REPUBLIC OF SLOVENIA
MINISTRY OF EDUCATION, SCIENCE AND SPORT

EUROPEAN UNION
EUROPEAN STRUCTURAL AND INVESTMENT FUNDS
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Mid-term evaluation

Title of the programme: **Sustainable and innovative construction of smart buildings**

Acronym of the programme: **TIGR4smart**

S4 priority area: **Smart buildings and home with wood chain**

Evaluator:

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1. Introduction: basic data on the project and mid-term evaluation

The project TIGR4smart (Sustainable and innovative construction of smart buildings) is aimed at the development of products and technologies, which enable the establishment of a healthy living and working indoor environment. Technologies and products are developed following three major diverse and interrelated products, including wooden construction systems (RDP1), intelligent components and smart building management (RDP2), and building envelope products (RDP3). Then each RDPs is divided in two parts, one at lower TRL (3-4) looking at the development of concepts and laboratory validation, and one at higher TRL (5-6), looking at the validation and demonstration in a relevant environment. The project is composed by 16 partners.

The documents used for the mid-term evaluation are:

- progress report, sent to this evaluator on 21.03.2019 by the Ministry of Education, Science and Sport;
- the original project proposal;
- three printed presentations that were given during the on-side evaluation on 16.04.2019. An electronic version of the presentations was also provided.

The on-site visit was held at Trimo, Prijateljeva 12, 8210 Trebnje on 16.04.2019. During the morning of the visit, the project leaders of each RDPs were able to present and summarize the major achievements in all different sections of the project. The presentations of each RDPs were very well organized, being able to present the background of the innovations, the methodologies and the major achievements. The presentations were also at the right level of

details to leave suitable time for questions and discussions. In the afternoon, it was possible to visit the demo where the project partners showed the major technologies and achievements, successfully integrated in a single and coherent house demo. The organization of the on-side visiting was perfect, as it was possible to clearly verify the results of the project and to understand how the project has been developed, how the achievements are coherent with the original proposal and how the partners have effectively collaborated. Indeed, the integration in the single demo was an outstanding performance both for showing the effective collaboration between partners and the integration of the different technologies proposed in the project.

The agenda for the on-side visit was:

10.00-10.15	Opening and company presentation, TRIMO d.o.o.
10.15- 10.30	Introduction, ZAG
10.30-11.00	Presentation of RDPs: M.SORA 1.1 in 1.2
11.00-11.50	Presentation of RDPs: L-TEK 2.1 in 2.2
11.50-12.30	Presentation of RDPs: TRIMO 3.1 in 3.2
12.30-14.00	Lunch and production visit
14.00-16.00	DEMO BUILDING Each partner presents results of RD work.
16.00	Conclusions

The structure of this mid-term evaluation report is based on the instructions received for this external assessment.

2. **Assessment of the progress made with regard to the objectives outlined in the project proposal of the programme and its research and development projects**.

The project has been developed according to the original proposal. It is quite surprising to see that, in spite of the presence of many different activities, the planned research and development projects have been realized without any major deviations. This is indeed a clear indication that the original project has been very well planned. The few minor problems that occurred during the implementation, such as those mentioned in RDP 3.2.2 and RDP 3.2.4, are extremely small in terms of numbers and relevance and, in any case, they are much lower respect what normally expected in such a large innovative project.

As reported in the original proposal, the project is aimed at the development of 6 major research and development projects, three (RDP 1.1, RDP2.1 and RDP3.1) at the TRL 3-4 and

three (RDP 1.2, RDP2.2 and RDP3.2) at the TRL 5-6. Following the progress report, the presentation during the on-site visit and the discussion during the demo visit, the major prototypes have been realized as originally planned. For example, the achieved prototypes include: machine hard wood sorting device, hybrid structural system, intelligent window of large dimensions, intelligent controller for building blocks, distributed building management system (BMS), smart lamp with adjustable light spectrum, electronic axial ventilator, safety switch with integrated meter and plug-in units, protocols for integration and analytics of IoT components, technical system for safety of people in buildings, EPS Supertherm GFP and EPS Supertherm insulation boards, family of insulation panels, polygonal glass element, etc. . Indeed, most of these technologies have been effectively integrated in the demonstration building, being also the example of plug and play residential unit originally proposed. The original plan was also targeting the realization of 6 total individual RDPs, the achievement of 3 patents and 20 innovations, 18 prototypes of products and 1 demonstration accommodation unit, and many other indexes reported in table 2.1 of the original proposal.

2.1. General observations with regard to mid-term report and visit

The progress report describes the major achievements with an initial short summary of the achieved results and then detailed descriptions of each subsections of the proposed RDPs. For each subsection, the completed activities are reported in a few paragraphs, describing the background of the innovation, the adopted methodology and the major achievements. The overall organization of the progress report is excellent, as in each subsection it is clear the motivation and background and how the program has been developed. Moreover, a few and relevant figures are reported to highlight the major achievements both in qualitative and sometimes in more quantitate ways, including figures with finite element analysis of the stress in large windows, just to report one example out of many. This organization was very useful for this evaluator to fully establish how the achieved results were precisely correlated to the original proposal. On top of this, it is also clear that the project has been developed in a coherent approach, enabling the integration of multidisciplinary technology and enriching the interactions between different partners. The progress report also includes a nice table of the program results and impacts, where the proposed indicators are at (or above) the values planned in the original proposal.

As far as the on-site visit is concerned, the organization was perfect, and it should be probably taken as an example also for future projects. Indeed, the presentations in the morning were performed only by the leaders of each RDPs, without avoiding lengthy presentations from each partner. This is excellent, as each partner tends naturally to go in a deep level of details which are not so useful in 1-day on-site visit. Instead, the RDP leader is able to shortly summarize the background, the state of the art, how the innovation is bringing some breakthroughs and the major achieved results. Moreover, in the home demo building, each partner was able to show the major results having in front the prototypes either integrated in the building or brought on a table for discussion. Even if this was possible due to

the nice and unique approach having a home demo integrating different technologies, the overall organization shall be considered a stellar achievement. On top of these positive technical aspects, I would like to highlight that the hospitality was excellent and that the whole on-site visit was extremely pleasant.

2.2. Key highlights

Most of the proposed achievements and innovations are at excellent level. I will focus here on three key highlights which stand out, based on my impression during the on-site visit and on the received documents. Of course, out of so many innovations, it was not easy to pick-up the most relevant ones, being most of them at excellent level.

The first one is Intelligent window system of large dimensions. The results were excellent not only because such dimensions are not available on the market, but also for the technology used, the methodology adopted to verify and design the whole system, both from the thermal and mechanical stress point of view.

The second one is new generation of insulation panels and the development of EPS Supertherm boards. All the results are very interesting and with very high market potentials.

The third one is the “Plug and Play” modular residential unit, very effective also in the home demo.

All the other achievements are also at very high-level. In general terms, I think that some additional effort and funding shall be provided to complete the set of innovations proposed in the project. This consideration holds for most of the innovation proposed in the project and not only on the top three key highlights previously mentioned. Instead, the ones that are still at good level but not in top tier, at least in terms of breakthrough technologies, are a couple of technologies related to the electronics side. For example, the distributed building management system (BMS) and the intelligent controllers for building components are at very good level and they can be still considered successful in the proposed project; however, it is unclear how they are breaking through the existing state of art and which market potentials they can currently targeting or plan to in the short-term future.

2.3. **Changes made to the project**

As outlined also in the progress report, there are only very marginal variations with respect to what was proposed in the original project. This is also confirmed in presentations during the on-site visit and on the progress report. Thus, it is clear that – as previously mentioned – the project was developed following closely what originally proposed. This is a major achievement, given the large size of the project. On top of this, the ability to integrate the different technologies on the home demo is an additional plus, difficult to realize given the diverse and interdisciplinary contributions involved.

3. Role of the partners in the project

During the on-site visit, I had the impression that the partners have successfully collaborated with an effective and cohesive approach. This is probably due to a proactive organization by the project coordination and the strong motivation to integrate all the different technology in a single demo. This was not easy, as RDPs were in very different fields starting from the mechanical, thermal, material and electronics ones. Moreover, both during the presentation and the face-to-face conversations in the afternoon in demo house, it was evident also the strong *enthusiasm* of the partners for the results achieved and for being able to work as a cohesive team. This is an additional positive aspect of the project.

4. Internal and external communication

Based on the impression received during the on-site visit, the internal communication activities went very well, as all the partner were able to give effective contributions to the project with an excellent knowledge of what the other partners were doing. As previously mentioned, the fact that all the partner contributions were able to collaborate in a solid cohesive group is probably also due to the positive leading role of the coordinator and the effective communication between partners.

As far the external communication is concerns, it was easy to establish excellent activities of the research partner, being focused on publishing scientific papers. For the industrial partners, there have been excellent examples on showing the technologies in fairs. However, the demonstration in terms of communication in industry associations and networks was less clear from the presented documentation, although mentioned during the on-side visit. In any case, the overall evaluation is positive also under this point of view.

5. Assessment of dissemination and exploitation of the project results in the phase TRL7-9

The progress report does not report any relevant change with respect to the original program. Looking at the results, the number of inventions and all the technologies reported in the house demo, it can be concluded that some of the proposed technologies developed up to TRL 6 have very strong potentials for the market. Moreover, some of them can be considered also above TRL 6. While there have been some conversations on how each company is planning to adopt such technologies, I was not aware of detailed plans for the industrialisation of products and plans for their marketing of the major proposed technologies. For some of them, such as those involving directly Trimo, there was a clear path and market evaluation and potential. For others, this was less clear or not completely documented. Under this perspective, I need to point out that several of the proposed innovations are of very high potential impact. Thus, I strongly encourage the companies to continue the support of such innovations, both with internal funding and pushing also for continuation of other projects; one good example is what outlined in section IV of the progress

report, where a new project is also mentioned, as a follow-up of this one. In any case, I hope R&D of each company will find additional internal funding to push the proposed innovations at the level they deserve.

6. Assessment of quality of main scientific achievements

From the scientific point of view, I feel that the technologies in RDP1 and RDP3 are the strongest one. The one reported in RDP2 are also very good, but they are more on the incremental side (from the scientific perspective) although relevant from the industrial point of view.

7. Cooperation between public and private partners

In general terms, the project has a good presence of universities partners. This presence was important to give a solid and rigorous methodology to develop the proposed innovations. Thus, the overall assessment of the synergies between public and private partners is excellent. Such approach shall be pushed also for future projects.

8. Concluding remarks

The project was developed as originally planned. It is a clear example of very successful project from many different points of views. The most relevant one is the level and quality of the proposed innovations, that will enrich the market position of the involved companies. The right combination of public research institutions and private partners was also the key enabling factor for developing ideas and innovation with rigorous methodology also from the theoretical point of view. Indeed, also from the scientific point of view, there has been an excellent progress in the research and development, with several new ideas, products and patents. The key stellar point of the project is the ability to have single demo to integrated most of the proposed innovations. This approach was very effective from many points of views, both in terms of exploitation, visibility and integration of different partners contributions. Moreover, this approach was probably also the enabling factor that pushed all the partners to work together in a very efficient way.

As a conclusion, the overall evaluation is excellent, and this project shall be taken as an example of very successful outcome of this funding initiative. I do strongly suggest the companies for additional R&D support to complete some of the proposed innovations in this project. In general terms, I also suggest the funding of future similar initiatives, as the enabling tool to increase the future competitiveness of the Slovenian industries on a local and global market scale.