EMBRYO PROJECTS: STRATEGIC CATALYST TO IMPROVE THE SCIENTIFIC RESEARCH CULTURE

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Abstract

Architecture, urbanism and design occupy a crucial role in contemporary society, having a deep impact in the definition of people's quality of life. Investigation carried out on these fields must guarantee a high level of rigor and scientific quality. CIAUD, the Research Centre in Architecture, Urbanism, Design and Ergonomics of the Lisbon School of Architecture, University of Lisbon, has designed an internal initiative aimed to improve the scientific research culture through innovative approaches, as well as to promote high-level scientific indexed publications. In the period 2021-2023, internal competitive calls for "embryo projects" were launched offering a funding of €7.500 to develop early-stage research initiatives, in exchange for the preparation of a competitive R&D application and the publication of an article indexed in ISI/Scopus indexation platforms. The applications were evaluated by external international panels ensuring that the supported projects align with the best global practices, standards, and relevant actual themes. The first results of this initiative have already shown that it not only promotes innovation and scientific excellence but also serves as a stimulus for researchers, representing a significant step toward the development of more integrated, interdisciplinary research with high social and scientific impact. To further enhance competitive R&D, CIAUD plans to maintain an annual investment in embryo-projects for 2025-2029, in order to leverage IC&DT and exploratory investigation projects for junior and senior researchers looking to start new lines of investigation and to foster new scientific research and technological development projects, boosting large-scale funding at the European level. This paper aims to share the experience and demonstrate how this initiative can provide a valid methodological approach to improve the culture of the R&D practices and support early career researchers to be competitive in open R&D calls.

Keywords: Research methodologies, R&D practices, Embryo projects, Innovative approaches.

1 INTRODUCTION: CIAUD AND THE EMBRYO-PROJECTS INITIATIVE

This paper aims to share with the scientific community the embryo-projects experimental program developed at CIAUD between 2021 and 2023.

CIAUD is a well-established Research Centre in the area of Arts and Humanities, with a focus on the role of creativity in the economy and in society. Architecture, Urbanism, Design and Ergonomics are the key disciplines of the Centre [1]. They are integrated in a transdisciplinary environment, with a view to strengthen knowledge and to promote innovation and development.

It stands out for its breadth of scope, contributing towards territorial cohesion in Portugal. Based in Lisbon, at the Lisbon School of Architecture of the *Universidade de Lisboa*, it has hubs in Viana do Castelo, Porto, Covilhã, Castelo Branco and in the Algarve [2].

Created in 2006, the Centre has grown to adjust itself to the fast changes in society. Internally, it has evolved towards a structure where the activities of researchers are centred on research groups, with guided focus and interdisciplinarity [3]. It is made up of 143 Integrated Members who define policy on science, and who elect the President and the Executive Committee of the Centre; 79 Collaborating Members, who carry out research in an active and regular way, as well as 94 PhD candidates with approved Research Projects, who carry out R&D activities in Research Groups (February, 2024). It also includes research grant holders, selected through open and competitive procedures.

The Research Centre is funded directly by Portuguese national funds through *Fundação para a Ciência e a Tecnologia* (FCT), leveraging research development from the ground, through competitive projects, with national and international funding, and diversified applied research with governments, central and municipal public administration, business sector, non-governmental organizations, and society in general.

CIAUD promotes an environment for innovation, placing creativity at the service of the community. Communication between ground research, applied research and masters' projects, PhD and post-doctoral

research add value, and dynamizes entrepreneurship while placing R&D at the service of progress and of the new generations, and responding to the constant paradigm changes and new research challenges.

Following its internal and external international evaluations, in 2018 and 2019, the Scientific Board was confronted with the need to promote internally the scientific research culture through innovative approaches, as well as to promote high-level scientific indexed publications. The increase in the number and success of applications to competitive base and applied research funding was also a priority, justifying the need to support base scientific contents, and to support the consistence of these applications. The embryo-projects program was conceived to answer these objectives.

2 METHODOLOGY: CRITERIA FOR THE EMBRYO-PROJECTS PROGRAM

The embryo-project program [4] was approved in March 2021, by CIAUD's Executive Committee, promoting a policy of competitive internal calls for CIAUD-funded research projects, financing up to € 7.500,00 per project, with the aim of supporting future national or international applications and projects.

An internal regulation defined the program's rules. The composition of the international evaluation panels was defined by the scientific board of CIAUD to the four main research lines: Architecture, Urbanism, Design and Ergonomics. The objectives for the development of 'embryo projects' by teams of CIAUD researchers were:

a) To ensure the qualified execution of the Multi-Annual Funding Program-Contract for 2020/2023, signed between FCT and CIAUD.

b) To achieve the Assembly of CIAUD Researcher's strategic objectives: to raise the internal standards of scientific demand, distinguishing excellence; to offer better support structures to the Researchers; and to promote the cross-cutting and critical dimension of the research projects and their integration in research groups, as well as the establishment of partnerships with companies, non-governmental organizations, public administration, and other universities.

c) To fulfil the objective stated in CIAUD's Strategic Guidelines for 2020/2023, according to which CIAUD's Executive Committee will annually promote calls for funding of short duration projects that allow the consolidation of a future proposal to competitive external funding.

d) To increase CIAUD's self-financing capacity for external Scientific Research and Technological Development (IC&DT) projects, as well as for ID&DT protocols with companies or the Public Administration, by supporting Researchers in the preparation of solid applications, as well as increasing indexed scientific production.

e) To support the development of innovative IC&DT projects originating from the research groups, in a high internationalization framework, as well as strengthening its cross-cutting nature and interdisciplinarity.

Embryo-projects could be submitted by integrated members, with the following eligibility criteria:

a) The Principal Investigator (PI) had to be an Integrated Member of CIAUD.

b) The projects should include in the team a minimum of 3 Integrated Researchers.

c) Each Integrated Researcher could present only one application as PI and integrate another as a participant.

d) Each PI could not benefit from more than one project simultaneously.

e) The PI of a funded embryo project could not apply in the subsequent call.

f) Each Collaborating Member could only integrate one application for an 'embryo project'.

g) Each embryo project could be presented in a single scientific area.

By the allocation of funding by CIAUD to an embryo-project, the PI and the team of Integrated CIAUD Researchers were committed to:

a) Apply, in the following year, to the FCT call for IC&DT projects in all scientific domains, or another equivalent competitive call.

b) Submit a scientific article with indexation (ISI or Scopus), or equivalent, within 6 months after the end of the 'embryo-project'.

The methodology for selecting and ranking the embryo projects was established exclusively by the Project Merit (PM) indicator and was based on the following criteria:

a) Scientific consistency of the proposal, with a weighting of 30%.

b) Scientific relevance to the discipline, with a weighting of 20%.

c) Economic and social impact, with a weighting of 20%.

d) Potential to generate a competitive application in R&D calls, with a weighting of 20%.

e) The application having resulted from a not funded application to a competitive R&D call (FCT or similar) in the previous years, with a weighting of 10%.

The evaluation was carried out by panels of independent experts, predominantly affiliated to foreign institutions, with experience and with recognized merit and competence, selected by the scientific council. These panels are made up of three effective members and one alternate member, per scientific area, appointed in accordance with the following criteria:

a) Chairman: Full Professor Fernando Moreira da Silva, former President of CIAUD, common to the panels from all scientific domains.

b) Two effective members from the following scientific fields:
   - Architecture: Professor Antonello Monaco (2021, 2022); Professor Peter Testa (2021, 2022, 2023); Professor Gleice Azambuja Elali (2023).
   - Urbanism: Professor Maria Rubert de Ventós (2021, 2022, 2023); Professor Frank Eckardt (2021, 2022, 2023).
   - Design: Professor Ken Friedman (2021); Professor Terence Love (2021, 2022, 2023); Professor Rachel Cooper (2022, 2023).
   - Ergonomics: Professor Tareq Ahram (2021, 2022); Professor Marcelo Soares (2021); Professor Waldemar Karwowski (2022); Professor Erminia Attaianese (2023); Professor Andrea Gaggioli (2023).

3 RESULTS

First call for the presentation of proposals opened on May 4, 2021, for 30 embryo projects [Table 1]. Second and third calls opened on May 2, 2022, and on June 7, 2023, respectively, for 25 and 26 embryo projects [Tables 2 and 3].

The evaluation of CIAUD's embryo project initiative and its results is still underway. Each year, projects could start at the second semester, after the internal call and external evaluation. Having a period of execution of 12 to 18 months, and one more year to complete its dissemination and application to a R&D external call, only the 2021 projects completed their cycle. The 2022 embryo projects will be evaluated at the beginning of 2025, and those of 2023 at the beginning of 2026.

3.1 The 2021 embryo projects evaluation

Focusing on the 2021 embryo projects, 36 candidates apply for a call to finance 30 projects, 28 being approved by the jury, representing an approbation rate of 78%. All the evaluations included a peer review and suggestions of the jury to the applicants. From these, 24 embryo projects were concluded, representing a success rate of 86% [Table 1].

Table 1. Embryo Projects 2021.

		call for projects	***candidate projects***	***approved projects***	***executed projects***
2021	architecture	12	12	12	10
	urbanism	7	8	5	4
	design	8	13	8	7
	ergonomics	3	3	3	3
		30	**36**	**28**	**24**

More interesting is the observation of the results of the 24 concluded projects. About 12 embryo projects (50%) published at least one ISI/Scopus article and/or a book chapter at an international editor classified as A or A+ by the *Universidade de Lisboa*, e.g. Taylor and Francis, Springer, etc., although, from these, 13% are articles and/or 42% are book chapters. At this stage, the rate of ISI/Scopus index articles within CIAUD's publication culture is yet to be stimulated.

On the opposite side, 4 projects didn't present any publication until the present date, representing a concerning unsuccess rate of 17%. Although not considered at the program regulation, other types of scientific outputs were presented, such as national books, pedagogic materials, software production, digital databases, support to PhD thesis support and catalogues. Some of these types of outputs might be considered for future versions of the program. About 58% of the 2021's embryo projects also reported paper presentations at international conferences.

On a general overview, in 2021, 7 embryo projects (29%) answered to the type of publications CIAUD's wanted to promote – ISI/Scopus article and/or a book chapter at an international editor classified as A or A+ by the *Universidade de Lisboa* –, 4 embryo projects (17%) answered to a competitive R&D call, and 3 embryo projects (13%) did both. At this stage, it might be wondered if the program hadn't fixed to high demands by targeting both high level publications and the preparation of R&D calls, proportionally to the timetable and volume of financing provided, attending to the human reality of the Centre – in a very high rate integrating researchers that are also professors, several having also administrations responsibilities.

On the opposite side, 10 embryo projects (41%), didn't answered to this type of publications neither presented a proposal for a competitive call, although several of these have considerable scientific results – revealing the need to keep promoting internally the scientific publications culture.

3.2 The 2022 embryo projects evaluation

Focusing on the 2022 embryo projects, 15 candidates apply for a call to finance 25 projects, all being approved by the jury. At this moment, CIAUD's board observed a saturation following the first-year initiative, particularly at the Urbanism scientific area, exactly the one with higher rates of undergoing base and applied R&D financed projects. From these, 14 embryo projects were concluded, representing a success rate of 93% [Table 2].

Table 2 Embryo Projects 2022.

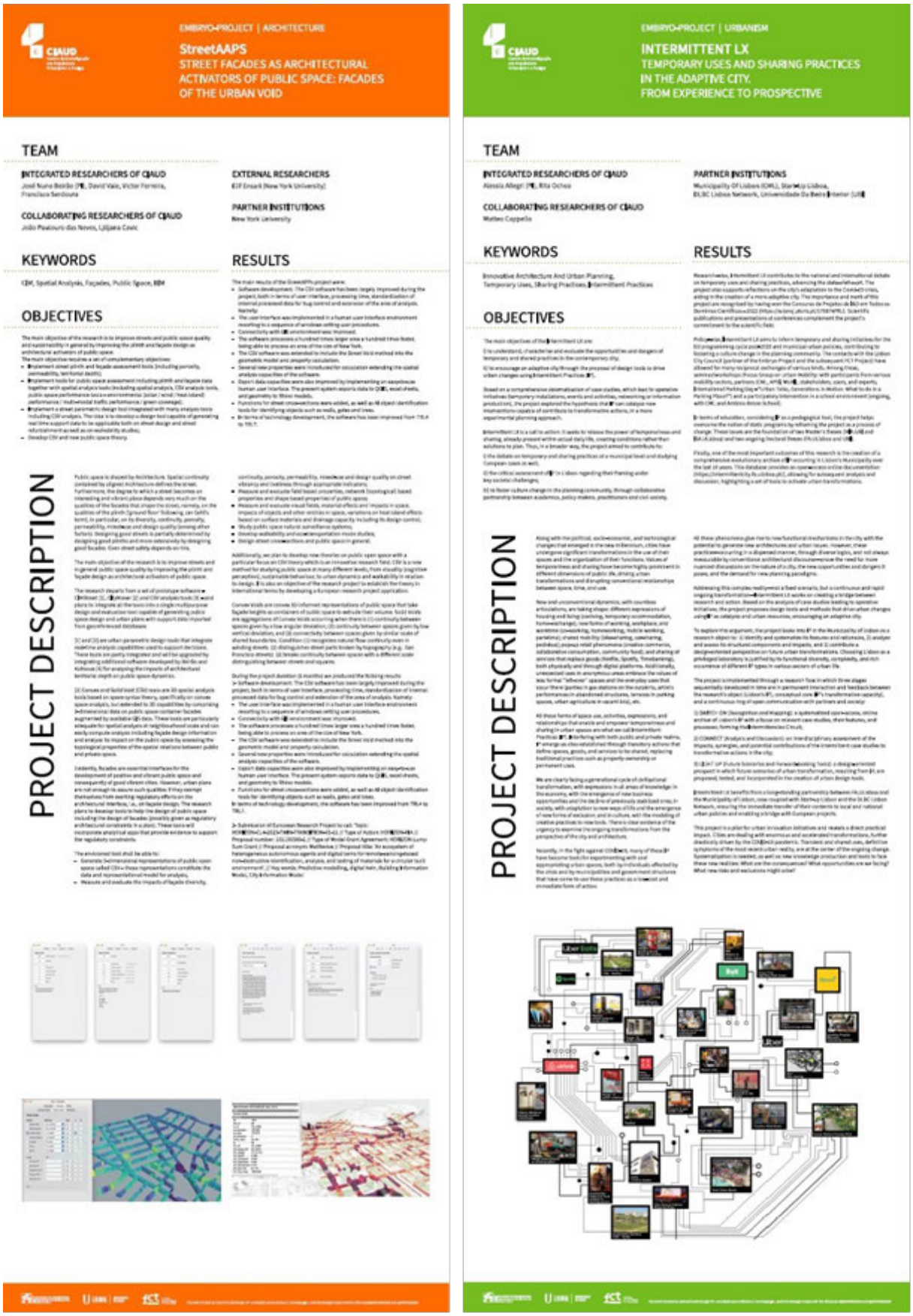
		call for projects	***candidate projects***	***approved projects***	***executed projects***
2022	architecture	10	8	8	7
	urbanism	6	0	0	0
	design	7	4	4	4
	ergonomics	2	3	3	3
		25	**15**	**15**	**14**

These embryo projects can conclude their outputs until the end of 2024, and only by 2025 it will be possible to produce a realistic evaluation. Nevertheless, still with four months of work ahead, some figures already deserve a closer observation.

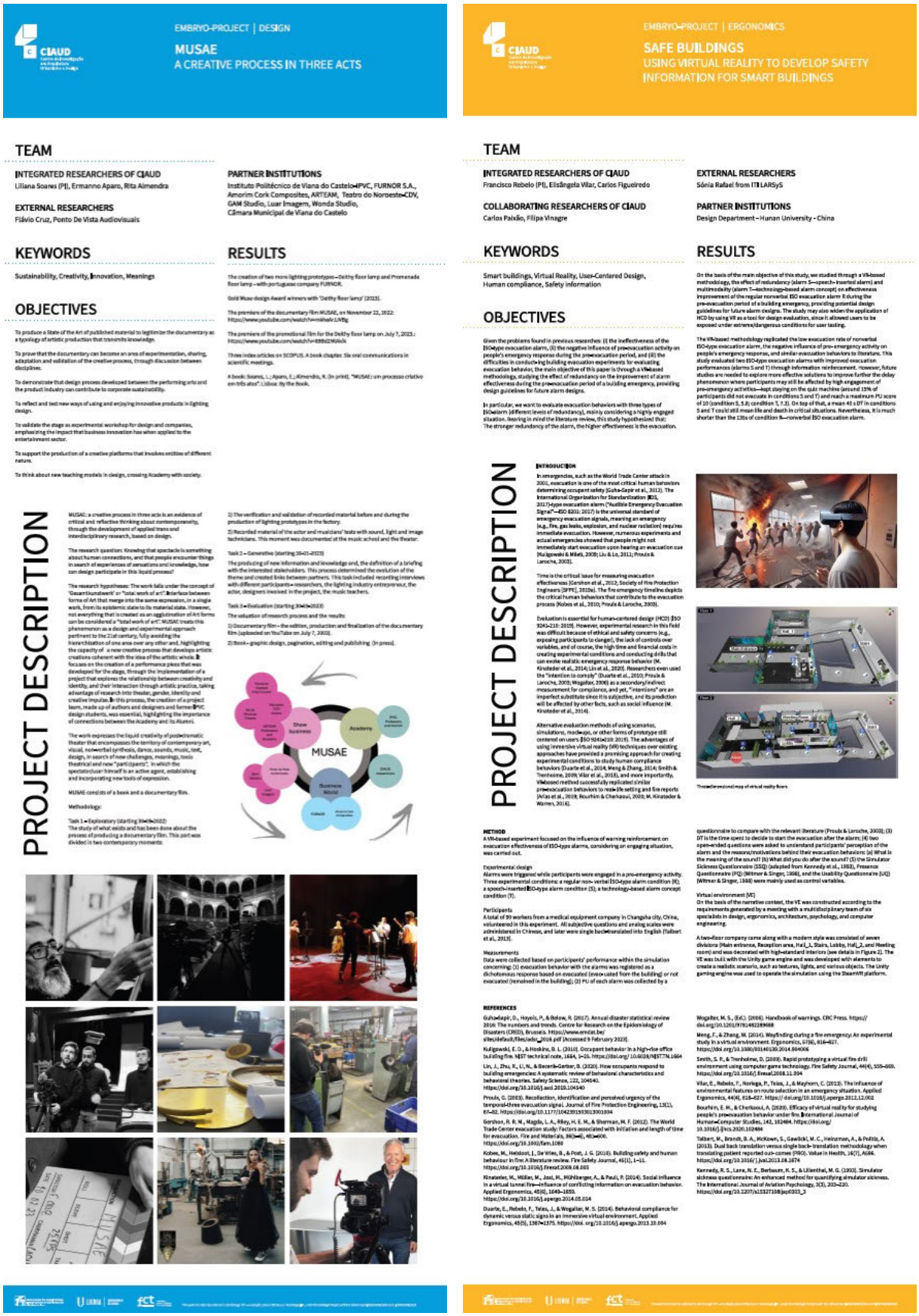
Firstly, at this stage, 21% of the embryo projects have published the type of publications CIAUD's wanted to promote – ISI/Scopus article and/or a book chapter at an international editor classified as A or A+ by the *Universidade de Lisboa* –, almost the double of 2021. The same 29% of embryo projects answered to the type of publications CIAUD's wanted to promote – also considering book chapters at an international editor classified as A or A+ by the *Universidade de Lisboa* –, revealing an increase and fulfilling one of the objectives of the program. On a closer look, this value should consider the fact that no Urbanism embryo projects are under development in the 2022 group; on the opposite side, 57% of the Architecture embryo projects don't present yet any publication, although this value can be corrected until the end of the year.

3.3 Some examples of 2021 and 2022 embryo projects

Four examples of the embryo projects are synthetically exemplified, one from each research line, representing the universe of the 38 executed in the two years.



Figures 1 and 2. Embryo projects StreetAAPS and Intermittent Lx exhibition panels, CIAUD, 2024.



Figures 3 and 4. Embryo projects Musae and Safe Buildings exhibition panels, CIAUD, 2024.

3.3.1 StreetAAPS (Architecture, 2021, PI: Professor José Nuno Beirão)

The main objective of this embryo project is to improve the quality and sustainability of streets and public spaces through the optimisation of plinth and facade design as architectural activators of public space. During the project duration, two main results were achieved:

- The improving of CSV software in terms of usability, performance, and analytical capacity, with a new user interface based on sequential windows to guide procedures. GIS connectivity was optimised for better spatial data integration. The software can now process areas 100 times larger at 100 times faster speeds, with the ability to analyse cities the size of New York. The Street Void method was integrated to extend geometric and property calculations. New spatial properties were introduced to expand the software's analytical capabilities. Export functions were enhanced, allowing data to be transferred to QGIS, Excel, and Rhino geometric models. New features include street cross-section analysis and artificial intelligence tools for identifying objects such as walls, gates, and trees. The software's technology readiness level (TRL) was raised from TRL4 to TRL7, indicating its maturity for operational applications.
- The submission of a European Research Project with the title "An ecosystem of heterogeneous autonomous agents and digital twins for remote-sensing-based non-destructive identification, analysis, and testing of materials for a circular built environment" to the call HORIZON-CL4-2023-TWIN-TRANSITION-01-11 [5].

3.3.2 Intermittent LX (Urbanism, 2021, PI: Professor Alessia Allegri)

Intermittent LX embryo project contributes to the discourse on temporary urban uses and sharing practices, advancing the state-of-the-art in these areas. The project also plays a crucial role in examining urban adaptation to the Covid-19 crisis, supporting the development of a more resilient and adaptive urban environment. The significance of this research is underlined by its success in winning an application to the FCT competitive R&D call in 2022 [6].

This recognition is further strengthened by scientific publications and presentations at conferences, which reflect the project's dedication to contributing to the scientific community. From a policy perspective, Intermittent LX seeks to influence temporary use and sharing practices within the context of the post-2020 EU programming cycle, as well as municipal urban policies. The project aims to promote a culture shift in urban planning by engaging with key stakeholders, including its partner, the Lisbon City Council (CML), which has fostered multiple forms of exchange. These collaborations have led to initiatives such as seminar-workshops (e.g., Focus Group on Urban Mobility, featuring participants from mobility sectors, CML, APSI, MUBI, and other experts and stakeholders), International Parking Day's event "Urban Talks, Generations in Motion: What to do in a Parking Place?", and a participatory intervention in a school environment (ongoing with CML and the *António Arroio School* in Lisbon). A major outcome of this research is the creation of a comprehensive, evolving archive documenting temporary urban uses in Lisbon over the past decade [7]. This database is publicly accessible online [8] and provides a valuable resource for further analysis and discussion. It also offers a set of tools designed to facilitate urban transformations.

3.3.3 MUSAE (Design, 2022, PI: Professor Liliana Soares)

Developed at the CIAUD's Viana do Castelo Hub, the MUSAE embryo project – a creative process in three acts – is an evidence of critical and reflective thinking about contemporaneity, through the development of applied trans and interdisciplinary research, based on design. The work expresses the liquid creativity of post-dramatic theatre that encompasses the territory of contemporary art, visual, non-verbal synthesis, dance, sounds, music, text, design, in search of new challenges, meanings, theatrical tools and new "participants", in which the spectator/user him/herself is an active agent, establishing and incorporating new tools of expression [9].

At this stage, the main results of the project are six oral communications in scientific meetings, three index articles on SCOPUS, and one book:

- L. Soares, E. Aparo, R. Almendra, "Designing a creative process between music, performing and visual arts and the business world", in *Advantages in Design and Digital Communication IV. Springer Series in Design Innovation* (N. Martins, and D. Brandão, eds.), pp. 336-344, Springer, 2024. [10]
- L. Soares, E. Aparo, R. Almendra, F.M. Da Silva, "Design for Systemic Lighting Products", in *Advances in Design, Music and Arts II. EIMAD 2022. Springer Series in Design and Innovation, vol 25* (D. Raposo, J. Neves, R. Silva, L. Castilho, R. Dias, eds), pp. 490–50, Springer, 2023. [11]

- L. Soares, E. Aparo, R. Almendra, F.M. Da Silva, “MUSAE: a creative process in three acts”, in *Perspectives on Design III - Research, Education and Practice. Springer Series in Design and Innovation. SSDI, volume 34* (D. Raposo et al eds.), pp. 365-376, Springer, 2024. [12]
- Soares, L.; Aparo, E.; Almendra, R. (in print). “MUSAE: um processo criativo em três atos”. Lisboa: By the Book.

3.3.4 SafeBuildings (Ergonomics, 2021, PI: Professor Francisco Rebelo)

The SafeBuildings embryo project aims to study, through a VR-based methodology, the effect of redundancy (alarm S—speech- inserted alarm) and multimodality (alarm T—technology-based alarm concept) on effectiveness improvement of the regular nonverbal ISO evacuation alarm R during the pre-evacuation period of a building emergency, providing potential design guidelines for future alarm designs. The study may also widen the application of HCD by using VR as a tool for design evaluation, since it allowed users to be exposed under extreme/dangerous conditions for user testing.

The VR-based methodology replicated the low evacuation rate of nonverbal ISO-type evacuation alarm, the negative influence of pre- emergency activity on people's emergency response, and similar evacuation behaviours to literature. This study evaluated two ISO-type evacuation alarms with improved evacuation performances (alarms S and T) through information reinforcement. However, future studies are needed to explore more effective solutions to improve further the delay phenomenon where participants may still be affected by high engagement of pre-emergency activities—kept staying on the quiz machine (around 15% of participants did not evacuate in conditions S and T) and reach a maximum PU score of 10 (condition S, 5.8; condition T, 7.3). On top of that, a mean 40 s DT in conditions S and T could still mean life and death in critical situations. Nevertheless, it is much shorter than the 135s of condition R—nonverbal ISO evacuation alarm [13]. Three publications at Springer Editor have been produced:

- Z. Wang, R. He, F. Rebelo, E. Vilar, P. Noriega, “Human interaction with virtual reality: investigating pre-evacuation efficiency in building emergency”, in *Virtual Reality, Volume 27*, pp. 1039-1050, Springer, 2023. [14]
- Z. Wang, R. He, F. Rebelo, E. Vilar, P. Noriega, J. Zeng, “A human-centered design approach: design a new evacuation alarm system for building fire emergency considering the influence of pre-emergency act.”, in *Theoretical Issues in Ergonomics Science, 25* (2), pp. 225-245, Taylor and Francis, 2023. [15]
- Z. Wang, R. He, F. Rebelo, E. Vilar, “Using virtual reality to study the effect of information redundancy on evacuation effectiveness.”, in *Human Factors and Ergonomics in Manufacturing & Service Industries. Volume 33, Issue 3*, pp. 259-271. Wiley, 2023. [16].

3.4 The 2023 embryo projects

The projects initiated in the 2023 edition present a projected completion deadline by the end of 2024, having one more year to complete their publications and application to a R&D competitive call. With this schedule, this generation of embryo projects is still under development and have not yet fully realized their anticipated outcomes – therefore couldn’t being yet evaluated by conclusive indicators.

Table 3. Embryo Projects 2023.

		call for projects	***candidate projects***	***approved projects***	***executed projects***
2023	architecture	10	12	12	11
	urbanism	6	10	10	9
	design	7	1	1	1
	ergonomics	3	3	3	3
		26	**26**	**26**	**24**

In the 2023 embryo projects generation, 26 candidates applied for a call to finance 26 projects, being all approved by the jury. From these, 24 embryo projects are under development, representing a success rate of 92% [Table 3]. Comparatively to 2022, the Urbanism scientific area recovered and presented itself to 10 embryo-projects, while, by opposition, the Design scientific area only applied to one, revealing the same saturation observed with Urbanism in 2022.

4 CONCLUSIONS

Between 2021 and 2023, the embryo projects initiative demonstrated substantial success in advancing research culture within CIAUD. The program attracted a total of 77 proposals, achieving a participation rate of 71% among the integrated researchers. Out of these submissions, 69 projects were funded, covering the key areas of Architecture, Urbanism, Design, and Ergonomics [Graphic 1].

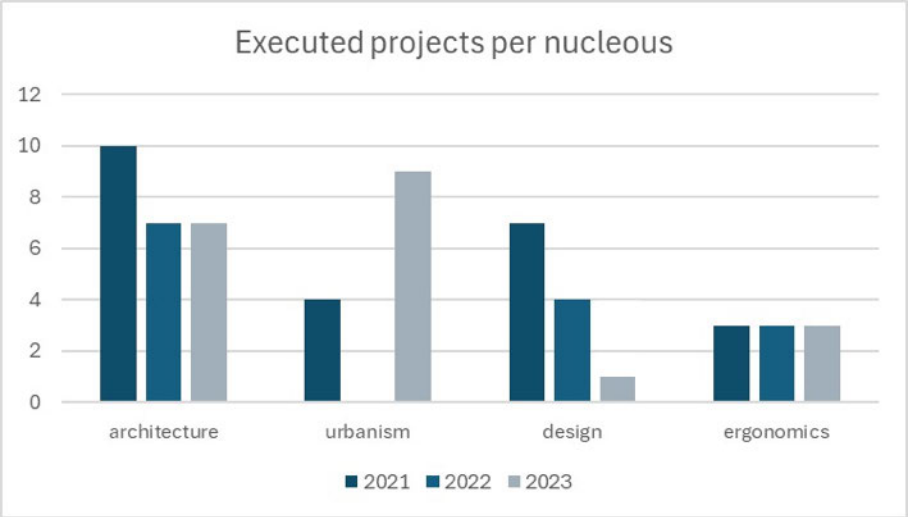


Figure 5. Executed embryo Projects, per research line, 2021, 2022 and 2023.

The embryo projects initiative has proven to be an effective strategy for enhancing the research dynamics within CIAUD. By fostering early-stage research, teamwork, new ideas, encouraging interdisciplinary collaboration, and promoting high-quality scientific publications. The program also laid a strong foundation for future success in securing competitive research funding. The initiative has not only elevated CIAUD's scientific profile but has also created valuable opportunities for researchers at all stages of their careers. As the program continues to evolve, it promises to play a critical role in advancing innovation, fostering impactful research, and strengthening CIAUD's contribution to both the national and international research landscapes.

One of the main goals of the initiative is to encourage high-quality scientific output. A significant portion of the supported projects resulted in the publication of indexed articles on platforms like ISI and Scopus or books and book chapters in equivalent international book editors such as Routledge or Springer. Still in need of further work, the growth and orientation towards these outputs highlighted the initiative's effectiveness in promoting rigorous research and improving the institution's research culture as a whole.

In terms of securing external funding, the embryo projects initiative played a crucial role in enhancing CIAUD's capacity to attract competitive research grants. Numerous projects were successfully submitted to both national and international funding bodies, including FCT (*Fundação para a Ciência e a Tecnologia*) and major European programs. This success also strengthened international collaborative networks, positioning CIAUD as a prominent player in transdisciplinary research initiatives.

A significant outcome of the initiative was its promotion of interdisciplinary collaboration. Multiple projects brought together researchers from different fields within CIAUD, facilitating cross-cutting approaches to complex problems. Moreover, many projects established valuable partnerships with private enterprises, public institutions, and non-governmental organisations, thereby increasing the economic and social impact of the research conducted.

The evaluation of the projects by international expert panels was highly positive, with strong praise for the scientific quality and innovation of the proposals. The panels' feedback consistently reflected an appreciation for the program's significant contribution to advancing research, and also the general high quality and creativity of the proposals. Moreover, researchers involved in the program emphasized that it stimulated new lines of inquiry and improved their readiness for future competitive funding opportunities.

Looking ahead, CIAUD recognizes the importance of continuing this successful initiative. Plans are already in place to extend the funding for embryo projects through 2029. This continued investment aims to support the development of new ideas and further boost scientific output and technological innovation.

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