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SUSTAIN – CE

Integration of Sustainable Design and Circular Economy Concepts in
Civil Engineering Curricula

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2nd Biannual Evaluation Report

June – December 2021

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1 INTRODUCTION

SUSTAIN-CE addresses circular economy concepts and principles within the construction sector, aiming at integrating principles of sustainable development and circular economy (SD/CE) in civil engineering curricula, which should consider all steps from raw material to the life cycle of the end-product in the construction sector.

Infrastructure is the backbone of sustainable development and forms much of the foundation for quality of life. However, it consumes vast material resources and energy. For this reason, it is of paramount importance that prospective engineers, who will design, construct, and maintain these systems for the next 50 or more years, are equipped with the awareness and knowledge of sustainable infrastructure design.

Civil engineering covers a wide range of disciplines that incorporates infrastructures: construction, environmental, geotechnical, water resources, structural and transportation engineering. Therefore, it is imperative civil engineering undergraduate students get accustomed to concepts and principles needed to meet the requirements of sustainability in civil engineering projects. As a response, SUSTAIN-CE project will attempt to enrich the contemporary civil engineering undergraduate programs' curricula, which are mainly focused on regulations, standards, codes and safety and serviceability of infrastructure systems, by incorporating sustainability, resilience and circular economy concepts in various stages of the design courses.

SUSTAIN CE will result in the co-creation of a new innovative undergraduate civil engineering curriculum that covers sustainable infrastructure design to ensure graduates can apply concepts and principles of sustainable design (SD) and circular economy (CE) in the design and construction of civil engineering projects.

In short, SUSTAIN-CE will result in the following deliverables:

- 1) The syllabus and contents of a new course supporting the SD/CE concepts in civil engineering
- 2) Three Training Events – Training Academies - implemented in Portugal, Greece, and Turkey.
- 3) Three evaluation reports summarizing the results of the three Training Academies
- 4) A guideline for other educational institutions willing to implement SUSTAIN-CE Training Academies.
- 5) One VLE platform (design, develop and content)

PARTNERSHIP

SUSTAIN project is being conducted by a consortium of six partners from three European countries: Turkey, Greece and Portugal. Comprised of three universities, one research centre, one construction company and one partner with extensive experience in curriculum design and circular economy, SUSTAIN consortium covers the expertise needed to successfully implement the project goals. Table 1 presents all six partners.

Table 1

PARTNER	Acronym	COUNTRY
YASAR UNIVERSITESI COORDINATOR	YU	Turkey
IZMIR INSTITUTE OF TECHNOLOGY	IYTE	Turkey
ARISTOTLE UNIVERSITY OF THESSALONIKI (ARISTOTELIO PANEPISTIMIO THESSALONIKIS)	AUTh	Greece
SOUTH-EAST EUROPEAN RESEARCH CENTRE (KENTRO EREVNON NOTIOANATOLIKIS EVROPIS ASTIKI MI KERDOSKOPIKI ETAIREIA)	SEERC	Greece
INSTITUTE FOR TECHNOLOGY AND QUALITY (INSTITUTO DE SOLDADURA E QUALIDADE)	ISQ	Portugal
FOLKART YAPI SANAYI TICARET A.S.	FOLKART	Turkey



2 QUALITY EVALUATION AND MONITORING STRATEGY

SUSTAIN CE consortium has developed a Quality and Evaluation Handbook aiming at ascertaining the methodology and tools that will be used to evaluate and monitor the quality of the project and its deliverables.

Focusing on the 3P model¹ developed by ISQ, the Quality and Evaluation Handbook was designed to support the project management and to guide all partners on evaluation and quality issues. As such, besides the definition of the evaluation methodology, rooted in the 3P model and in specific questionnaires designed for the evaluation of (a) meetings, (b) training activities and (c) multiplier events, the Quality and Evaluation Handbook includes a set of **performance indicators** (see table 4 of the Quality and Evaluation Handbook), agreed upon by all partners, aiming at providing a quantitative measure of the project quality and performance and, hence, the possibility to act upon any less positive result in due time.

In terms of quality evaluation and monitoring, major milestones are the *interim* and *final* reports, delivered at the middle (month 16) and the end (month 32) of the project lifecycle. These will be the most important quality evaluation and monitoring documents, comprising a combined analysis of all the quality data collected up to the time the report is released, including results from the 3P questionnaire. The main goal of the interim report is to demonstrate the strengths and the issues that need to be addressed in the project, as well as identify possible risks and mitigation actions. The Final report then evaluates whereas whatever was hindering the project best results was overcome, as well as main results achieved by the consortium.

In-between these, quality evaluation will be made every 6 to 7 months in the form of biannual quality reports which aim at gathering all quality results collected by the quality evaluation tools applied in that period. These comprise quality evaluation questionnaires specifically designed for (1) *meetings*, (2) *learning activities* and (3) *multiplier events*.

This is the second of those biannual quality reports and pertains to the period June-December 2021.

MEETINGS

Meetings are a fundamental component of project management and development: they are a valuable opportunity for discussion and decision-making. And for that reason, aspects pertaining to the preparation of the meeting by the coordinator, how prepared each partner attends the meeting and presents their point of view and work progress to date, and the overall attitude of a given partner during the meeting, do have considerable impact on the way work progress and quality go.

For quality evaluation purposes, two types of meetings are considered: Transnational Project Meetings (TPMs) and Follow-Up meetings (FUMs). TPMs are project meetings foreseen by the proposal and hence destined for specific decision-making moments, according to the project status when the meeting takes place.

Follow-up meetings are online meetings scheduled as and when the consortium feels the need to discuss and decide on a given subject.

In the case of the SUSTAIN-CE project, it was decided not to evaluate follow-up meetings given the fact that a considerable number of them were attended by the members of a specific working group and, hence, it would not be possible to compare meetings held by different groups of partners and hence to draw reliable conclusions from evaluating individual FUMs. So, for the case of SUSTAIN project, only TPMs were evaluated at the end of each meeting.

¹ 3P stands for (i) Process and Project Management; (ii) Partnership and (iii) Products, the three dimensions evaluated at the middle and at the end of the project lifecycle.



The questionnaires developed by ISQ for transnational project meetings are organized around three main moments: **before** (meeting preparation), **during** and **after** the meeting. Additional dimensions evaluated are **attendance** and **technical discussions**. Please see next section for the evaluation results of the first TPM – the kick-off meeting.

LEARNING, TEACHING, TRAINING ACTIVITIES

The teaching and training activities play an important role in achieving the objectives of SUSTAIN-CE. They will take the form of one train-the-trainers event (C1) and three training academies (C2, C3 and C4). These academies constitute part of the quadruple helix co-creation process.

The new innovative curriculum developed for the design courses in selected areas of civil engineering will be tested in the three training academies. Each training academy will have a different thematic. The anticipated thematics that will be evaluated and finalized in O1, to be covered in the academies are as follows:

- C2 will focus on **water resources** and **transportation engineering**,
- C3 will focus on **construction materials and buildings** and
- C4 will focus on **structural and geotechnical engineering**.

In each of the academies, trainees selected at a national level (junior and senior undergraduate students, recent graduates and professionals) and partner experts as trainers/mentors, will collaborate and test the training material developed in O2 and the training methodology (O3) and co-design a selected civil engineering project using SD/CE applications on the chosen thematic of the academy. The effect of SD/CE concepts on the design process will be evaluated. After each Training Academy, the organizing partner will assess the results of the academy and will produce a thorough evaluation report, in order to reengineer and further improve the course contents related to SD/CE and the deliverables of O2 and O3.

Moreover, in C3 and C4 the SUSTAIN-CE VLE platform, developed for offering open and distance learning opportunities to a broader audience of trainees will be piloted during the trainings. Therefore, the Training Academies will also enable the improvement of the VLE platform based on the feedback comments of the trainees and the trainers.

MULTIPLIER EVENTS

Three multiplier events will be organized to promote and disseminate the results of the project. The first two will be organized in combination with the scheduled training activities (trainers' lab and the three training academies) in different partner countries. The third multiplier event will be in the form of a Final Conference disseminating the final outputs of the project and opening the floor for a discussion on the recent trends and further developments in the fields of Sustainable Design and Circular Economy. The final multiplier event will take place at the same time with the last Transnational Project Meeting in Izmir and therefore representatives of each partner will be able to attend and contribute to it.

Multiplier events not only provide feedback to the project but also reverse-feedback to these stakeholders and increase their awareness. It will force them to think and ask questions on the subject. Therefore, in the short-term a change in their approach to the SD and CE could be expected. In the long term, the developed sensitivity is expected to steer their decisions become SD and CE friendly. The civil engineering graduates that go through the new innovative curriculum will be able to perform the necessary tasks with the new approach. The local people, economy and the environment will benefit from these changes.

3 PROJECT ACTIVITY FOR THE PERIOD UNDER EVALUATION

Between June and the end of December 2021, the SUSTAIN-CE consortium continued working on the tasks under Intellectual Output 1 (IO1). In particular, the methodology for the quadruple-helix co-creation was finalised and a first sketch of the Blueprint for the New Curriculum was agreed upon.

IO2 took off, with the creation of 6 working group designed to develop the contents of the main circular economy (CE) and sustainable construction related areas under civil engineering set for the new curriculum in IO1. Main conclusions and ideas for development from the work of this thematic working groups were then discussed on the C1 event, held in Thessaloniki from the 2nd to the 4th of November 2021.

Work under the Co-creation Focus Groups continued, with different partners adopting slightly different approaches. Still, ISQ report on their Focus Group interviews is still to be delivered at the time this report is produced.

Finally, the SUSTAIN-CE consortium started working on IO3, for the development of the Virtual Learning Environment (VLE) platform that will house the new course on sustainable construction.

The consortium met four times, namely:

- i. for the **2nd follow-up meeting**, held on the 8th of June,
- ii. for the **3rd Follow-up meeting**, held on the 13th of July,
- iii. In the 4th Follow-Up meeting, on the 1st of October, for the preparation of the 2nd TPM and train-the-trainers event, scheduled for the beginning of November, and
- iv. for the **2nd Transnational Project Meeting**, held in Thessaloniki on the 2nd and 3rd of November.

From the 2nd to the 4th of November, C1 took place for the discussion of what should the new SUSTAIN CE curriculum consider, as well as for the definition of its structure and the build up of the VLE platform contents.

4 QUALITY RESULTS FOR THE PERIOD UNDER EVALUATION

4.1 Meetings

Table 2 presents all meetings held from June to the end of December 2021.

Table 2: Meetings held in the period

MEETING	DATE
FUM2 - Online	08/Jun/21
FUM3 - Online	13/Jul/21
FUM4 - Online	01/Oct/21
2 nd TPM - Thessaloniki	2&3/Nov/21

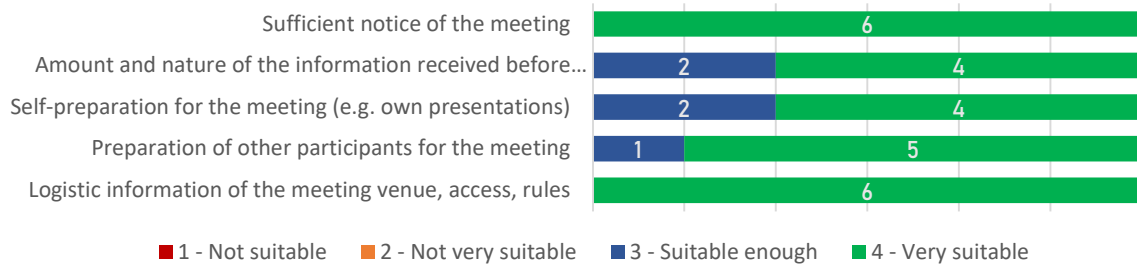
4.1.1 2nd Transnational Project Meeting, Thessaloniki, 2nd and 3rd November 2021

Graphs 1 to 5 show results obtained for the evaluation of the second TPM, the first held in person.

Overall, it was very positively evaluated by all partners, with no negative ratings given to any individual aspect. The “During the meeting” dimension was particularly positively evaluated, with all but one question rating the highest value possible of satisfaction. The “after the meeting” was the best rated dimension, with all partners replying with “very suitable” to all questions.

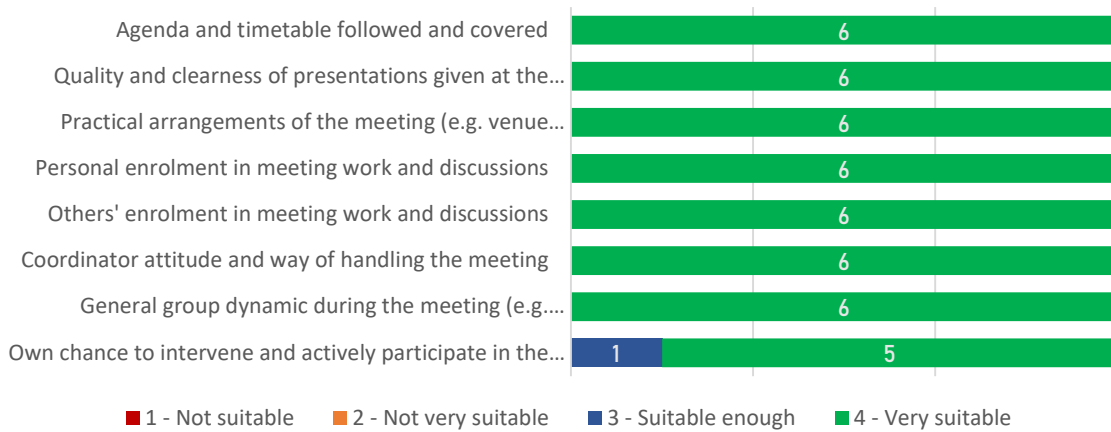
Box 1 shows results obtained for the open question (comments and suggestions).

Before the meeting



Graph 1: Before the meeting evaluation

Meeting evaluation



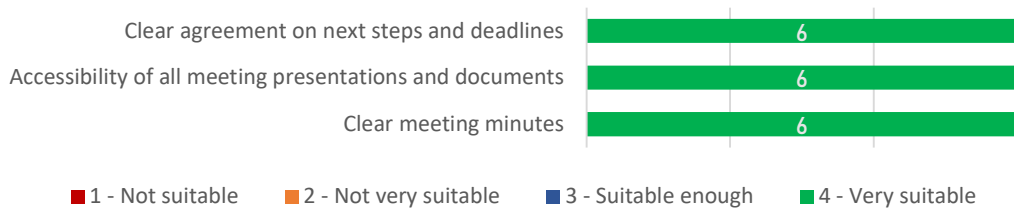
Graph 2: During the meeting evaluation

Did you stay for the whole meeting?



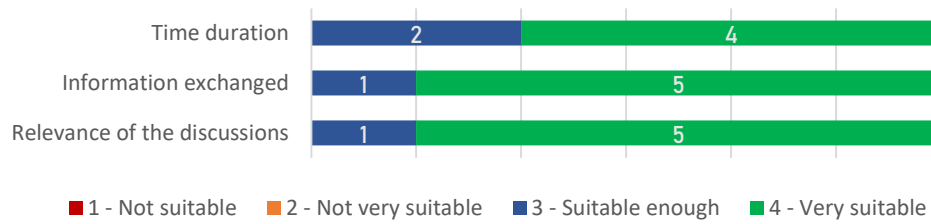
Graph 3: Attendance

After the meeting



Graph 4: After the meeting evaluation

Technical discussions evaluation



Graph 5: Technical questions evaluation

Box 1

Comment 1

It was a pleasure indeed. Great team, in all aspects.

Comment 2

Efficient

Comment 3

The meeting and the collaboration among the partners is excellent. Nothing more to add.

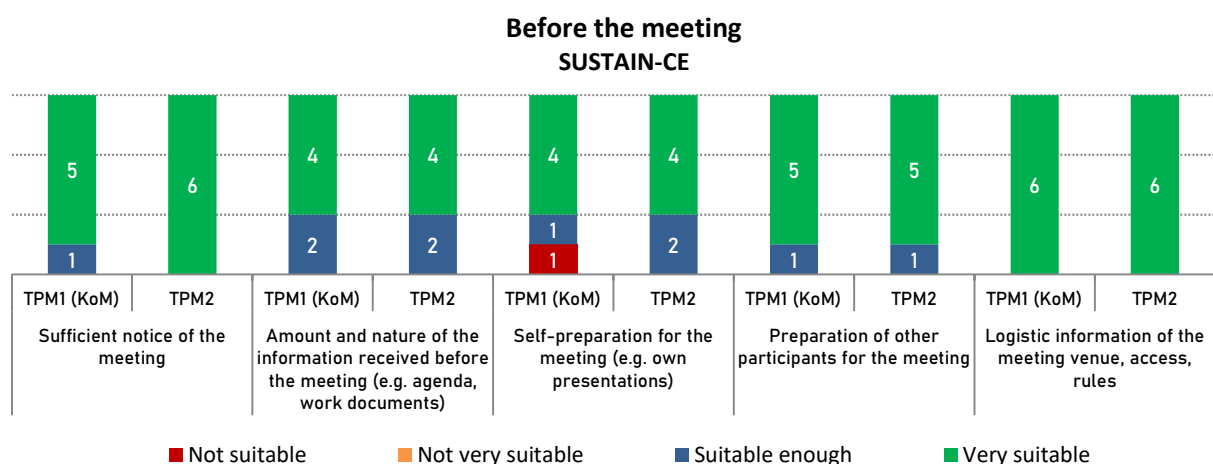
Comment 4

N/A

4.1.2 Transnational Project Meetings Evolution Evaluation

The quality evaluation and monitoring methodology developed by ISQ also considers evaluating how the several aspects evaluated in each questionnaire evolve throughout the project. As two TPMs have already taken place, this section looks at how the main dimensions evaluated for TPMs, namely (1) *before the meeting*, (2) *during the meeting*, (3) *after the meeting* and (4) *technical discussions* have been rated from one meeting to another.

Graphs 6 to 9 depict results obtained for each dimension in the two transnational project meetings held so far, and Graph 10 shows the average satisfaction level scored by each meeting.

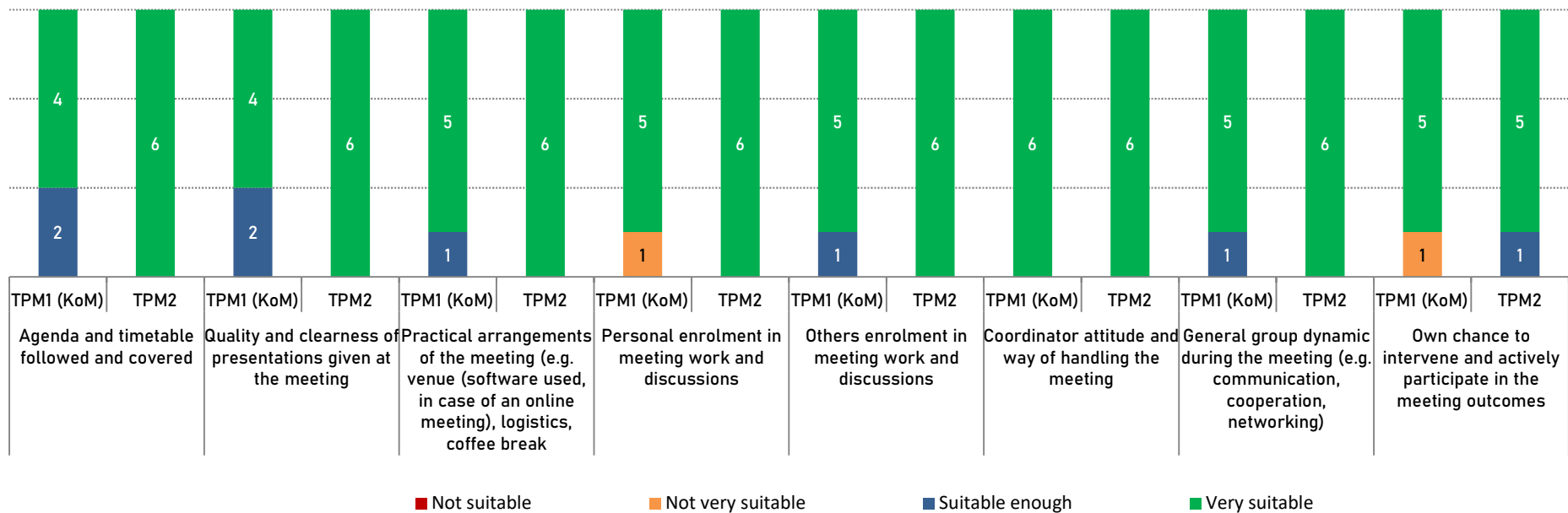


Graph 6: Before the meeting dimension

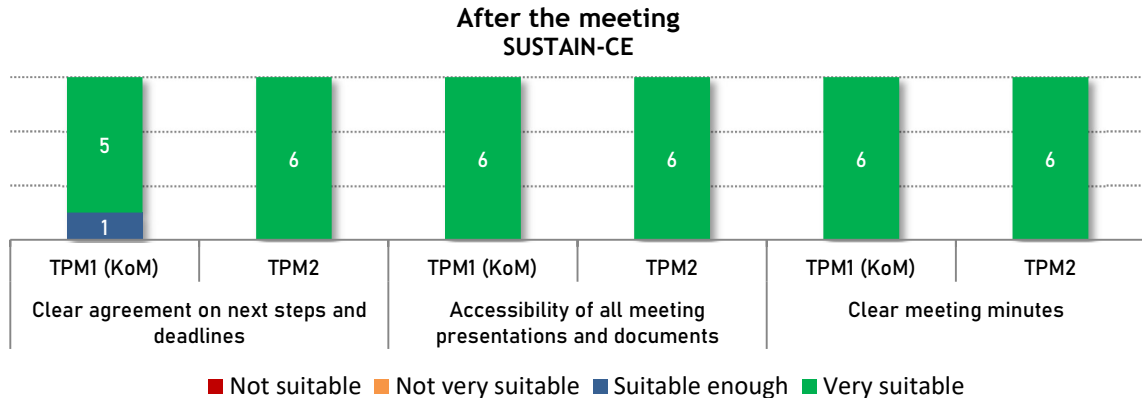
From these results we can see that, overall, all dimensions' evaluation improved from the kick-off meeting to the meeting held in Thessaloniki. Besides the fact that the latter was held in person, the time between the two meetings, and the opportunity to get better at working together as a group that comes with it, may explain these improvements. The higher average satisfaction rate obtained for TPM 2 (see Graph 10) is a result of that.



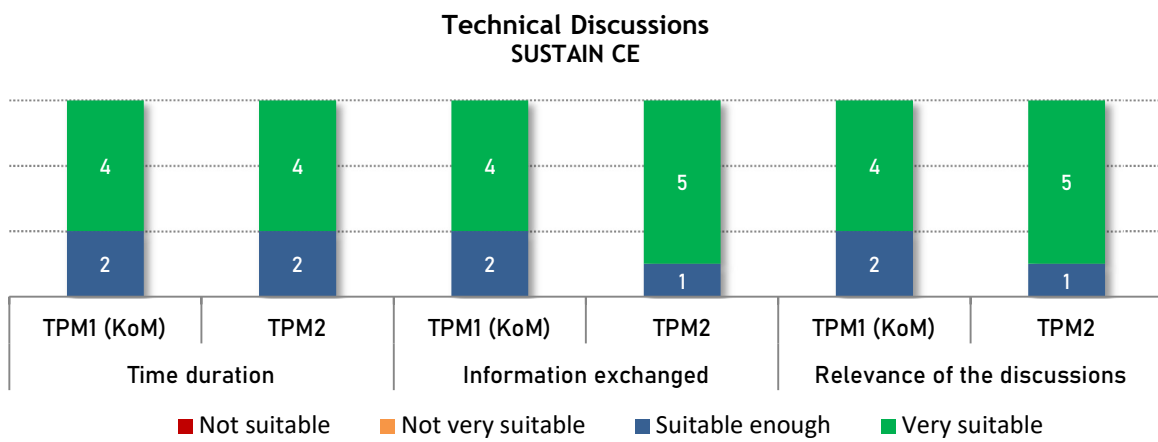
During the meeting SUSTAIN-CE



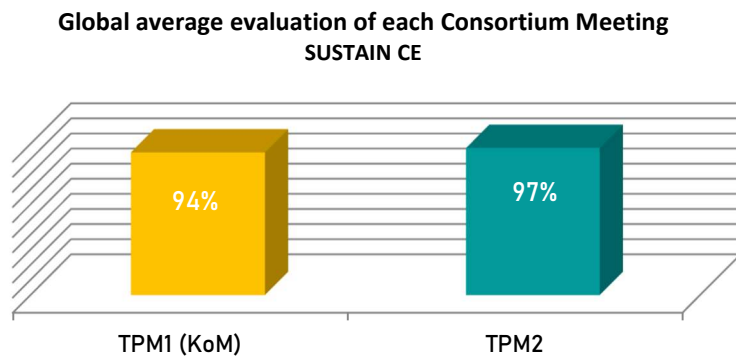
Graph 7: During the meeting dimension



Graph 8: After the meeting dimension



Graph 9: Technical discussions dimension



Graph 10

These results not only demonstrate that there are not major issues needing to be resolved, as they show that the SUSTAIN consortium is aligned and working together towards tackling any obstacles pertaining to delivering the SUSTAIN project objectives in time and with the desired quality standards. They also confirm the main conclusions from the first biannual quality report, which accounted for a motivated consortium happy to be working together in delivering SUSTAIN-CE project.

4.2 Training Activities

C1 – train the trainers lab was the only training activity undertaken in the period this report refers to.

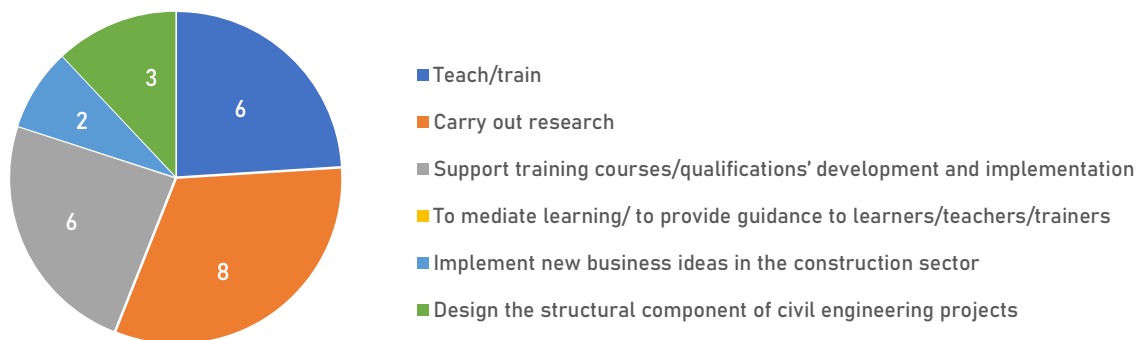
The questionnaire designed by ISQ for the evaluation of training activities considers a total of 50 questions, accounting for the following sub-dimensions:

- Participant’s profile: professional background and main interest in participating (2 questions)
- Content Delivery (9 questions)
- Partnership evaluation (30 questions – 5 per partner)
- General satisfaction (5 questions)
- 4 open questions (comments, suggestions, etc.)

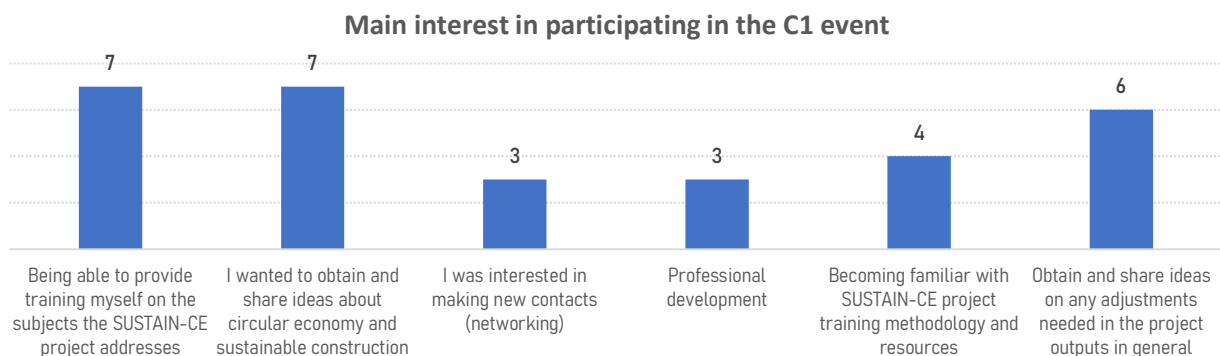
4.2.1 C1 Quality evaluation results

Graphs 11 and 12 depict results obtained for the first two questions on the C1 participant’s profile.

In your job, your role is mainly to...



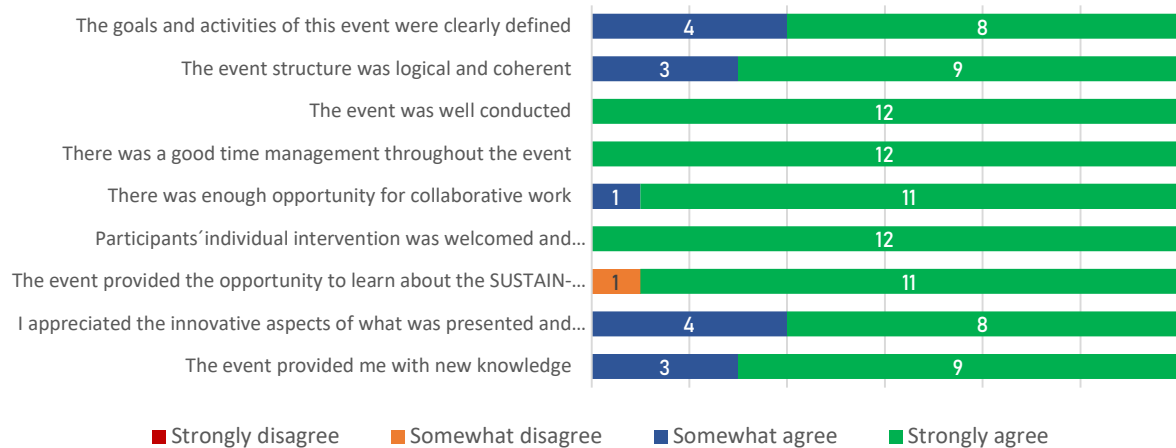
Graph 11



Graph 12: Main motivation for participating

Graph 13 shows results obtained for question 3 (**content delivery**), which got one negative evaluation to the question “*The event provided the opportunity to learn about the SUSTAIN-CE curriculum*”. As no comment from the open questions (see Boxes 3 and 5) sheds further light onto the possible reasons for this result, one can only assume it might be related to someone not working close in the project and who could not know much about the new curriculum from the C1 event. Still, it addresses the need to make sure that, in future similar events, the consortium makes sure to give a brief, more or less detailed, presentation of the new curriculum structure and main contents.

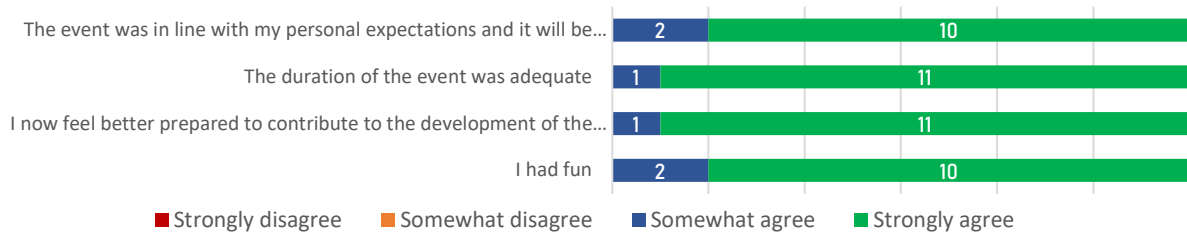
Content Delivery



Graph 13

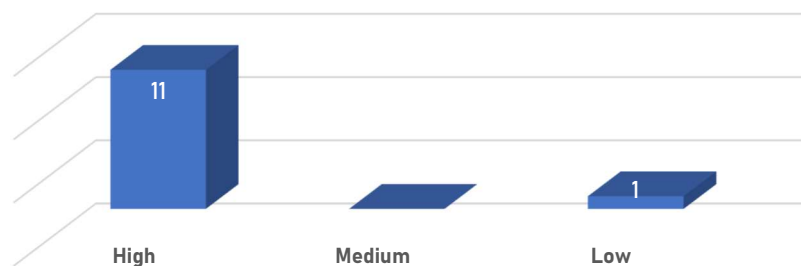
As for the questions evaluating general satisfaction, the results were, overall, very positive, with only one person relating a poor level of satisfaction (see Graph 15). Still, having in mind the results depicted in Graph 14, it is not possible at this stage to pinpoint what the negative aspects sustaining that answer might be.

General Satisfaction



Graph 14

How would you rate your level of satisfaction with this event?

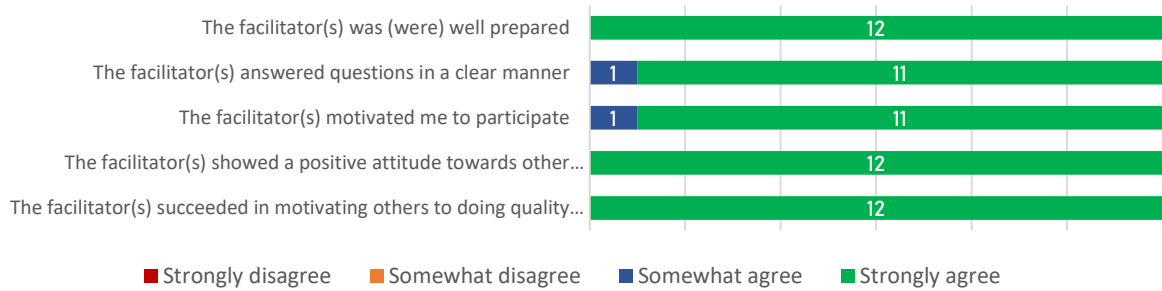


Graph 15

Finally, graphs 16 to 21 present the results pertaining to the partners 'participation evaluation. SEERC was the best evaluated partner was SEERC and the one least positively evaluated (with four negative answers) was FOLKART, probably due to some difficulties the partner from FOLKART had with communicating in English.

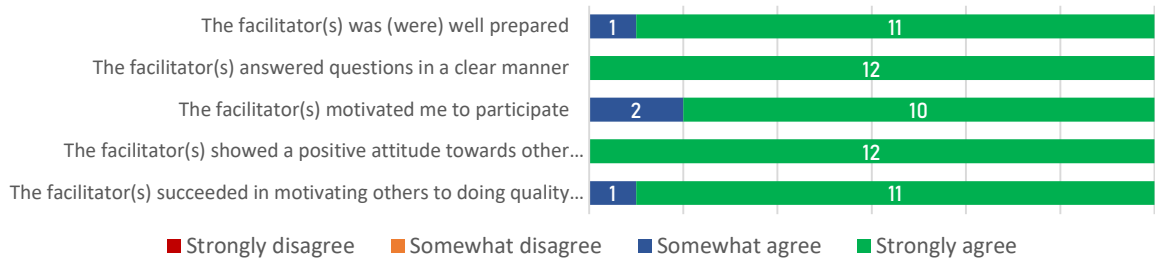


Partners evaluation | SEERC



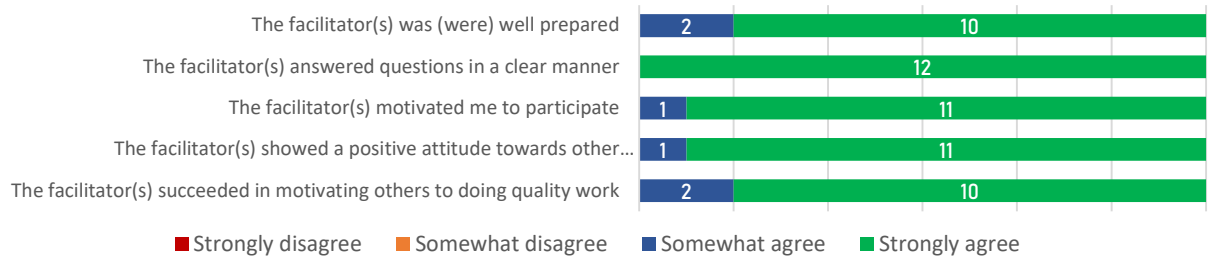
Graph 16

Partners evaluation | Yasar University



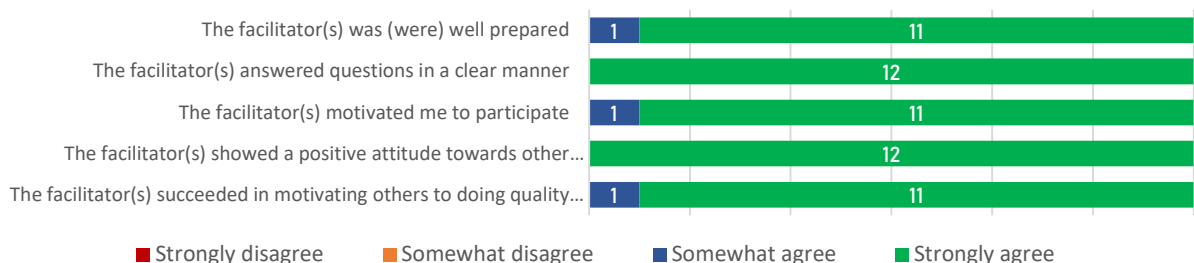
Graph 17

Partners Evaluation | Izmir Institute of Technology



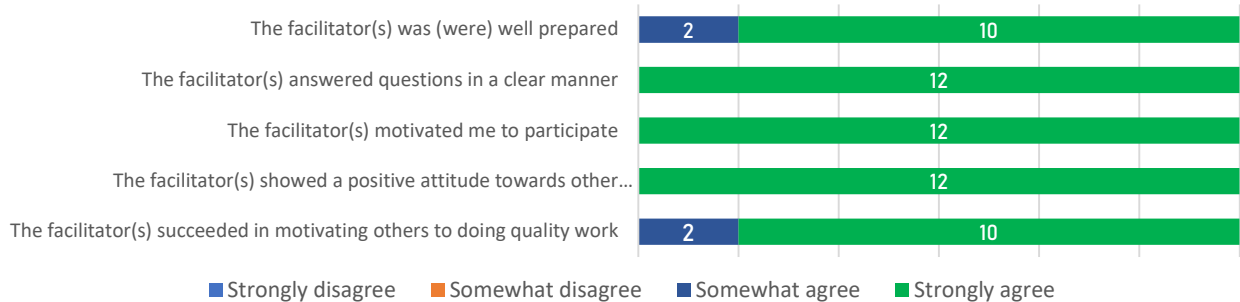
Graph 18

Partners evaluation | Aristotle University of Thessaloniki



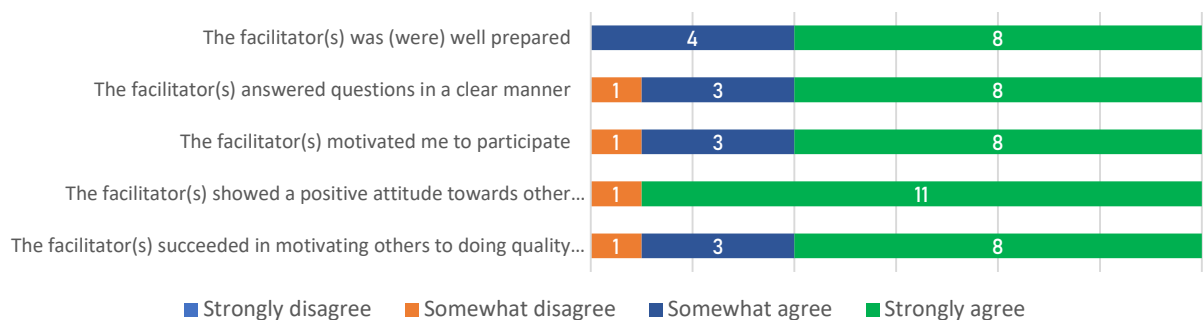
Graph 19

Partners Evaluation | ISQ



Graph 20

Partners Evaluation | FOLKART



Graph 21

Box 2: Answers to the question "What was the most positive aspect of this workshop? Why?"

Comment 1

Getting together as a team and discussing the specific tasks of the project in depth.

Comment 2

Collaboration, sharing ideas

Comment 3

The subjects Sustain CE project addresses and the training methodology were clearly defined. Therefore, a significant development on the project's outputs was done.

Comment 4

Being able to discuss the details of a given task, which is always more difficult by writing (as in an email). This resulted in things being clearer to everyone (at least in my opinion). Being able to discuss these details and feeling free to ask all the questions really made a difference.

Comment 5

Finally, to be able to meet in person. The opportunity to discuss project next steps, namely curriculum development, and clarify pending issues.

Comment 6

Collaboration exchange of ideas towards CE

Comment 7

Clarification of the major issues in the project

Comment 8

Co-creation in general: Module discussions, themes to be included in the curriculum related to each module, discussion on upcoming academies, etc.

Comment 9

The opportunity to co-create and exchange ideas with all partners



Box 3: Answers to the question “Do you have any suggestions regarding the subjects to be addressed by the SUSTAIN-CE curriculum? Which ones?”

Comment 1

No

Comment 2

BIM (Building information Management) can be added, and IOT (internet of things)

Comment 3

The energy efficiency of buildings and/or energy retrofitting strategies of existing buildings should be added as a part of one of the modules.

Comment 4

I am particularly interested in the hazardous component of CDW. Both in terms of technologies for sampling and recycling and / or depositing these materials, as well as in terms of specific markets and potential secondary use.

Comment 5

I fear that the curriculum could become too extensive, in an attempt to aggregate all the possible subjects related. I think it should be a bit more focused and developed in more detail. Otherwise, we can stick to a set of scattered case studies without a proper theoretical context.

Comment 6

No

Comment 7

All suggestions have been discussed in the meeting

Box 4: Answers to the question “Do you have any recommendations regarding the development of the SUSTAIN-CE curriculum? If you do, which are they and why do you think they are important?”

Comment 1

I believe we will have a better understanding about expectations after the pilot studies.

Comment 2

To build up a table of materials ‘relevant properties in terms of civil engineering which could be used as a transversal tool (for the materials and structural modules, for instance, as well as for the general introductory course on CE and sustainability (to be referred to in the LCA section, for instance).

Comment 3

It's important to make sure that the Curriculum meets the universities and VET providers/industry representative's needs. If some partners directly involve their teachers and students, other will meet industry and civil engineering sector. The final output (curriculum) should aggregate these different realities at a national level too. Otherwise, the project results will not suit our different realities.

Comment 4

I am quite satisfied with the discussed topics. Could further elaborate on construction management topics.

Comment 5

All recommendations have been discussed in the meeting

Box 5: sole answer to the question “Further comments and suggestions”

Comment 1

It was really a pleasure meeting everyone in person. I also believe this project has a lot of potential. I am very glad to be a part of it.

4.3 Performance Indicators

Table 3 shows results for the performance of the quality indicators applicable (bound to be evaluated) to the current state of the project. These are classified according to a 3-colour scale:

- (1) **Green** for absolute compliance
- (2) **Amber** for minor deviations
- (3) **Red** for unaccomplished targets

Table 3

IO/Activity	LEADER	PI	
I01	SEERC	<p>1.1. A quadruple-helix co-creation methodology is created identifying, at least 24 best practices;</p> <p>1.2. Three stakeholders' lists (1 per country) are created;</p> <p>1.4. Minimum of 60 best practices, in total, on a global or national level, are identified by partners on a benchmarking exercise of SD/CE;</p> <p>1.5. One focus group per country (three in total) is formed to confirm and further elaborate on the skills matrix and benchmarking results;</p>	
I02	IYTE	<p>2.1. A list of SD/CE concepts is produced by the academic partners and incorporated to existent courses of Civil Engineering Curricula, for each of the previous selected thematic;</p>	
Project Management	YU	<p>6.3. At least, two "catch-up" virtual project meetings are organised during the project lifetime;</p> <p>6.4. TPM meeting agenda sent to all partners at least 3 weeks before the meeting;</p> <p>6.5. Virtual project meetings agendas sent to all partners at least 1 week before the meeting;</p> <p>6.6. Meeting minutes sent to all partners within 2 weeks after the meeting;</p> <p>6.7. To-do lists updated every 3 months;</p> <p>6.8. All partners evaluate the project meetings in a positive way;</p>	
Dissemination and Exploitation	YU	<p>7.1. The project website is created within the first six months of the project;</p> <p>7.5. At least, 2 project e-newsletters are released, per year, by the partnership during the project lifetime;</p> <p>7.6. Minimum of three social media channels, for dissemination purposes, are identified and used during the project lifetime (Facebook, LinkedIn, Twitter and other(s));</p>	
Quality and Evaluation	ISQ	<p>8.1. Quality and Evaluation Handbook with inputs from all partners;</p> <p>8.2. All partners answer to the evaluation tool for the project meetings;</p> <p>8.6. All partners use the evaluation tool for the Training Activities Events (C1-C4);</p> <p>8.7. All partners compile and deliver the Training Activities Events Reports, on time;</p>	

From Table 3, we can see that the majority of performance indicators has been achieved. The exceptions were:

- PI 6.5 (Virtual project meetings' agendas sent to all partners at least 1 week before the meeting) - red
- PI 6.6. (Meeting minutes sent to all partners within 2 weeks after the meeting) – amber and
- PI 7.5. (At least, 2 project e-newsletters are released, per year, by the partnership during the project lifetime) – amber

PIs 6.5 and 6.6 were not met for any (virtual) follow up meeting, as can be seen from Table 4.

Table 4

MEETING	MEETING HELD	AGENDA SENT	MINUTE SENT	OBSERVATIONS
FUM2 - Online	08/Jun/21	08/Jun/21		Not sent. Uploaded to the drive later
		Same day		
FUM3 - Online	13/Jul/21	12/Jul/21	No minute	
			1	
FUM4 - Online	01/Oct/2021	30/Sep/21	22/Oct/2021	
		1 day	22 days	
2nd TPM - Thessaloniki	2&3/Nov/21	11/Oct/21	29/Nov/21	
		22 days	27 days	



Unfortunately, as the “before” and “after the meeting” dimensions are not evaluated for follow-up meetings, it is not possible to evaluate whereas this has been perceived as an obstacle for proper preparation of the meeting by partners. However, it was evaluated for TPMs and the results show that it has not been felt by any partner as a hindrance to the preparation and full potential of the meeting (see Graphs 6 and 8), probably because the communication (by email) works well between the consortium members.

As for PI 7.5, the second newsletter of the project is due to be published in January 2022, contrary to the initial plan of having it ready until the end of December 2021.

5 FINAL REMARKS

The second half of the first year of the SUSTAIN project confirmed the good relation between all partners. After the definition and discussion of the SUSTAIN curriculum structure, contents development is underway. Despite some aspects still needing improvement, pertaining mostly to delays in sending out some deliverables, the results seem to indicate there are the necessary conditions for these to be mitigated and to quality work being delivered.