying away from the campus for extended periods, the project must be constructed far from the selected site and then transported there.

To address these targets, the methodology applied to the studio is based on the following teaching strategies:

- Focus on pop-up architecture: This approach commonly refers to small and strategic interventions in public spaces to improve social interaction (Lähdesmäki 2016). Unlike top-down approaches promoted by urban regeneration initiatives, pop-up structures rely on bottom-up approaches. Successful enhancement of public space lies in strategically placed small interventions. By identifying the main aspects of the local context, these comparatively smaller, flexible, and adaptable projects can provide more viable and feasible solutions to respond to and mitigate the problems faced by a community after experiencing a major earthquake.
- Select a place with a small community: This ensures that key social needs can be clearly identified. A village with 5,000 inhabitants, located 10 km from one of the major affected cities, was chosen. Through surveys and conversations with villagers, at least two possible locations were selected for the temporary installation of the project.
- Introduce design-for-disassembly (Crowther 2005): Rooted in the notion of circular design, this approach involves conceiving architectural projects not only to be assembled but also to be disassembled. It evaluates design proposals in terms of material availability, transportation issues, and on-site installation logistics.
- Establish a hands-on approach to design through scale models: Since the feasibility of proposals hinges on their potential for assembly/disassembly and transportation, the process of building a scale model, with its associated problem-solving demands and practical experience, served as both an experimental and testing platform for the designs.
- Apply differentiated teaching techniques: Based on differentiated grouping and stepped tasking (Algozzine and Anderson 2007), special attention was paid to students' individual skills and interests. This allowed for the reorganization of teams according to the differentiated tasks required throughout the entire studio process.

1.2. Studio settings

The studio was originally planned to cover three major stages, as summarized in Table 1. It involved 42 students, 4 instructors, and 2 assistants (PhD architecture students). Among the instructors, three possessed practical knowledge in timber construction, and one of them also had expertise as a structural engineer.

Table 1: Overall description of the initial design-build studio planning. Source: (Mauricio Morales-Beltran)

stage	*goals*	*method*
conceptual proposals	exploring conceptual ideas for pop-up interventions in the village	Introducing pop-up architecture through case studies; group of students + instructors visit & study the village; surveying for defining social needs; presentation & discussion with the whole studio; class is organized in 14 teams; each proposes a design in either site (A/B), considering design-for-disassembly aspects; external review panel assess the potential of each proposal for further development
project development	defining one project to be built in the next stage	Introducing differentiated & hands-on teaching approaches: class is reorganized in two units, each comprising former 7 teams; within each, 2 teams develop the chosen design; 2 teams develop logistics, transportation and disassembly strategies; 2 teams produce 1:50 and 1:10 scale-down models, and one team adjusts its work to unit's demands; each unit presents its revised proposals; studio instructors choose one proposal to be built
detailing & construction	building-up a prototype and advanced development of construction details	Understanding & assessing construction detailing through development of a 1:1 prototype (team A) and detailed 1:5 models and assembly/disassembly strategies (team B); revising design & construction decisions based on hands-on learning experiences; producing construction and project drawings

The first stage involved the development of conceptual design proposals for further selection and development. This conceptual phase aimed to (1) gather key site information through a technical trip, (2) acquire pop-up architecture-related knowledge through a case study exercise, and (3) obtain conceptual proposals by organizing the 42 students into teams of 3. In this stage, students were informed about material constraints, specifically the use of commercially available timber sections, and constructive constraints such as the necessity of having a structure that could be prefabricated, assembled, disassembled, and transported. Although commonly used in timber construction, the use of steel plates and connectors was prohibited to encourage critical thinking about timber connections and reduce the need for expert carpentry labour. Moreover, this initial stage aimed to stimulate students' competitive natures and encourage the development of projects that best suited the community's needs.

The second stage involves the development of only two selected proposals, one for each chosen site, so the class is divided into two units. Each unit is supervised by one instructor, while the other two instructors support teams with topic-specific tasks. In this stage, within each unit, teams separately focus on design development, production of scale-down models, and study of the assembly/disassembly process and design issues related to the transportation of the final project. This differentiated tasking was introduced to encourage further development of the projects while benefiting from having at least two teams working on the same topics for each project, thus enabling the selection of the best idea to implement. The third stage basically encompasses the construction of the prototype and the development of all building construction drawings.
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2.0 RESULTS

The results of the applied methodology, studio settings, schedule, availability of materials, and instructors', assistants' & students' commitment and performance can be summarized in the scheme displayed in Figure 1.

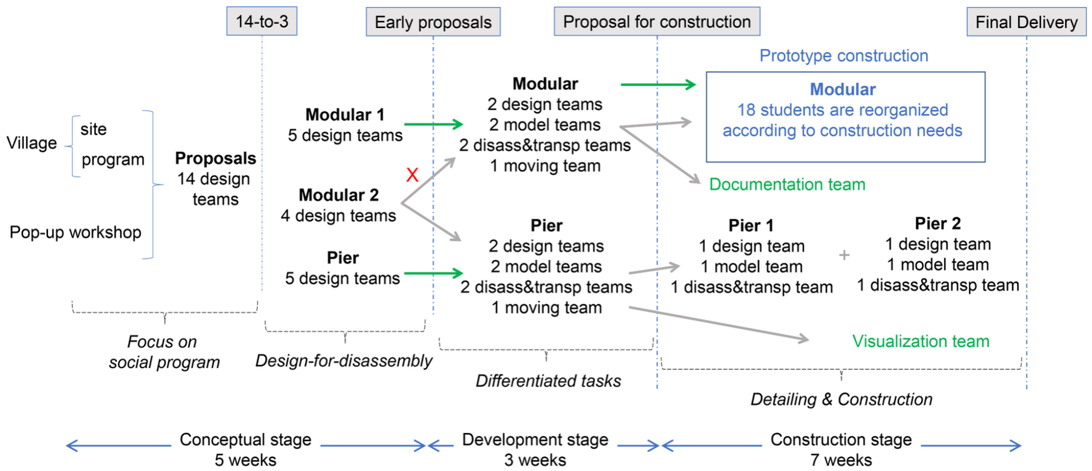

Figure 1: Schematic overview of the applied studio methodology, including the main conceptual, development, and construction stages. The imaginary timeline runs from left to right. Source: (Mauricio Morales-Beltran)

2.1. Site trip by a few students and instructors

Lack of funding and the uncertainties associated with traveling to a post-disaster area, prevent students' participation in the site trip. Only seven students and two instructors visited the selected village to gather information on the site and the needs of local people, six months after the earthquake. They collected technical, cultural, and topographical information and conducted an architectural site analysis, which concluded with the selection of two project sites, and a third one to be used if authorization to use either of the first two was not obtained (Figure 2). Following discussions with villagers, the decision was made to design a social space where the community could gather for events such as weddings, anniversaries, the exchange of local products, open cinemas, and religious activities, as well as providing a safe and playable area for children. All collected information was shared using an internet storage platform, ensuring accessibility to all documents, and encouraging discussion among all students.

Figure 2: Aerial view of the village displaying chosen sites A – River side and B – Cemevi. Site C - School was surveyed in case the other two could not be used, so it remained as the last option. Basis image source: Google Earth. Source: (Ömer Can Bakan)

2.2. The 14-to-3 reduction

The sought design simplicity and the students' natural inexperience in dealing with projects that should be continuously reassembled led to a homogeneous response in terms of conceptual proposals. On the one hand, modularity emerged as the most logical design response to the challenge posed by transportation and assembly/disassembly issues. On the other hand, most proposals reflected design conceptions based on the notion of a building rather than on open and semi-open spaces, which were pointed out by the instructors as suitable during the studio discussions. Since there were a few exceptions, instructors decided to reorganize the 14 design teams around three promising conceptual proposals. Two of them, based on the idea of modularity, were placed on the river side, while the third one, a sort of pier-like intervention, was placed on the Cemevi site (Figure 3).

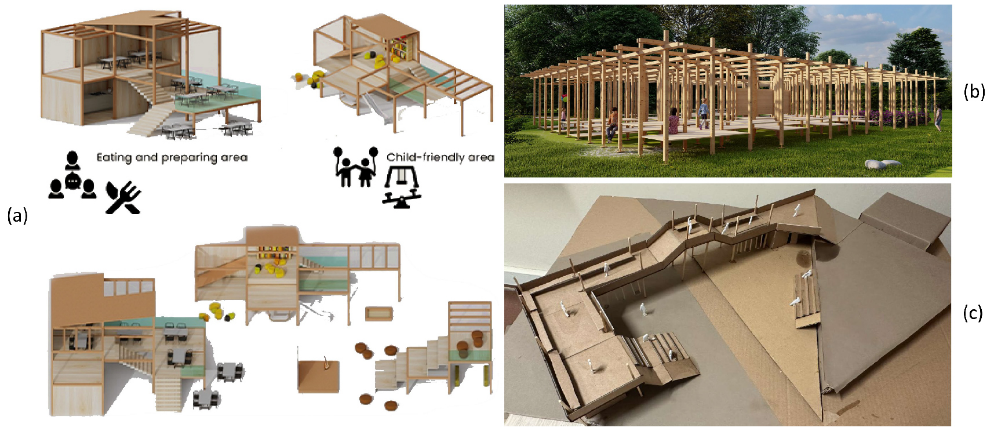

Figure 3: Selected early proposals: (a) – (b) Modular 1 and 2, on the river side, and (c) Pier on the Cemevi site. Source: (Design Studio Students 2023)

2.3. Early proposals

Each of the three selected proposals offered different potentials and setbacks. Modular 1 focused on the social needs of the community, yet it lacked unity as a proposal. Modular 2 offered a clear definition in terms of construction, yet it produced repeated narrow spaces contradicting the idea of openness and multifunctionality of the targeted project. The Pier displayed a powerful intervention integrating the open areas in front of the Cemevi, yet it posed many questions on its transportability and reassembling process. To widen the design options and explore solutions, 4-5 teams revised each of these proposals under the leadership of a single instructor. This decision aimed at avoiding confusion among the students, enabling fast progress on the design definitions.

In this stage, students were provided with a preliminary list of available materials to guide the design developments towards materialization. They were also required to submit designs using common architectural drawings (site plan 1:500, floor plans and sections 1:100, system sections 1:20, details 1:5, revised material list) to better articulate their ideas and practical solutions, preferably using timber. Timber was chosen as a primary building material due to time limitations, local availability, minimal equipment requirements, and the low learning curve of the construction skill set. Simultaneously, to reduce the knowledge gap, students were provided with practical timber construction solutions. A site trip to an actual timber structure of similar dimensions and features to the one planned was organized to further increase their understanding of the material and construction system.

After two weeks of intense work, all 14 teams presented their revised versions of the originally selected proposals. The instructors selected Modular and Pier (Figure 4). The former, based on the idea of modules, allowed easy adaptation to the ever-changing needs of the social gathering space, offering versatility to produce closed and semi-open spaces using a simple assembly logic. Although revised proposals of Modular 2 were not selected, the chosen proposal benefited from Modular 2's constructive approach based on a single-level grid scheme, simplifying the construction process by removing the original different levels. The Pier, on the other hand, offered a gathering exterior area that could be used as an extension of the religious facility existing in its vicinity. Moreover, conceived as an urban space with several functional layers, it could potentially host different social activities and create a real meeting area in the centre of the village.

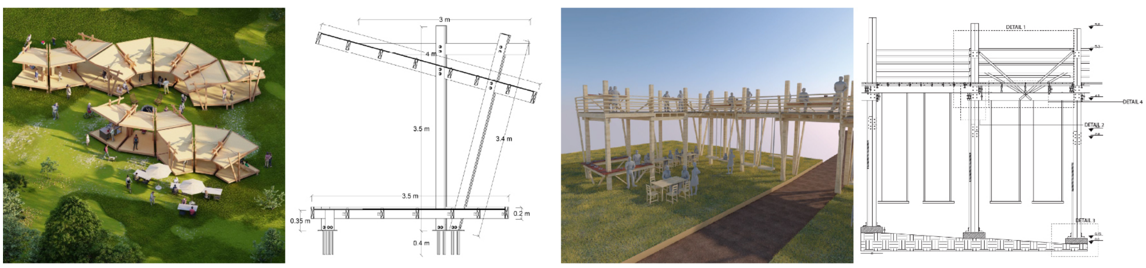

Figure 4: Render visualization and system section of the Modular (left) and the Pier (right) projects. Source: (Design Studio Students 2023)

2.4. Proposal for construction

All former design teams were reorganized in this stage according to specific tasks (Figure 5). This strategy, based on assigning differentiated roles to teams, aimed at providing students with specific learning skills (e.g., model making, problem-solving) while benefiting from faster progress in the development of the projects. In addition, design teams were supported by structural engineering consultancy provided by one of the studio instructors. The goal was to ensure that the building construction systems were in line with a structural logic, thus avoiding late additions of extra structural reinforcement. As a consequence, the three projects are based on modules structured by truss-like vertical elements, acting as columns. Although the cantilevering roof of the Modular project was somewhat challenging, the major challenge was posed by the Pier's variations which acted as true bridges and hence required further studies to ensure compliance with both gravity- and seismic-based design principles.

Figure 5: Differentiated roles in the project developments of the Modular: design team (left), physical modelling teams (middle), and assembly/disassembly, transportation and logistics teams (right). Source: (Ecenur Kızılörenli)

After a few weeks of developing the projects, the Modular was selected for prototype construction, while the Pier was set as a backup plan for further development. This decision, made by the instructors, was based on the following criteria:

- Although the Pier project was also based on modules at that moment, their variation and mostly their sizes posed many challenging questions, yet to be solved in a short time. On the contrary, the inherent constructive simplicity of the basic module of the Modular project showed a clear path for prototyping it.
- Due to the relatively small size of the Modular's prototype to be built, having 42 students working on it seemed quite impractical.
- The need for a backup project arose for two reasons: not having permission yet to build on the river site (thus requiring an alternative project and site) and the uncertainty of securing additional funding/support for two projects.

After the selection of the Modular for construction, the design teams behind the Pier could not agree on future directions for its further development. Due to an until-then-undetected tension among the students and the added lack of motivation after their project was not selected, instructors allowed the split of the whole Pier team into two sub-groups. Each of them worked on a specific design and construction system of the proposal. Consequently, by the 9th week of the semester, there were again three projects (Figure 6).

Figure 6: Development of the projects by the 9th week: Modular (left) and the two variations of the Pier (right). Source: (Design Studio Students 2023)

2.5 Final deliveries

During the final 'detailing & construction' stage of the studio, further differentiated tasks were assigned. One of the Modular teams was assigned to data collection and archiving. Over the last semester weeks, the data collection team was responsible for gathering materials, precedents, pictures, and files from the other teams. Additionally, they were required to monitor and document the 1:1 prototyping process and promote the studio work on social media. Another team, originally part of the Piers' project, was asked to enhance the visual communication quality of the final deliveries, due to their visual representation abilities. This visualization team's assignment was presentation-enhancing of images, consistent visualization of the projects, and elaboration of the construction booklets for each project.

This strategy allowed the rest of the teams to focus on either proper construction drawings or the construction of the prototype. The Pier teams worked simultaneously on construction drawings and models of their proposal at different scales. Due to the difference in size and complexity of the Modular and Pier projects, the pace of the development expected for each project was different. For instance, final 1:5 models of each project were not developed simultaneously (Figure 7).

Figure 7: Non-simultaneous development of Pier 2's and Modular's 1:5 models of the modules: during the same week (left) and final deliveries (right). Source: (Mauricio Morales-Beltran)

Moreover, targets were different for each process: while the Modular team used the models to foresee possible construction and assembly issues and to explore practical solutions, the Pier teams used the models as testing for construction insights and consistency. Therefore, while the construction drawings of the Modular were developed in an almost linear timeline, the construction drawings of the Piers' projects were better informed through an iterative process of feedback (Figure 8).

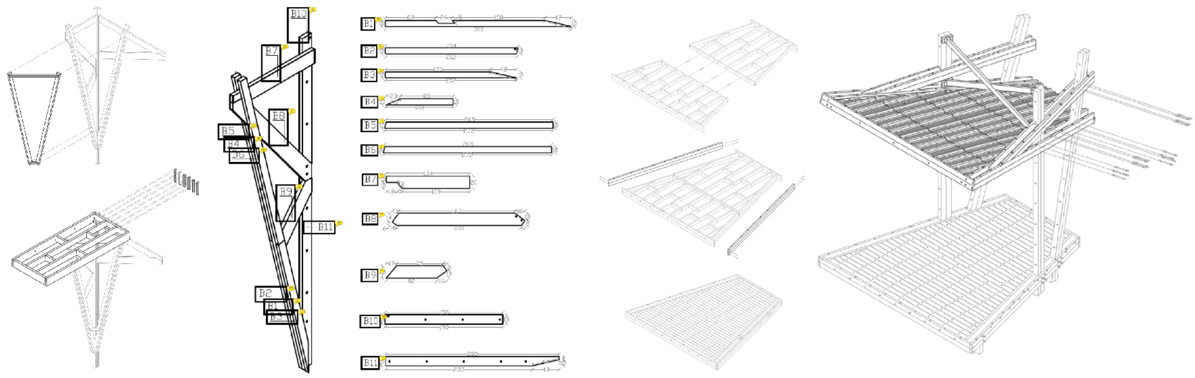

Figure 8: Drawings details prepared as part of the construction booklets: Pier 2 (left) - Modular (right). Source: (Design Studio Students 2023)

The production and assembly of the prototype (Figure 9) were guided by one instructor who acted as a construction leader; hence, the rest of the team followed instructions, helped to solve problems arising from the construction itself, and organized themselves according to their skills' levels for carpentry and power tools manipulation. In some cases, they were also organized according to their physical strength, often required due to the constant assembly & disassembly process. For this reason, students were no longer organized in teams but were constantly reorganized and assigned to different tasks, ranging from problem-solving (e.g., unforeseen connection sequences) to logistics matters (e.g., acquiring screws and bolts).

Figure 9: Construction process of the 1:1 Prototype of the Modular project. Source: (Ecenur Kızılörenli)

3.0 DISCUSSION

3.1. Lessons learned

Studio vs. real project complexities. The design method was structured in a two-phase process, enabling students to develop their design skills by proposing original designs and then acquire specific skills for fabricating such designs by developing scale models and studying assembly/disassembly sequences. Initially, students worked in groups, with each group proposing a design. During the final studio stage, the students submitted a complete architectural project and a set of construction drawings, allowing the pop-up structure to be prepared, built, assembled, and reassembled. In addition, the construction of a prototype at a 1:1 scale provided students with in-depth and real construction knowledge, including managing all associated tasks such as architectural design, construction schedules, documentation, budgeting, communication, and sponsor research.

This structured approach allowed students to transition from conceptual design to practical implementation, providing a comprehensive learning experience that bridges the gap between theoretical knowledge and real-world application. The emphasis on both the theoretical and practical aspects of design and construction enhances students' understanding and prepares them for the challenges of real-world projects.

Studio vs. real project dynamics. The main achievements and learnings of the students revolved around acquiring essential professional features such as teamwork and collaboration, and dealing with materials availability and constraints. Despite inherent difficulties related to teamwork, task division, and information sharing, students grasped the importance of effective communication among team members and the value of using the right tools for a given task to simplify the process. This became particularly evident during the iteration process, where the structure was designed, assembled as 1:10 or 1:5 scale models, and then re-designed until satisfying results were obtained.

The studio provided a dynamic environment that closely mirrored real-world project dynamics, allowing students to navigate challenges similar to those encountered in professional settings. The emphasis on iteration and continuous improvement reflects the iterative nature of design and construction processes in practice. These experiences contribute to the development of practical skills and a mindset that is crucial for success in the professional realm.

3.2. Social engagement

A drawback of remotely preparing the pop-up structure to be built in the village (which was about 1,000 km away) was the limited opportunities for students to engage with the local community during the 15-week studio period. This engagement could have occurred on various levels, including in-depth interviews with the locals, gathering high-precision site measurements for further modelling, and collaborative building with the community for the community's benefit. The only interaction students had with the villagers occurred during the field trip conducted at the beginning of the studio, which, due to budget limitations, was only feasible for a small percentage of the class.

As expected, students who participated in the site trip to the village were more sensitive to the community needs than those who only accessed post-visit information. The main consequence of this difference is reflected in the scale of the proposals: while the modular design, created by students who joined the trip, displayed overall modular dimensions of 3.5 x 3.5 x 4m, the two versions of the pier proposals displayed average heights of 6m. This height and the design complexity of the projects were critical to both the idea of design-for-disassembly and the rural residential scale of the village.

While the studio did not succeed in raising social/earthquake awareness among all students, it did better in drawing attention to the needed recovery efforts in the affected area, especially in the village. A crucial factor in this was the decision to launch a social media account to reach a broader audience, including the local construction industry and other universities. This account regularly provided updates on the studio's efforts, aiming to gain more social visibility, encourage similar initiatives, and potentially secure additional funding for the overall project. Due to time and budget constraints, it remains uncertain whether the local community will perceive the project as a socially beneficial contribution to their everyday lives affected by the earthquake.

3.3 Transferability and shortcomings of the projects

Due to mainly focusing on the constructive aspects of the design proposal, the main shortcoming of the studio was leaving the social aspects of the projects unattended towards the final stages of development. Although both projects had their genesis in responding to community needs, the degree to which either could be more integrated into the local context and responsive to the social needs of the village is uncertain. This is because the simple open modularity-based approach of the Modular, which may offer functional flexibility, may also fail to provide users with closed areas, especially during cold and/or rainy days. Conversely, the semi-modularity features of both versions of the Pier and their site-specific design approaches induced a sense of integration with the immediate context, although the scale of the proposals clashes with the residential scale of the rural context of the village.

3.4 Studio environment

Given the differentiated tasking roles assigned during the semester, the studio environment became dynamic and turned hectic towards the end, especially during the prototype construction (Figure 10). However, the somewhat natural separation of the studio spaces according to different projects and teams mirrored a more profound division rooted in the disappointment of those teams whose designs were not selected for construction. Although all teams had been thoroughly informed that only one project would be further developed towards actual construction—the prototype, some students experienced serious difficulties dealing with their frustration and lack of motivation after the selected project was announced.

Apart from the natural difficulties of teamwork, perhaps one of the reasons for this division was the idea of a studio competition, implicitly put in place at the beginning of the studio. Such an initial competitive atmosphere, which aimed at expediting the selection of a single project for construction, damaged social relationships within the class at an early stage, leading to the creation of a hostile environment. According to (Canizaro 2012), such attitudes are inherent to the challenges associated with design-build programs. In this case, this unfortunate situation not only reflected the fragile condition of some team members' egos but openly conflicted with the social intentions of the projects. Despite being a social aid project intended to help people repair their traumas and regain hope, some students found it challenging to divert their thoughts from their own conditions and ego-based concerns.

Figure 10: Studio environment during the initial phases (left) and at the last stages of the projects (right). There, the studio is used for both designing and construction, while additional workshop facilities were used for model making. Source: (Ö. C. Bakan)

CONCLUSION

This paper proposes a didactic attempt to cover the entire process of materializing an architectural work within an academic semester, and whose outcome helps to palliate the urgent post-disaster social needs of a small community. The proposed hands-on and embedded teaching format focused on pop-up architectural design explorations, following design-for-disassembly principles, ensured students' in-depth learning of construction techniques, detailing, and managing a project. Due to time and material limitations, however, not all students benefited from the possibility of building their own designs, leading to a sometimes-estranged studio environment.

By balancing the benefits and shortcomings of the presented teaching approach, two suggestions are proposed for an enhanced version of the design-build studio of a nature similar to the one described here:

- During the selection process, explore several sites to understand potential benefits, such as accessibility, availability of additional construction space, and potential drawbacks, including topography and property availability. This varied set of options would diversify the responses, especially at early stages and will make proposals more responsive to site-related features.
- During the development stage, explore cross or interdisciplinary collaborations to enrich the technical nature of the building construction solutions. For example, structural/service engineering students could also engage with architecture students during the design definitions of the proposals

Finally, an extended study version of this experimental studio should consider interviewing the students. Due to time constraints, the students' voice is missing in this paper.

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