Agile-Transdisciplinary Conceptual Framework for Retrofitting Mediterranean Built Environments

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1 Introduction

Transdisciplinarity appeared as a result of the linear development of scientific activity into more new overlapped disciplines [1]. It is identifying the different formulae and the search for unity in produced knowledge that can be joined together, characterized by integrating two conflicting movements of disciplinary thinking. It is essential to reopen scientific approaches to flourish the epistemology to fulfill the same objective, which necessitates constant cooperation throughout the professional practice stages, linking with theories [2–4]. Although the concept has been growing since it emerged in the 1970s, academic progress is still sluggard, particularly in energy research [5, 6] and retrofitting practices as well.

Energy retrofitting practices are essential to achieve numerous benefits for the environment and humans that almost interact with all sustainable development goals [7]. However, they are highly complex processes [8]. That is epitomized in the accompanying obstacles, which can be related to legalizations, policies, socio-culture, and techno-economic factors, from one side [9–12] and managing the relationship between the stakeholders themselves [13–15]. Especially in rural Mediterranean commons that are characterized by locals' enclosed nature and distinguished landscape-cultural values, besides facing exclusive environmental challenges as one of the most fragile and sensitive areas due to climate change exceeding the global averages [16, 17].

Thus, from the fact of the complex and interlocking relations among the collaborators in traditional settlement retrofitting practices, we focus on stakeholders

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themselves as we believe engaging and managing the right, and not the available, stakeholders is a real challenge. That can ensure the process's success and solve the interconnected real-world problems, as has been emphasized in the Refs. [18–21].

The initial step of project communication management is to identify the people and organizations (stakeholder identification) who possibly impact (positively or negatively) and are interested in the project. Then to be classified (stakeholder classification) based on similar interests, and claims, to their roles and attributes. That can be grouped into three domains. Firstly, the high-engaged stakeholders (internal, primary, or participating) provide a highly active contribution that impacts the objective. Secondly, the low-engage stakeholders (external, secondary, non-participating) indirectly affect the decisions, like the interviewed locals to explore their perception about a given issue. Thirdly, supportive stakeholders (sponsors or intermediaries) who facilitate the process, like NGOs [22–24].

Although the proven role of stakeholders' engagement, the conflict between them is inevitable and remains a significant barrier [25], also in organizations, groups [26], and any project environment [27]. Transdisciplinarity itself is characterized by conflict [28]. Many previous studies publicized several aspects that affect conflict in collaboration. For epitome, include poor communications [29], cultural diversity [30], and lack of coordination [31]. To clarify, those related to different languages understand the local culture and proper name pronunciation. In addition to feedback to team members, such as avoiding questions on the received feedback, even the wrong, because, in some cultures, it may mean disrespect.

Thus, this research aims to provide a novel transdisciplinary framework that integrates energy retrofitting and project management practice with the agile methodology initiated in software development, which proved a successful and efficient team management tool in software and other domains. Likewise, we hypothesize that the agile framework will succeed in resolving the anticipated problems between the selected stakeholder and organizing their relations, in addition, to mitigating the uncertainties associated with retrofitting process in traditional Mediterranean settlements and as a sequence will succeed in implementing the retrofitting.

2 Materials and Methods

2.1 Methodology and Limitations

The study integrates different methods in order to achieve the aims. Firstly, theoretical and analytical methods: are based on the relevant theoretical concepts about the three domains (software engineering and project management with energy retrofitting practices). To answer three questions: To what extent can the agile methodology be adopted in transdisciplinary practices? What are the restrictions and benefits of adjusting the agile method in collaborative work? Finally, what is the agreement level about the participatory approach?

Secondly, field study and qualitative methods: applying the proposed framework to two similar traditional settlements in developing and developed Mediterranean countries, representing the entire region, respectively, Lasaifar Albalad village, Egypt, and Pontinia village, Italy, and then validating the proposed framework using the focus group technique. Notably, this study is integrated with the findings of a previous publication provided recently by the authors [32]. The study is limited to the planning and early decision-making and planning stages in Lasaifar Albalad and Pontinia, followed by an on-ground implementation conducted only in Lasaifar Albalad.

2.2 Agile Methodology—Introduction

Agile terminology means "moving quickly" [33]. It is a justified, engineering-based approach [34], characterized by the ability to create and react to change implied by a massive collaboration where the team works together comprehensively toward a shared aim [35]. The "Agile Alliance" developers originated the concept in 2001 within the "Manifesto for Agile Software Development." The manifesto comprises four pillars: people, communications, deliverables, and flexibility. Namely, paying consideration to efficient management of the relations among the engaged stakeholders, delivering products with the highest priority and maximum value, achieving client satisfaction, and continuous adaptation regarding inputs variations and fluctuations [36, 37].

"*When the water falls, it cannot go back up*" [38]. Hence, the *waterfall* methodology (the traditional approach) employs a consequent or linear method for software development [39]. That tolerates high costs and risks that affect information management efficiency. The customers are excluded [40] or participate in beginning and following up until receiving the completed deliverables to be seen succeed or not. It is a documentation-driven and heavyweight process [41]. In project management, the waterfall process is a linear and straightforward process. Simply, when the step finishes, the next starts. The requirements and data are being collected and documented from the beginning, including the expected outcomes.

Vice versa is that the agile approach is divided into short phases based on iterations and multiple deliveries. The team is multidisciplinary. The customer is involved as an active contributor. Changes in deliverables are anticipated and less impactful. It is a more collaborative and transparent approach [42]. It counterpoises the unstable requirements during all product life cycle phases in a short time and within the budget [43].

In managing retrofitting projects, for instance, the traditional approaches within the construction industry are weak because of a lack of client interest, monitoring, and limiting testing to check performance. Otherwise, the project retrofitting coordinator (rather than a project manager) is essential to support the stakeholders and improves the process [44]. Fox [45] mentioned retrofitting project management within firms requires more consideration than any domain because the process faces

additional risks, like overtime and unforeseen events. Thus, the team members and project managers should interact efficiently and have sufficient experience and interest, and they should clearly define objectives and roles to be aligned with the project.

2.3 Agile Methodology in Project Management and Software Development

Agile methods are a set of practices in software development, including many frameworks, such as eXtreme Programming [46], Lean [47], and Scrum [48]. All focus on social factors as a mainstream practice in the field [49]. The basic principle is to amplify the business value, reduce product development tasks, eliminate needless things that affect the completion, and get rapid feedback. Meanwhile, it can make flexible decisions in the late stage of the project. To solve problems with long-term solutions, not just symptoms [50].

In general, creating an agile environment requires three elements. Firstly preparing mindset: determines how the project member can act in an agile and transparent manner, what they can deliver rapidly to get feedback, and how they can act? Second, leaders (facilitators) play a crucial role in team empowerment, accomplishing the goal, and removing organizational obstacles. Thirdly, aspects related to team structure.

While delivering an Agile project (implementation) requires four phases. First, the project charter is essential to describe how the team works together regarding the shared vision. Second, the standard practices enable learning from the past to enhance the current by refining the backlog. Third, challenges troubleshooting, such as unclear aims and needs. Fourth, quantitative and qualitative measurements facilitate the agile transition.

In a nutshell, as it is evident, we can describe the agile mindset as continuous development and a resilient methodology. In the meantime, we believe the traditional way is not wrong. It is a matter of limitations, context, political situation, and the whole scene, supporting Ref. [51] findings. However, we argue that the agile mindset fits our argument (providing efficient micro-transdisciplinary practices). We selected the Scrum tool for two reasons: the annual survey among practitioners from 100 countries demonstrated that it is the most common approach, and 81% of the respondents use Scrum models [52]. Also, it proved effective in different domains, like the construction industry [53], non-software production industries [54], and education [55].

3 How Does Scrum Model Work? [56, 57]

Scrum is like "*the rugby huddle, and the players come together to possess the ball*" [58]. Regarding the Scrum Glossary—it helps "*people, teams, and organizations to convert ideas to values through adaptive solutions for complex problems*" [59]. Sprint is Scrum's core. Regarding the Scrum Guide [60]: Scrum determines the stakeholders' roles (framework) rather than guiding how to accomplish the tasks (methodology). The project life cycle is divided into small and repeated segments (one or more sprints) until the product (service) is completed. Where each member implements different artifacts within a particular event, each sprint is implemented with a length of 1 month or less to create coherence. Therefore, Scrum is an interlocking matrix grouped into three pillars: stakeholders, artifacts, and events (ceremonies), Table 1. The components of the Scrum framework.

The first pillar is the team (involved stakeholders) that should consist of (3–9) members. The projects can also consist of many scrum teams regarding the nature, goal scale, and requirements. It is evident that the smaller the team members, the higher the communication and productivity. Firstly, the *PO* is responsible for setting the agile environment, namely, stating the vision from a top-down, creating the roadmap, total responsibility of the product log set, and the aims of the iterations *Sprints*. The *PO* is a concept or process rather than a person.

Secondly, the *SM* is the *servant-leader* responsible for handling the environment and team jointly and defining the characteristics of the requirements, either products or an outcome in any topic such as energy retrofits, to facilitate the entire process. The *SM* could be an external expert (e.g., a university professor or regulations expert) who enhances the performance and communications of the team. Thirdly, the *DT* is a talented member, is self-organized should have multidisciplinary skills responsible for receiving the main goal from the *PO*, developing the project, creating the micro plans for the *Sprint*, and ordering and testing the *Sprint Backlog*.

The members ensure the effectiveness, integrate the outcome with the whole system, and create the necessary documentation, and the output is defined as (*Done-Work*) approved in *Sprint Backlog*. Once the output in the *Sprint* is a "marketable feature," it is called *Release* to receive end-user feedback. By projecting the Scrum practices to the study context (retrofitting), the involved stakeholders help attain the project goal. Theoretically, Scrum promotes cross-functionality and multidisciplinarity skills among the team. We developed this to transdisciplinarity because of the engagement of the locals, academic and non-academic.

Table 1 The featured components of the Scrum Model

Scrum Pillars	Description
Team (Stakeholders)	Product (Scrum) Owner (PO), Scrum Master (SM), and the Development Team (DT)
Artifacts	Product Backlog, Sprint Backlog, and Increment
Events (Ceremonies)	Sprint, Sprint Planning, Daily Scrum, Sprint Review, Sprint Retrospective

The second pillar is the *Artifact* of the project documents. The *Product Backlog (PB)* is the only source for tasks that the teamwork should respect. It is an emergent, ordered list of what is needed to improve the product to determine how the *Product Goal* will be achieved. It is the only source for issues that the team should respect. The stakeholders' requirements (needs) are classified under midsize items (epics) and themes.

For example, each story should state: *As a Stakeholder (role), I want (a goal), so that (benefit)*. The aim is to enable the *PO* to refine the project details' boundaries (e.g., required time). The *Acceptance Criteria* (common scenario-oriented approach) should accept the *User Stories* that describe the criteria in the *Given/When/Then* format to look at the problem (or risk) from the end-user perspective [61]. What was implemented in Lasaifar Albalad can be taken as an example; the Given was (the first author had to inform the local authority) When (he met the stakeholders in the village) Then (he should engage an employee from a public body).

The target outcomes are the scope clarity, acceptance of all requirements, accepting all necessary risks and mitigating them, and sizing the requirements within the *Sprints*—this so-called *Product Backlog Refinement*. This process consumes 10% of the total sprint length (1–4 weeks). It frequents as needed. It enables the team better understands the items and prepares them for further Sprints.

The next stage is *Release Planning*. It is a high-level timeframe for realizing a group of product requirements, from the highest priority to the lowest features, offering a pivotal place for the project team to assemble. Based on the goal, the number of *Sprints* can be determined. Each release plan has a release goal (if any requirement is not associated with the goal is kept in the *PB* until it supports another goal). All goals should be prioritized. Why is this requirement necessary? Which requirement has the high risk to be tackled first? Finally, what is the minimum set of (the must-have) features to achieve customer values and quality expectations?

The third pillar is the *Events (Ceremonies),* where the life cycle consists of five events, as discussed, the *Sprint* and *Sprint Planning* (e.g., Sprint goal, vision statement). Then the team starts the implementation phase, which coordinates the tasks in the *Daily Scrum*. Next, the *Sprint Review* to justify the working product (by *Sprint's* end) to be complete for delivery or to collect feedback on what the team has finished and inspect the overall roadmap PB. It is about the product meeting the user's needs. The *Sprint Review* meeting should include all the stakeholders. Finally, the *Sprint Retrospective* (Sprint conclusion) is provided to the internal stakeholder (the team) to evaluate the work by the end of each sprint. Thus, it is an action-oriented approach to improving team skills. Figure 1 summarizes the Scrum framework.

As a result, this study developed Scrum Zero, and the implemented literature review using (Scrum and Retrofitting) keywords proved that no reference indicated this issue before. Specifically in energy retrofitting practices[1] in rural Mediterranean

[1] Noteworthy, the only implementation of the Scrum into retrofitting was within a project in 2015 in the Netherlands, to retrofit a small building, as discussed in Ref. [70]. The similarity with our study is the limited team members and the building scale. Contrariwise, they belong to the same organi-

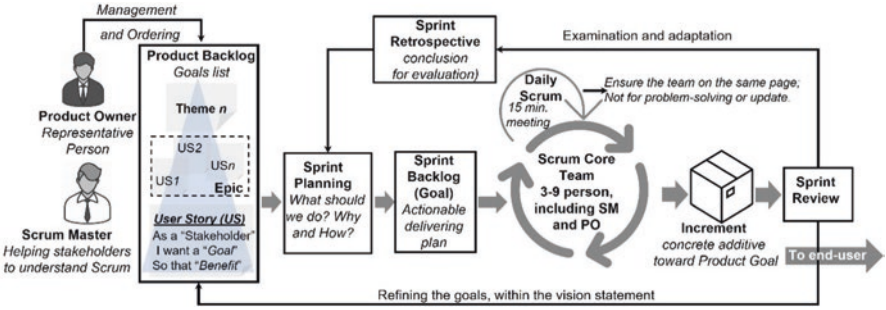

Fig. 1 A summary of the process of the developed Scrum framework. The study developed a novel definition of the proposed team: including academics, local authorities, and locals (the scrum team usually consists of technical experts). The "Product" is redefined as the required intervention in the villages of Lasaifar Albalad and Pontinia

commons. As a supportive step, the first author has contacted an expert software engineer[2] to discuss the related Scrum issues to enhance framework validation. In this case, in line with the adaptive nature of Scrum, the estimation should be fine-tuned based on our experience (waterfall approach), supporting what we have argued: "the traditional way cannot be excluded totally; however, we promote an agile approach."

In sum, Scrum utilizes an incremental and iterative way to mitigate the uncertainty (risks prediction) and engages members with sufficient skills to carry out work. Scrum model is an empirical-based approach characterized by transparency**.** All project limits should be visible to the team to ensure that the project aligns with the work procedure's goals (inspection to explore any emerging problems for adapting to the obstacles instantly and correcting the compass). This agile life cycle occurs through a dynamic environment based on repeat-until-correct and partial deliverable tasks to receive participatory feedback (from the stakeholders) and achieve the end-user value (local community, supporting the national policies, and the academic enthusiasm).

zation and have the fund to implement the intervention (which is absolutely different from our study). We also observed the project's timetable shown in Ref. [71]. The sequence of the time frame was going linearly (traditional way), and it is not clear enough how the discussion with the team back looped into planning (the agile iterative nature).

[2] The first author acknowledges the technical support (four online discussion sessions) from engineer Mohamed ElSerngawy https://ca.linkedin.com/in/mohamed-elserngawy-46637510 (Accessed 27-06-2022) about the scrum practices in the software domain.

4 Framework Validation and Sprint Zero in Both Contexts

The participatory approaches are crucial for energy transition [62], with community participation, especially in rural development projects [63]. By considering their generic obstacles, such as socio-cultural ones, in other words, how to enhance local belonging to possessing development, and legislative and administrative obstacles like bureaucratic laws and the conventional one-way communication (top-down) [64], which is proved its failure (without bottom-up) [65]. We implemented broad discussions with the locals in both contexts to consider the barriers. After a deep on-site investigation and face-to-face discussions, it was easy to identify the influencers in both contexts, highlighting the critical role of contacting the locals on the ground (as one of the transdisciplinary characteristics). The details of the framework validation were concluded in Ref. [32].

In Sprint Zero, briefly, the vision statement is to decide together and be on the same page to retrofit our built environment within the potential and the obstacles. Simultaneously, the first author acts as SM (servant leader) responsible for explaining the technicalities of the scrum principles. DT was the selected stakeholders, including versatile participants[3] (decision-makers, locals, cultural experts, and local suppliers). The entire process was mentored and supervised by the second author. The initial Sprint Planning was estimated at 1 week and making a plan to reach the goal the development team aims to fulfill within the Sprint.

We found that Scrum helps determine an effective work procedure that combines short iterative development and assessments, leading to holistic reviews and in-depth feedback. The initial Sprint in the retrofitting process is the validation process- Sprint Zero. In Pontinia, the intervention started from a bottom-up approach and ended with support from the Municipality. The authors acted as PO and SM (client), who stated the requirements, vision statement, and goals (aimed to assess the participatory transdisciplinary framework). Then, the sprint review process with the stakeholders from different perspectives. Table 2 localizes the developed scrum practices within our intervention.

It is noteworthy that the Ref. [66] has argued that Italy is an unusual country in Europe in every aspect, including project management, characterized by continuous changes in planning, as supported by the Ref. [67]. That gives a rudimental indicator to understand the local Italian culture. Consequently, we advocated that understanding the local culture (daily life situations, traditional music, and movies) enhances communication and project performance. Supported by the Latin statement "*Si fueris Romae, Romano vivito more.*[4]" Thus, the first author (as a foreigner) gave heed to these details 3 months before the on-site investigation. He noticed the argument's effectiveness, represented in the high appreciation from the locals while implementing the practical part and their willingness to do something for their community.

[3] The significant variance between the software development and the Netherlands practice are the limited team to the technical ones.

[4] Latin statement attributed to Saint Ambrose, it means: *If you are in Rome, live according to the Roman custom.*

Table 2 Localizing the scrum practices within the workshop, integrated with Ref. [32]

Team	Artifact	Event	Description
PO & SM	Product Backlog	Vision statement	Stating the vision (developing a built environment together, e.g., energy communities). The necessary work to fulfill the project objective orders these needs into a list. PO shows a requirement to the members, asks questions, and mange discussion.
PO,SM& DT	Sprint Backlog	Sprint Planning (Direct goals)	*What can be accomplished and delivered as Increment* (How can we do it). What are the obstacles and benefits (approving the user stories). Localizing the concept of agile and scrum. What are their point of view directly about both framework and suggested interventions. How can we implement a real scenario case?
PO	Sprint Backlog	Sprint Planning (indirect)	Observe their facial expressions, communication levels, and preferences.
PO and Sponsors	Sprint Backlog	Daily Meetings	Preparing for the workshop activities (Short meetings with facilitator stakeholders) and inviting the stakeholders.
PO and External	Supportive item	Daily Meetings	Preparing for the workshop technically and short face-to-face with volunteer external experts (researchers) and the mentor to receive feedback about the framework.
DT	Increment	Sprint	The sum of all the elements that were accomplished during the Sprint.
PO,SM& DT	Increment	Sprint Review	A summary of the accomplished tasks. Estimating the delivery dates and those targeted for the next Sprint.

4.1 Framework Refinement—Further Sprints in Lasaifar Albalad

Refining the framework has been conducted in the Egyptian case study only. Based on the outcomes of the initial Sprint, the framework has been adjusted at many levels, namely, the financial aspects, finding a pilot case study and a local representative, time frame, risks, and clear scope. We promoted solar energy for the self-consumption purpose (the initial step of the energy community). Which was accepted as one of the optimum accepted user stories (Sprint Zero) in terms of micro-scale, solar availability, technicalities know-how, and short implementation period, considering resolving the associated uncertainties, which can be grouped as shown in Table 3.

For elaboration in Sprint One, it took 2 weeks to plan the project, starting with the one-to-one meetings (online and by telephone) between the stakeholders. The

meeting discussed the client's needs, which had two concerns. First, to what extent the supposed system is safe for the building structure (the technical investigation confirmed, yes). Second, what is the possibility of removing and reinstalling the cells in case of any future extension? Therefore, we conducted a flexible structure.

Then the SM and DT of Edara implemented technical meetings (two daily scrums) within a week to discuss potential solutions (self-consumption, on-grid, or off-grid). After every meeting, the SM contacted the client online to simplify the conclusion. No feedback was received, only clarifications and answered immediately. The technical tasks have been divided between the SM (spatial and architectural analysis) and Edara's DT (solar energy technicalities). Two days later, a daily scrum was implemented (by phone) between the SM and DT leader, followed instantly by a call with the PO. No feedback was received.

The technical and financial file was received on 23 January 2022.[5] The SM immediately discussed it with the client and approved it in 2 days. Then, Sprint two was started to install the photovoltaic. It was planned to implement in 10 days due to the capability of the donor, considering that they are usually working in Cairo and they have their working procedure. The aim was to implement a pilot project in the village relying on renewable energy and avoiding retrofitting the buildings. Table 4 summarizes Sprint One's tasks.

Table 3 The outputs of the Sprint Zero (inputs to Sprint One)

Sprint One Inputs	Description
Input 1: Specific intervention	The vision statement, self-consumption buildings (zero energy building) serving the local community.
Input 2: Target case	The proposed building should be one of the public buildings, the health unit (which has been excluded), or one of the social buildings, the NGO private building. The aim is to implement the first (rapid) pilot study in the settlement (including the satellite villages).
Input 3: Socio-culture barrier	Convincing the client to accept the intervention (although their enthusiasm, it took 2 days to accept).
Input 4: Economic barrier	The author convinced a communities development company, "Edara" [68] (a representative was involved in the focus group), to support a pilot project as a societal role due to their internal policy.
Input 5: Setting the project and communication plan	The team consists of the PO: NGO (the client), SM: the first and second authors (coordinator and mentor, respectively), and DT, Edara Company (financial and technical support).

[5]The file is attached to the Project Log, available at: https://www.researchgate.net/project/Retrofitting-Built-Environment-in-Traditional-Settlements-in-Mediterranean-region-towards-Energy-Communities-Egypt [In Arabic] (Accessed 27-06-2022).

Table 4 Sprint One's summary

Item	Description
Tasks	Receiving the client's feedback, preparing detailed technical analysis, and approving the financial support, in line with the vision statement and including user stories in the product backlog (resulting from Sprint Zero).
Increment	Providing the technical offer, approving the funding, and preparing the user stories for the upcoming Sprint.
Scope Refinement	Selecting the proper technical solution after discussion.
Duration	Two weeks.

Table 5 Sprint One's summary

Item	Description
Tasks	Implementing the first self-consumption building, using an off-grid solar plant (3 kW), in line with the vision statement and the included user stories in the product backlog (resulting from Sprint One)
Increment	First self-consumption building from 100% renewable energy
Duration	Six days

4.2 Sprint Two

Sprint two took 6 days to prepare for the implementation phase. In this step, the tasks are divided into the team, the architectural analysis and communication provided by the SM, and solar panel technicalities provided by the DT (Edara's technical team). The approved funding was 48,000 Egyptian Pounds (EGP) (equaled to 2693 EURO in January 2022) to install the solar plant. The target building is located in Lasaifar Albalad, between coordinates 31°10′55.9″N 30°43′06.1″E. It is a typical one-story residential building with a different function: "Albakyat Alsalihat" NGO. The building provides many social services: a nursery (serving around 75 kids between 3 and 5 years) and orphan care. The area is 150 m^2, and the ground floor consists of one main hall, five classrooms, two toilets, a lobby including a kitchenette, an external store, and a stair leading to the roof.

In the second step: the data on the electrical appliances and electricity bills were collected. Building operation and occupant energy consumption behavior were discussed with the client. The maximum operation hours are between 7:00 am and 7:00 pm. The night load is for the fridge only. The total load is estimated at 6502 Watt/day. The load capacity (instantaneous total) is 2438 watts/day. So the inverter equals 2925 watts/day (3 kW) approximately. The peak charge plant was designed as per location peak sun hours 5 hours/daily to charge the batteries and feed the mentioned load for 24 hours. Table 5 summarizes Sprint Two's tasks.

The implementation day was determined as 29 January 2022. Then, three associated risks to Sprint Two emerged: First, although the date was chosen after checking the weather forecast to find a sunny day (this time of year is rainy). Some local internal road networks (narrow two-way) suffer from heavy mud between some

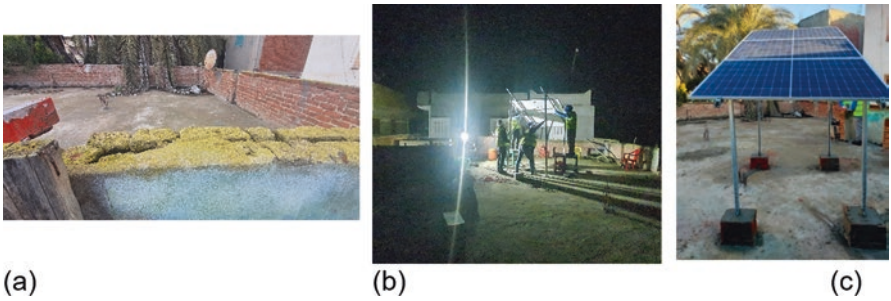

Fig. 2 The target building's roof (taken by Ahmed Abouaiana). (**a**) Green molds fungus indicates that the client ignores the roof and maintenance behavior post-retrofitting; (**b**) demonstrates work progress during the night; (**c**) shows the solar plant after completion

districts and rural settlements (due to heavy rains in the past days), limiting car speeds. Consequently, the equipment vehicle arrived 3 hours later, near sunset time. Hence, the installation was implemented at night to avoid consuming more time and money if the work was postponed to another day.

Another observation was the unoccupied roof beside the green molds on the brick parapet of the roof, Fig. 2a, which reflected that the client neglected the roof. The anticipated risk was the lack of maintenance by the client post installing the plant. Consequently, the team has stressed weekly operation and maintenance instruction and provided technical training. Finally, when the client stated, "*what if the system dropped? How can we retrieve the conventional electricity source?*" For this reason, although Edara guarantees this off-grid system technically, the plan was modified immediately (agile way), and a switch was added (2 days later) instead of the direct connection from the solar plant to the internal electrical distribution panel to enable switching.

4.3 A Nascent Practice and Promising Outcomes

The experiment is accomplished, and now the first self-consumption building in the village consumes the total produced energy from January until writing this paragraph (July 2022). We declare that the experiment is still in a too-early stage, but encouraging preliminary results have been achieved in the first week. First, socially, a wide segment of the inhabitants expressed their interest (on the Facebook platform, by phone, and through direct contact with the client) to know more details, asking for visits to see this "new" technology, and asked for its feasibility. A local said, "*really can I avoid paying 250 EGP of the monthly electricity bills?*". The kids expressed happiness in asking to see the experiment and about capturing photos wearing the safety helmets. The client herself expressed her gratitude for the "new" experiment.

Fig. 3 The author was interviewed on the official national TV program [69]. This may reflect the social impact of the experiment

Secondly, in raising awareness realm. In discussion with the client. Two additional findings were provided, to include simple environmental aspects (e.g., this experiment) in the teaching activities in the nursery (teaching now is limited to religious subjects and reading skills), considering that no structured curriculum developed. In addition to suggesting a public playground, serving the village's kids was suggested in front of the nursery. The project is planned to implement soon by the NGO.

Thirdly from the media side, after 2 days of publishing the experiment on social media platforms, the first author was invited to an interview in the official national program "Good Morning Egypt" to discuss the project results, Fig. 3. This interest reflects two crucial aspects: the importance of bottom-up practices and the role of the researchers and architects in developing the built environment, and the government's support for these kinds of interventions in line with (Goal 4, supporting innovation and scientific research) Egypt Vision 2030 to achieve sustainable development goals. In addition to the extraordinary attention, to all green initiatives, in line with hosting the UN Climate Change Conference (COP27) as planned in November 2022.

5 Conclusion

Built environment energy retrofitting is crucial to promote sustainable development objectives, mitigate climate change, and improve quality of life. The academic community pays great attention to energy efficiency, represented in the significant

increase in the academic publications related energy efficiency domain in the last 20 years. Jointly, the nature of the retrofitting practices is too complex due to internal or external factors, unlike any domain. What requires an intensive focus from various stances to mitigate these uncertainties. For this reason, integrating the efforts of academic bodies (as knowledge brokers) and practitioners across the different disciplines besides the local community, in other words, the transdisciplinarity can contribute efficiently to solving real-world related-energy problems, particularly in distinguished environments with limitations and characteristics like the traditional Mediterranean settlements.

That influences the global environmental scene (top of the pyramid), such as climate change, and the individuals (base of the pyramid), like paying much in energy bills. Although the vast benefits of transdisciplinarity, it is ambitious because it conceptualizes how to work, not what to do in detail for a specific project, and how to manage the interlocking relationship between the collaborators. This Study proposed a transdisciplinary approach by following systematic procedures to rationalize this ambition.

In the study context, the agile scrum method paved the way to resolve the expected conflict between team members. It deals with the high-level obstacles, namely, the interest of the decision-maker and locals with the research objective, requiring to clear the vision and mitigating the associated uncertainty, guiding the project's "servant leader" (the lead researcher) on how to educate, and monitor the team, and evaluate the process.

5.1 Conceptual Framework Novelty

In theory, this research is the first to provide integration of an agile mindset in retrofitting rural built environments in the Mediterranean region. By elucidating the interconnectedness with the nature of the energy retrofitting practices, where conceptualizing the uncertainty linked with it can be reduced. This occurred via a review of the relevant notional concepts about the trends related to cross-disciplinarity energy retrofitting practices. That is associated with the agile methodology practices of project management and software development domains, resulting in a framework that helped organize collaboration, enhance communication, and support planning and decision-making to retrofit. As a result, the study achieved triple contributions that positively impact the local society and the scientific community, and support the national policies.

The first category is energy retrofitting. The study localized the takes global challenges at a micro-scale by investigating the practices advocating more coordination between actors from a transdisciplinary perspective, manifests the acquaintances among the ability to involve the local community, decision-makers, academic bodies, and experts. Which is essential to enhance the energy efficiency, mitigate climate change and valorize the local identity with resilient strategies.

The second category is the project management domain. Improve the skills of the team members to understand the nature of projects, life cycle, management approaches, and how to ensure project success (team, work environment, and process). Furthermore, understanding the local socio-cultural aspects underlined a new approach to identifying the stakeholders. The third is software development. The scrum model provided practical steps to develop software products. Thanks to the rapid acclimatizing way that enabled us to eradicate superfluous things providing adaptable choices, effacing the given issue along the life cycle, and establishing broad lines between the team to improve their relationship.

The framework empowers information exchange, which in this study refers to a new way of interacting cooperative working, including simplifying the transdisciplinarity, involving all relevant stakeholders in the project development process, resulting in better collaboration and communication, and decision-making.

The scrum framework empowers information exchange, including simplifying the transdisciplinarity. This study refers to a new way of interacting in cooperative working. It promotes a better understanding of implementing efficient retrofitting strategies that provide a rapid adjustment of the work plan and equal feedback from the engaged stakeholders. That proved a success in mitigating the uncertainty in energy retrofitting practices. In addition, the short iterations helped adjust the project path at any time, only under a mainstream aim and precise inputs. It also helped in engaging the stakeholders and increasing their expectations. In addition, it upgraded the bottom-up way to a mixed one (with the top-down), as proved in Lasaifar Albalad and Pontinia.

Although the study focused on Egypt and Italy as representatives of the entire region, investigating different Mediterranean countries may lead to different results. The study was limited to the traditional farming-based settlements and the plain areas (morphologically). The research implementations did not apply to the historical and cultural heritage settlements. The real case scenario has been implemented in Lasaifar, while in Pontinia, it was limited to the planning phase.

From a local cultural perspective, we argue it will be a tendency among the other inhabitants. The novelty is the provided Scrum framework and all its connected procedures that enabled deducing sufficient feedback and preferences from versatile stakeholders and juxtaposing them on the same page using a restricted methodological approach. Besides, juxtapositioning versatile stakeholders on the same page using a restricted methodological procedure.

Meanwhile, we found that the researchers' social and cultural skills and life experience go hand in hand with technical skills. In addition, studying the historical background of the place, music, architecture, and local language can facilitate any on-site intervention. Thanks to social media platforms and ICT that helped in this, they played a significant role in communications in the exploratory phase. Especially as the first author, a foreign researcher working in the Italian context, observed a positive reaction from the Italians toward this, regardless of the techno-economic obstacles.

Scrum proved a successful tool for implementing the project, represented the rapid communications among the stakeholders, adjusted the work plan due to different inputs, enhanced the collaboration among the collaborators, and finally, no conflict was detected. The conversations with stakeholders and citizens are vital for creating groundwork. It is inevitable to implement a field study after the theoretical preparation. It affected the process positively.

To conclude, this paper has proposed a new direction of the investigation, which moves from a conceptual framework toward an agile practice to provide a new participatory approach that empowers knowledge exchanging and developing a cognitive model that can simplify transdisciplinarity interactions, involving all relevant stakeholders, enhancing the communications that enable possible retrofitting solutions of the Mediterranean built environment, on the one hand, and the other, showing how could it improve the capacity of researchers and practitioners, who promote bottom-up rural development interventions.

Finally, although the promising future of the intervention, we declare there is an essential need to evaluate the whole experience post-implementation and monitor it. Each part has its challenges, obstacles, and known and uncertain risks. Likewise, the scrum filled a gap in the early stage it might succeed in the further steps.

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Data Availability Statement Some data that support the findings of this study are available from the first author upon reasonable request.

Conflicts of Interest The authors declare no conflict of interest.

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