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Deliverable D3.1 | ENTRN DEL 3.1.01/2023

Open report on the current and future situation (strengths and weaknesses) of demand and supply of RD&I infrastructure and resources within the E^{3}UDRES^2 alliance | Date 30-Oct-2023

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Terms, definitions and abbreviated terms

List of project participants

Participant organisation name	Country
Polytechnic Institute of Setúbal (IPS)	PT
St. Pölten University of Applied Sciences (STPUAS)	AT
Hungarian University of Agriculture and Life Sciences (MATE)	HU
Politehnica University of Timisoara (UPT)	RO
University Colleges Leuven Limburg (UCLL)	BE
Vidzeme University of Applied Sciences (ViA)	LV

Abbreviated terms

AI – Artificial Intelligence

E^3UDRES^2 – Engaged European Entrepreneurial University as Driver for European Smart and Sustainable Regions

EU – European Union

HEI – Higher Education Institution

HR – Human Resources

R&D&I – Research, Development and Innovation

WP – Work Package

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Executive Summary

Work Package 3 of the E^{3}UDRES^2 alliance has the goal of mapping research infrastructure within partner institutions and developing a strategy for effective sharing. The package includes the analysis of internal research requirements and the assessment of infrastructural strengths and weaknesses.

Two different methods were utilized for data collection and analysis: a questionnaire survey for Task 3.1 and a self-assessment based on predefined criteria for Task 3.2.

The survey, which received a 31% response rate, provided insights into researchers' needs, infrastructure use, and satisfaction. The analysis highlighted areas that require improvement, including laboratory equipment and data centres.

The distribution of research areas across institutions suggests the need for strategic resource allocation and collaboration to maximize research potential.

Overall, the alliance has valuable infrastructure and professional expertise. However, common obstacles, financial challenges, and human resource issues need addressing.

Researchers have a strong demand for external infrastructure use and are open to international cooperation based on infrastructure sharing. Effective communication and dissemination of alliance initiatives are crucial to ensure all researchers are informed and actively participate.

In conclusion, the consortium's strengths in infrastructure and collaboration potential are promising. Addressing weaknesses and enhancing communication will further bolster the alliance's research capabilities and reach.

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1 Overview the WP3 workflow (M1-12)

1.1 Objectives and tasks

As stated in the Grant Agreement, the Work Package 3 is responsible for mapping out the research infrastructure operated and available by the partners of the E³UDRES² alliance. Furthermore, it is tasked with developing an effective and sustainable sharing strategy. The success of consortium-level development and innovation projects relies heavily on effective RD&I cooperation and resource sharing. Therefore, WP3 uses various methods and tools to help collaborating organisations position themselves advantageously in the R&D market and exploit the potential of RD&I cooperation.

To begin with, the strategic planning process focused on analysing internal research needs (demand) and RD&I infrastructure. This will help identify infrastructural strengths and weaknesses at institutional and alliance levels. In the project's first year, the following objectives were achieved and tasks were carried out as per the Grant Agreement.

Objectives achieved by M12:

- Forecasting researchers' needs and demand for R&D&I infrastructure and resources over a strategic (5-year) time horizon.
- Mapping of the partner institutions' own (directly exploitable) R&D&I infrastructure and resources, identification of the individual strengths and weaknesses.

Tasks done by M12:

- Task 3.1 – Forecasting researchers' demand for RD&I resources on a sample representing the scientific human resources of partner organisations.
    - As part of this task, WP3 analysed the requirements and infrastructure needs of the research staff, which are critical factors in determining the use of research infrastructure at E³UDRES². To gather the necessary data for our analysis, a questionnaire survey was employed. The information collected through this survey allowed us to perform a qualitative analysis of the current needs and demands of researchers, as well as their expectations for the future.

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- Task 3.2 – Map the RD&I resources and infrastructures directly available at each institution, identifying relative strengths and weaknesses.
    - The mapping of internal research infrastructure allows the Work Package to identify the relative strengths and weaknesses of each partner in the alliance, which will serve as a starting point for strategic planning. It is imperative to gain a comprehensive understanding of the infrastructural situation of the alliance partners, and this exercise will provide us with the necessary insights. By interpreting the strengths and weaknesses of each partner within the context of future cooperation and division of labour, an effective collaboration and allocation of resources can be ensured.

1.2 WP coordination and resources

WP3 is coordinated by the Hungarian University of Agriculture and Life Sciences (MATE), but it involves the participation of team members from all partner organisations. The workgroup is characterised by collaborative planning, data collection, and process supervision, with the evaluation and interpretation of results being carried out by MATE team members, taking into account feedback from group members. The primary work platform for the workgroup is online meetings held on the MS Teams platform, with the frequency of these meetings determined by the intensity of the work, typically occurring bi-weekly or monthly.

The most crucial resource of the work package is human capital, which the partners fully provide. Figure 1. displays the breakdown of WP members (number of individuals) by institution.

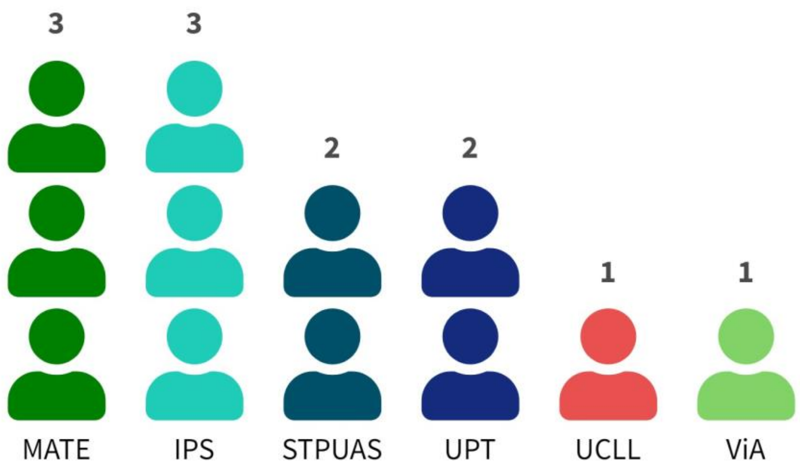

Figure 1. – The distribution of WP3-members by HEI (number of individuals)

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Other resources necessary for the operation of the work package (computers, analytical software and other questionnaire survey applications) are fully provided by the partner institutions and project management.

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2 Methodology

Two different methodological approaches were used to implement Task 3.1 and Task 3.2. For Task 3.1, a questionnaire survey was the main tool for data collection, and a quantitative forecasting methodology based on basic statistical processing was used for analysis. On the other hand, an common Excel workbook was used for data collection in Task 3.2, and the infrastructural strengths and weaknesses were evaluated through self-assessment using predefined criteria.

This chapter briefly describes these two different methodological approaches.

2.1 Questionnaire survey and qualitative forecasting

The questionnaire and the survey

An online questionnaire consisting of four panels was used to assess researchers' needs and demand for infrastructure. The questionnaire was developed during the work package meetings and finalised at the second GnA, ExB and WP meeting in St. Pölten.

The questionnaire consisted of the following panels:

- background variables, “demographics” of respondents [gender, age group, affiliation, primary professional role, membership in research centres, working experience in years];
- research interests [research field, research topic, research experience in years, degree, number of publications];
- personal needs regarding research infrastructure [personal requirements, internal/external infrastructure use, interest in international collaboration, regularly used instruments and tools];
- satisfaction with research infrastructure [laboratory equipment, field research stations, data and computing centres, desktops and notebooks for personal use, analytical software].

Each partner university reviewed and approved the online questionnaire with its own data protection officer and then sent it out to members of the target group (researchers involved in infrastructure-intensive research) via internal communication channels (email lists, departmental and institutional circulars, newsletters). Before sending out the survey, the working group set a target of a 20% response rate as a minimum representative threshold.

Table 1. displays the number of targeted researchers and actual respondents, along with corresponding response rates. Figure 2. compares the distribution of the target population and sample by institution.

Table 1. – Survey target group and sample size by HEI

HEI	Responses (sample)	Target group total	Ratio
IPS	116	504	23%
MATE	66	269	25%
STPUAS	17	111	15%
UCLL	65	107	61%
UPT	237	615	39%
ViA	19	51	37%
Total	**520**	**1 657**	**31%**

The response rate exceeded the expected 20% in total.The data collection for STPUAs commenced later than anticipated, as we had to address GDPR concerns within the institution. Consequently, we were only able to attain a response rate of 15 percent. Nonetheless, it's worth mentioning that obtaining a 15 percent response rate in an online questionnaire survey is not atypical or inadequate.

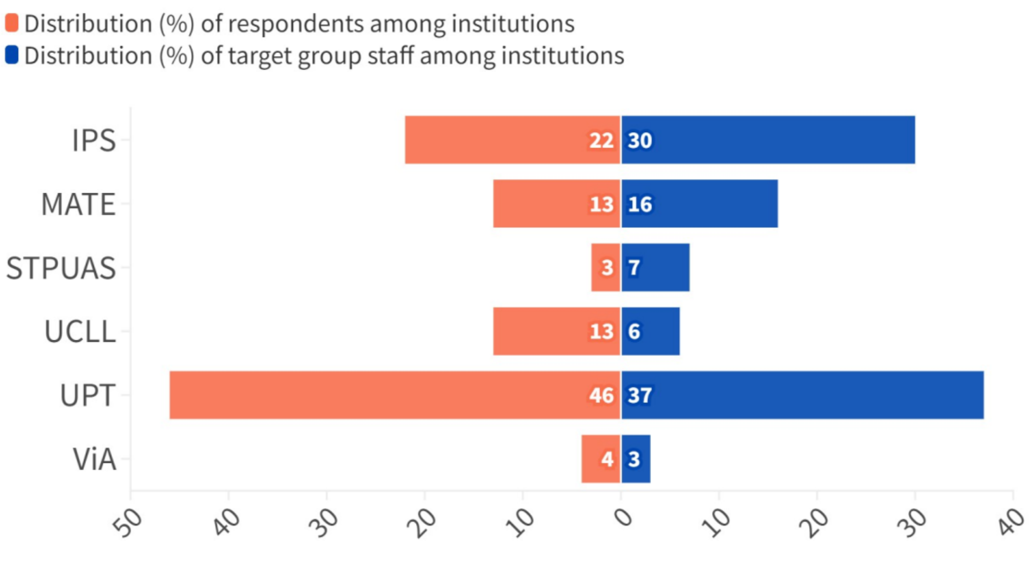

Figure 2. – Distribution (%) of the respondents and target group and the sample by HEI

The distribution of respondents by institution broadly follows the distribution of the target group. There are, of course, minor differences, but these do not pose a significant problem for the evaluation of the questionnaire.

Analysis and qualitative forecasting

The questionnaire's closed-ended questions are assessed using simple distribution ratios and averages, and represented graphically. The focus is on presenting and interpreting differences between institutions and research topics.

Open-ended responses will mostly be evaluated using a compact tool called word cloud analysis, which limits the scope for exploring dissimilarities between institutions and disciplines as respondents are free to provide optional and free-word responses.

The qualitative forecast is formulated by aggregating respondents' needs, future plans, and satisfaction regarding research infrastructure.

2.2 Mapping and analysing the institutional research infrastructure items

Data collection and database development

The analysis of the internal research infrastructure started with the institutional mapping and inventory of the infrastructure items. Each institution carried out the mapping independently, but using a standardised template prepared by IPS, with a macro extension, in Excel (.xlsx) format. The Excel spreadsheet consisted of two worksheets, the "NewRegistration" worksheet for recording and saving the data for each item (Figure 3.) and the "Database" worksheet as the actual dataset where these data were recorded (Figure 4.).

The excel template was used to record key identification and information variables for each infrastructure element. These variables are 'Name of the Partner', 'Organization', 'Department', 'Laboratory', 'Lab or Equipment Manager', 'Manager's e-mail address', 'Equipment', 'Brand and Model', 'Acquisition Year', 'Info and Specs'. With these variables, both internal and external stakeholders will easily search and browse the infrastructure items.

Following the institutional data collection, the institutional datasets were also saved separately in the WP3 work package files of the EMDESK[1] interface of the project and then merged into a single Excel file, which is also available for the whole project team at EMDESK.

[1] EMDESK is a web-based application that focuses on project and financial management, specifically designed for EU projects. See https://www.emdesk.com/

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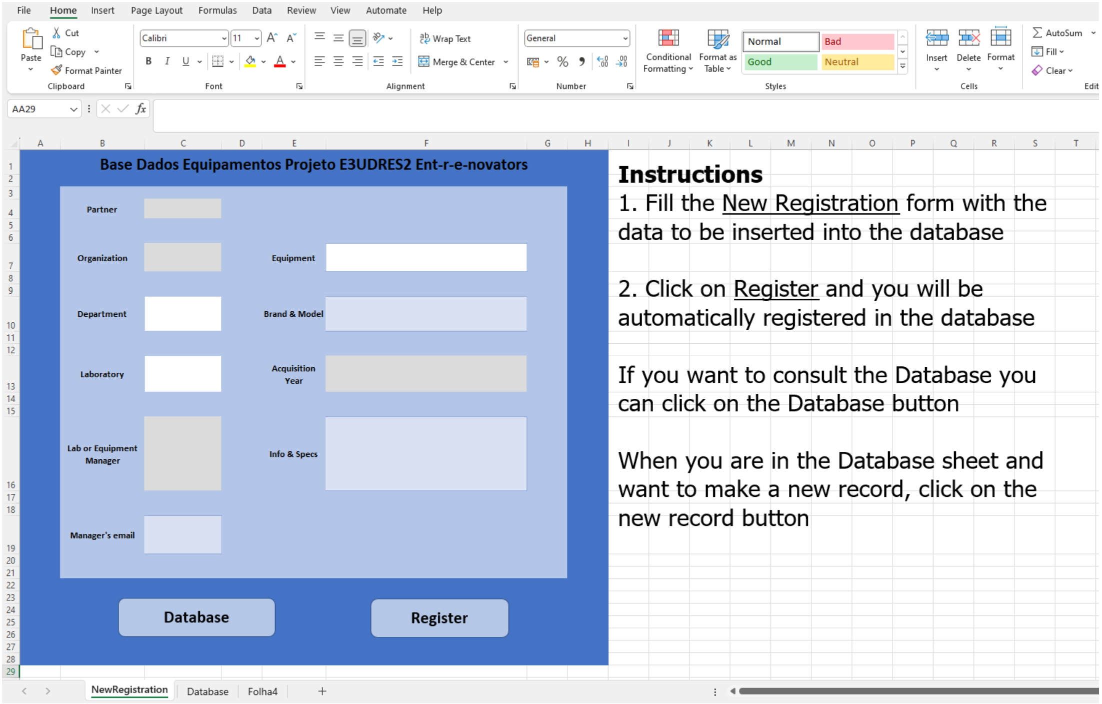

Figure 3. – Screenshots of the Excel template used: "NewRegistration" worksheet

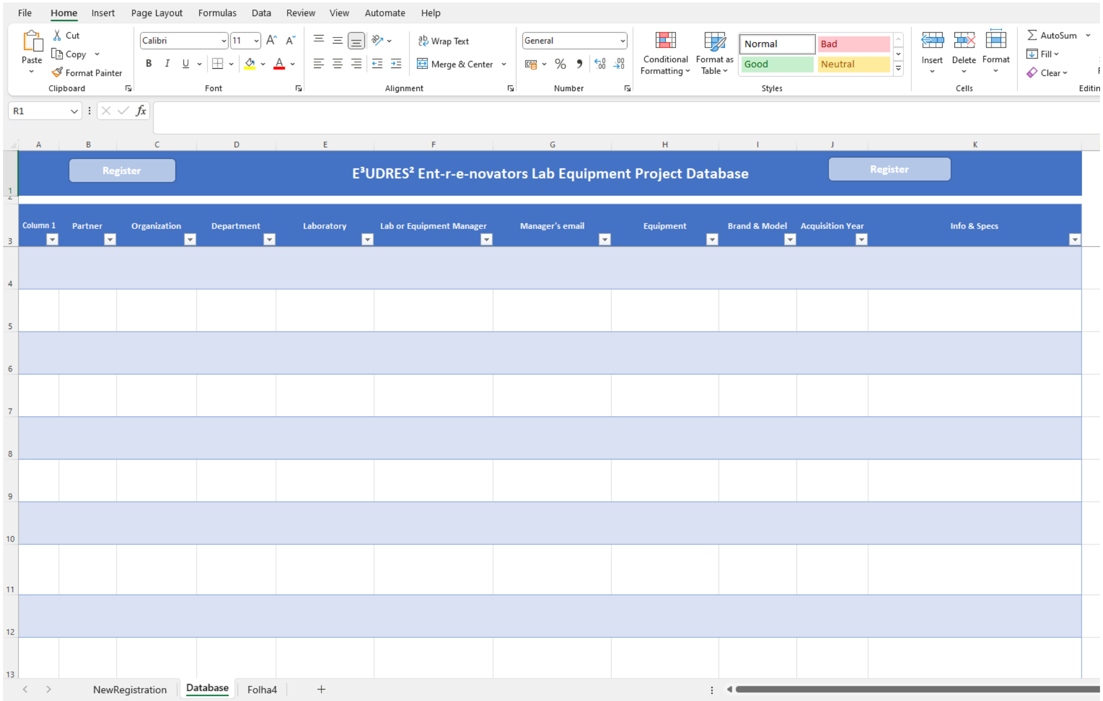

Figure 4. – Screenshots of the Excel template used: "Database" worksheet

The single database is not yet publicly disseminated, it is only shared with the project team and the institutional managers responsible for the area. Later it will be used as input for Task 3.4 (Designing sharing network interfaces, redundancy mitigation, and synergy plans) and Deliverable 3.4 (Sharing network interface and synergy key points plan).

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Analysis of strengths and weaknesses

The analysis of strengths and weaknesses was based on input from the infrastructure database. The methodology involved a self-assessment by each institution, using a template with standard evaluation criteria prepared by MATE. The template was distributed as an online Excel spreadsheet to the work package members, who then coordinated the self-evaluation process at their institution. This resulted in a list of strengths and weaknesses for all six institutions, which was created using the template shown in Figure 5. The figure displays the evaluation criteria and the fact that the evaluation had to associate the related infrastructure elements with some of the strengths and weaknesses.

	A	B	C
1	Please list **3-5 characteristics** of your Institution's technology/infrastructure based on the following aspects.		
2	Please, also **give examples** of items that proves the given characteristics if it is possible.		
3	Bear in mind that strenghts and weaknesses are **internal** capabilities and shortcomings.		
4	**Thank you for your cooperation!**		
5			
6	**Strengths (resource or capacity your institution can/could use effectively)**	**Please fill in the following section**	
7	Characteristics (below you can read ideas for brainstorming)	Characteristics	Item(s) that support the given characteristics
8	**Unique infrastructure** that cannot be found anywhere else		
9	**Advanced technology** found within your Institution		
10	**Marketable features** that any of the instrastucture holds (infrastructure that can be utilized in the competitive sector)		
11	Infrastructure/items that serve **strategic position** for the institution within the country or the EU		
12	Features of a given that contribute to **positive reputation** for the Institution		
13	New and/or well-maintained infrastructure with **growth potential**		
14	Characteristics in which the Institute is an **expert**		
15			
16	**Weaknesses (limitation, fault, or shortcoming in your institution)**	**Please fill in the following section**	
17	Characteristics (below you can read ideas for brainstorming)	Characteristics	Item(s) that support the given characteristics
18	**Outdated technologies**		
19	Features that the Institution's infrastructure **lacks of**		
20	**Limited resources**		
21	Any **uncertainties** the institution faces regarding technolgy		
22	Anything that results in **pressure** regarding the infrastucture		
23	**Technological problems** the Institution faces		
24	**Technological barriers** the Institution faces		

IPS | STPUAS | UPT | UCLL | ViA | MATE

Figure 5. – Self-assessment tool for the analysis of infrastructural strengths and weaknesses (institutional level)

MATE used the self-assessment results to summarize and evaluate the strengths and weaknesses of each institution at the consortium level, identifying key strengths and areas for improvement. The results and findings of the questionnaire survey were also taken into consideration during the evaluation process.

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3 Analysis of survey results

3.1 Sample characteristics, background variables

Prior to presenting the findings, a brief overview of the sample characteristics will be provided, comprising the distribution of background variables. The survey was completed by 520 participants and their institutional distribution has already been presented in section 2.1. The response rate of the 520 respondents exceeds the previously set 20% threshold, and the sample size is also above the sufficient sample size threshold of 313 calculated using standard statistical procedure[2].

The respondents are equally distributed in terms of gender, with approximately 51% being male and 46% being female. The remaining 3% either identify themselves as other or choose not to specify their gender. Figure 6 demonstrates the age distribution of both men and women. Out of the total sample, the middle age group (35-54 years old) comprises a majority of 60%, with the rest being evenly divided between those younger than 35 and those older than 54. The sample also includes 2 respondents aged 65 and over, as well as 2 respondents aged 24 and under. It is noteworthy that as the age decreases, the overrepresentation of men disappears and the proportion of women becomes higher, so the sample reflecting well the evolution of gender equality in European higher education over the past decades.

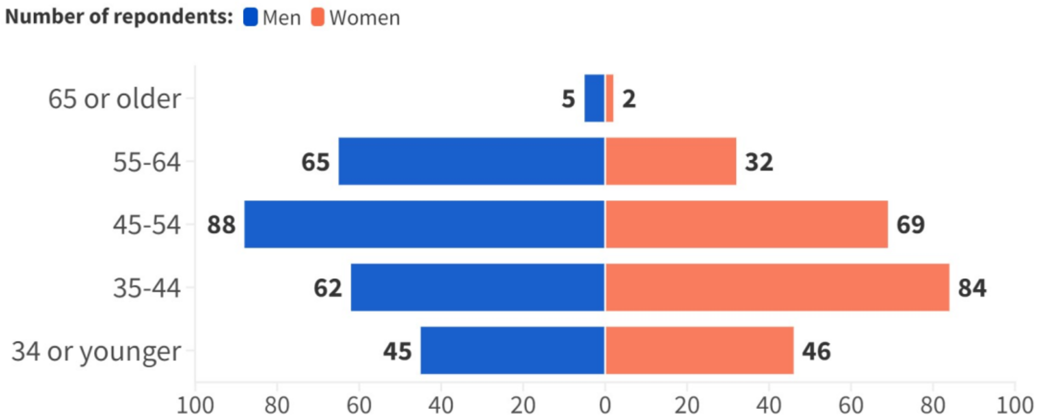

Figure 6. – Age distribution by gender3

[2] https://www.calculator.net/sample-size-calculator.html?type=1&cl=95&ci=5&pp=50&ps=1657&x=Calculate

[3] Note: Out of the 15 respondents who did not identify as male or female, six were under the age of 44, three were between the ages of 45 and 64, and six chose not to disclose their age.

Professional role, degree and experience

The majority of respondents (71.2%) work as full-time employees in their institution. A more significant question is what respondents consider to be their primary role in their workplace. Three-quarters of respondents (75.1%) identified teaching as their primary role, while one-fifth (20.1%) identified scientific research as their primary role. The remaining ~5% are shared by management/leadership (2.1%), technical support (0.9%), administration (1.1%) and other/unspecified (0.7%) roles. The intertwining of educational and research roles is also illustrated by the fact that most respondents (66.4%) are members of a research centre at their institutions.

67% of respondents have a PhD or equivalent degree. The proportions by institution are shown in Figure 7.

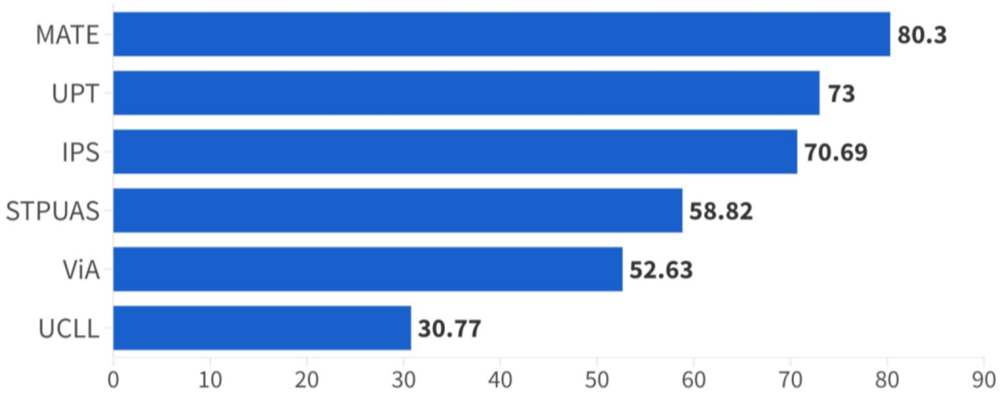

Figure 7. – Proportion (%) of PhD degree holders in the sample by institutes

3.2 Analysis of research interests

Given its importance, the research areas and research topics of the respondents are analysed in this separate subsection.

Table 2. – Number of respondents from different research field branches by HEIs

Research field branch	IPS	MATE	STPUAS	UCLL	UPT	ViA	TOTAL
Engineering	45	1	1	7	164	5	**223**
Computer Sciences and AI	22	3	14	8	51	7	**105**
Applied Life Sciences and Agriculture	23	36	4	17	18	2	**100**
Economics, Business and Management	21	33	2	10	16	7	**89**
Social Sciences and Arts	21	14	3	31	10	6	**85**
Natural Sciences and Mathematics	15	8	2	7	38	0	**70**
Geography, Earth and Environmental Science	10	8	1	3	35	1	**58**

Notes: (i) multiple choice between research field branches was available in the survey. (ii) The shade of green represents the proportion of respondents belonging to a discipline within a given HEI (darker shade = higher proportion)

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Based on the sample data, Table 2 summarises the research field branches that carry the highest relative weight in the partner universities. It reveals that all universities are involved in almost all research areas to some extent. However, notable variations exist in each branch's relative weight across different institutions.

- "Engineering" is the primary area of research at IPS and UPT, and also has a high relative weight at ViA.
- "Computer Sciences and AI" is a priority area for STPUAS and ViA, and also has a high relative weight at UPT and IPS.
- "Applied Life Sciences and Agriculture" is a priority area for MATE, and also a high relative weight at UCLL and IPS.
- "Economics, Business and Management" is of primary importance for MATE and ViA, but is also significant in UCLL and IPS research.
- "Social Sciences and Arts" is a priority in the UCLL and ViA portfolios, while it also has a significant relative weight at IPS and MATE.
- "Natural Sciences and Mathematics" does not play a primary role in any institutions, with medium-high relative weights for UPT, IPS, MATE and UCLL.
- "Geography, Earth and Environmental sciences" is not a priority at any institution. It has a medium relative weight at UPT and MATE.

It is important to note that the above list does not suggest that any institution should be ignored when developing research infrastructure for a particular research area.

3.2.1 Cross-reference and correspondence-check with D2.1

In September 2023, the Entrenovators project's Work Package 2 released the report titled "Report on E³UDRES² alliance R&I landscape after two years of collaboration" with the code D2.1. The report analyzed the alliance's formalized research themes, expertise backed by publication performance, and research collaborations. We have compared our own results with the "Topics" and "Expertise" areas from the D2.1 report for validation and a more comprehensive overall picture.

Topics

In D2.1 report, three thematic areas of E³UDRES² were analyzed. The two most relevant dimensions among them are the current Research Networks and the future focus areas. Currently, there are three Research Networks in operation - Wellbeing and Active Ageing, Circular Economy and Human Contribution to Artificial Intelligence. Additionally, four new Future Focus Areas have

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been identified: Health, Wellbeing and Social Inclusion for Regions, Digital Solutions & (Applied) Deep Tech Regions, Resilient Economy & Innovation for Regions, and Creative Industries for Regions.

The interactive graphs below show the linkages of these themes to the Research Areas represented by our own sample, and through the Research Areas, to the universities of the consortium:

- https://public.flourish.studio/visualisation/15479371/ (existing networks, see Figure 8);
- https://public.flourish.studio/visualisation/15479692/ (new focus areas, see Figure 9).

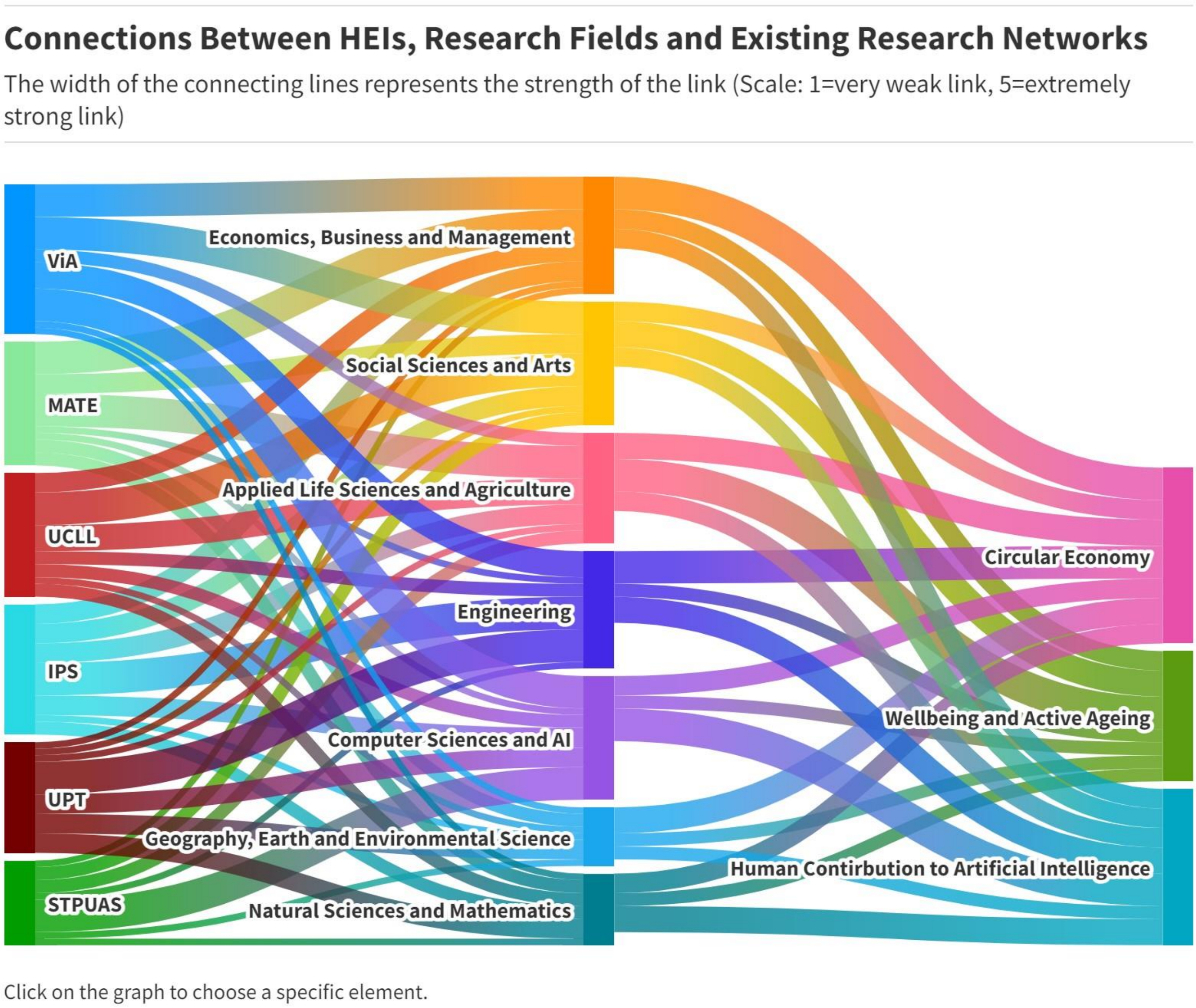

Figure 8. – Screenshot of interactive graph: Connection between HEIs, research fields and E²UDRES³ Research Networks

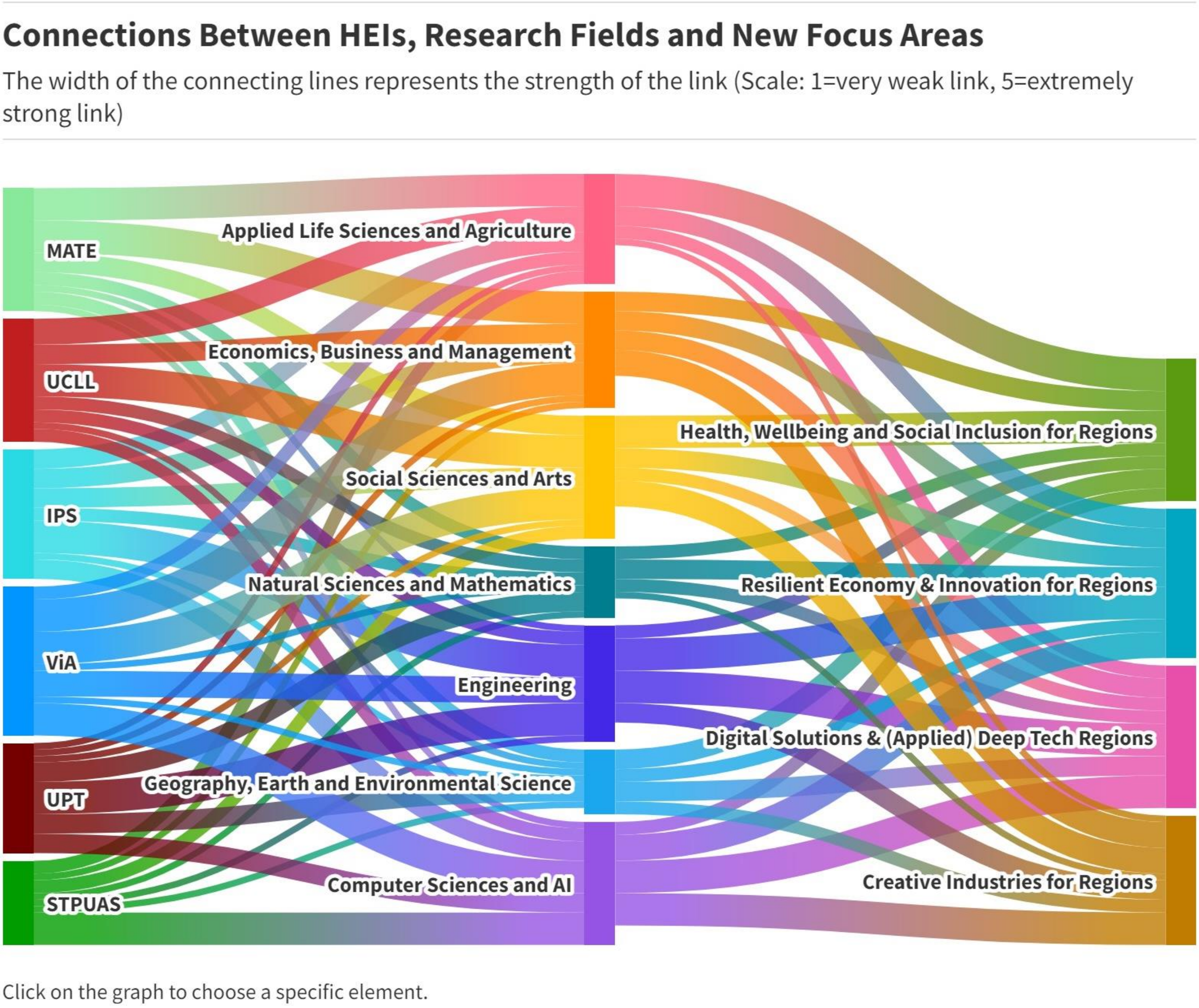

Figure 9. – Screenshot of interactive graph: Connection between HEIs, research fields and E²UDRES³ New Focus Areas

The graphs show that both current research networks and future focus areas have a significant demand for the areas of expertise covered by our sample. However, it is also clear from the D2.1 report that the participation of researchers in these research networks falls far short of the potential.

For reasons of space, we will not go into it here, but a similar significant connectivity is found in the E³UDRES² Open Innovation Hubs[4] launched in spring 2023.

Expertise

As a part of D2.1, a thorough SciVal publication survey was conducted to determine the research areas in which researchers from E³UDRES² institutions have published in Scopus-indexed journals

[4] For more details on Open Innovation Hubs, visit: https://eudres.eu/eins

on an international level. The survey results indicate that the university association's researchers have achieved commendable scientific results on a global scale, with significant publications in the following research areas (the percentage of publications in relation to the total publications is mentioned in brackets).

- Engineering (29,5%)
- Agriculture and Biological Sciences (22,4%)
- Computer Science (18,6%)
- Environmental Science (15,7%)
- Material Science (12,5%)
- Social Science (12,1%)

This list shows a very high similarity with the research areas covered by our own sample, which confirms the relevance of the areas we have identified and studied.

3.3 Satisfaction with the research infrastructure

The satisfaction of respondents with the research infrastructure was analyzed across seven different categories of infrastructure, as shown in Table 3. It is important to note that this analysis is not an objective assessment of the infrastructure of each institution. Rather, it is an assessment of the extent to which the current infrastructure meets the subjective expectations of the institution's researchers. This analysis helps identify which institutions and categories of infrastructure need improvement.

Table 3. – Satisfaction with different infrastructure categories by institutes

HEI	Laboratory equipment	Field research equipment/station	Data and computing centre	Desktops and notebooks	Analytical, scientific or engineering software	Digital and traditional Libraries	Online access to scientific journals	Total
IPS	2.65	2.37	2.42	2.41	2.53	3.33	3.67	2.77
MATE	3.04	2.69	2.90	3.40	3.19	3.77	3.52	3.21
STPUAS	3.86	3.15	3.86	3.88	3.75	3.81	3.71	3.72
UCLL	3.23	3.26	3.39	4.00	3.49	3.84	3.41	3.52
UPT	3.33	3.07	3.31	3.62	3.28	3.79	3.95	3.48
ViA	3.71	3.00	2.85	3.33	2.73	3.53	3.44	3.23
Total	**3.17**	**2.89**	**3.07**	**3.39**	**3.13**	**3.69**	**3.74**	**3.30**

Notes: (i) Respondents were asked to indicate their satisfaction on a Likert scale, where 1 = inadequate, 5 = very good. (ii) The table shows the average of responses by institution and by infrastructure category. (iii) The shade of green represents the proportion of respondents belonging to a discipline within a given HEI (darker shade = higher proportion)

In general, STPUAS has by far the highest satisfaction among the consortium partners in almost all categories (the only exception is the provision of computers and notebooks, where UCLL researchers have the highest satisfaction). UCLL and UPT are in second place in the satisfaction ranking with almost equal average scores, followed by ViA and MATE, also with close scores. IPS has the lowest average satisfaction score of all three, indicating a significant need for improvement.

The visual representation of the satisfaction results can be found at:

https://public.flourish.studio/visualisation/15451724/ (see Figure 10 and 11)

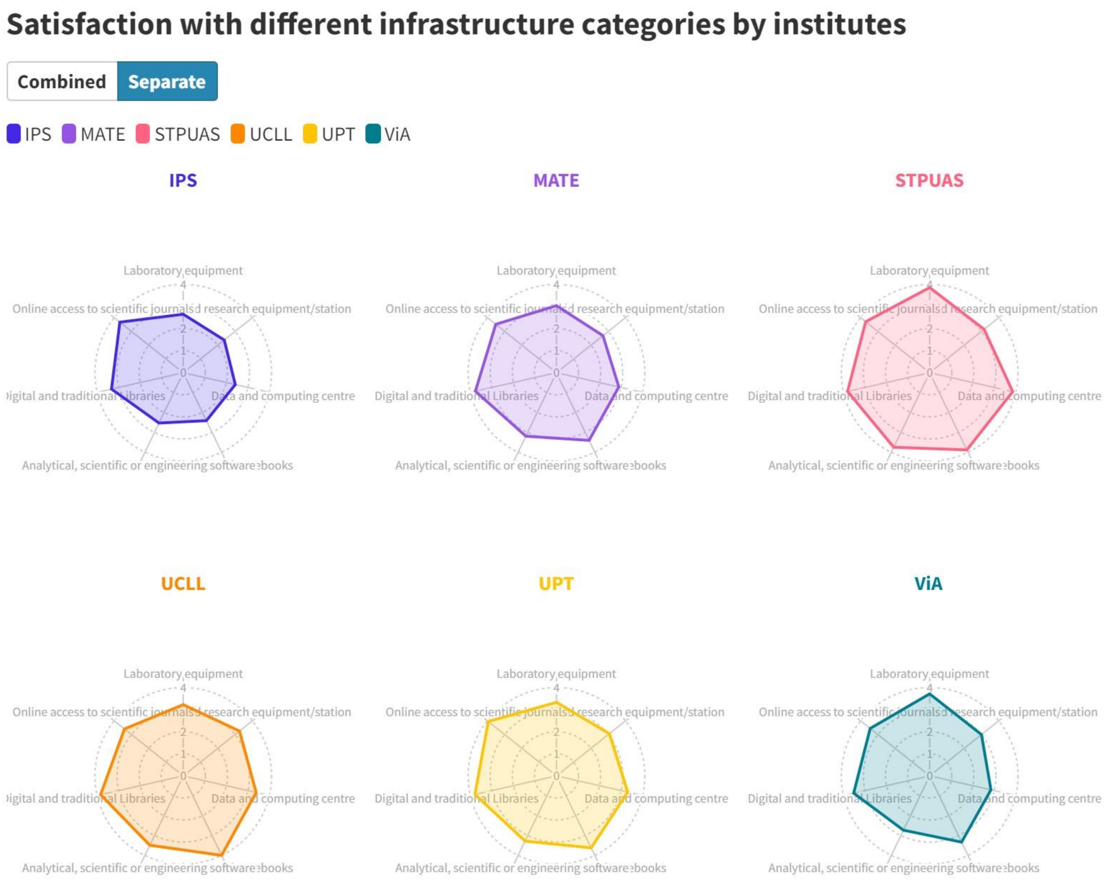

Figure 10. – Screenshot of interactive graph: Satisfaction with different infrastructure categories by institutes (separated)

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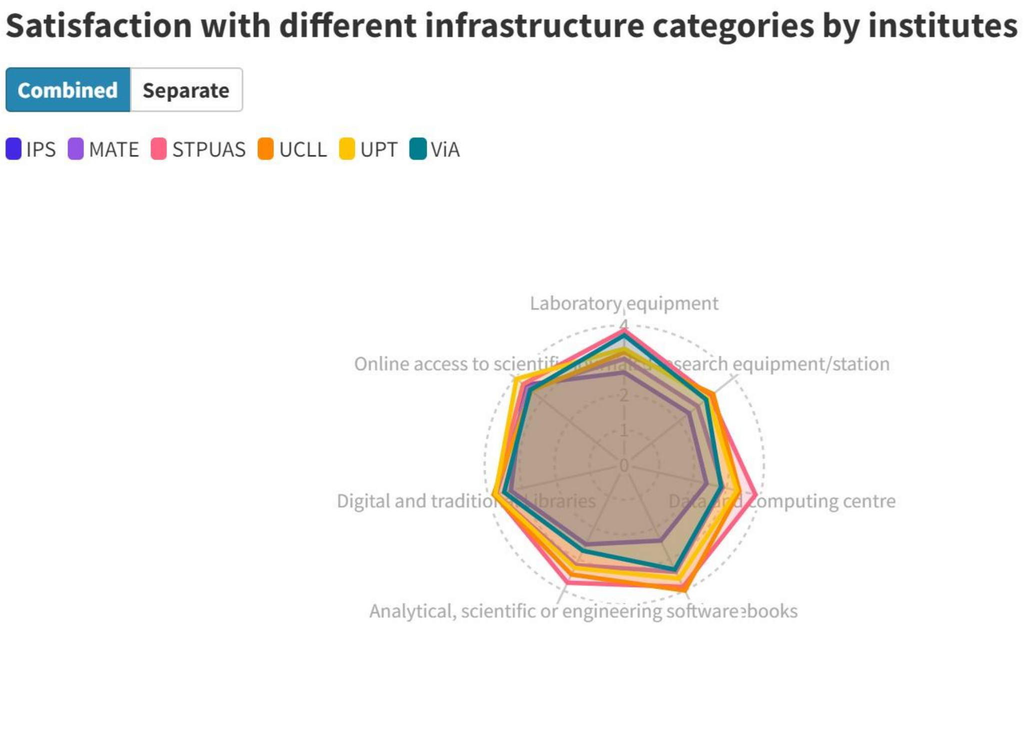

Figure 11. – Screenshot of interactive graph: Satisfaction with different infrastructure categories by institutes (combined)

Based on the table, we can draw the following conclusions:

- Access to online full-text databases and journals, as well as library services, are already meeting the staff expectations, and hence, do not require any significant improvements.
- However, the institutional infrastructure for field research equipment/station is not meeting staff expectations, and therefore, there is a strong demand for infrastructure improvements at all institutions.
- Data centers and computing capacity also have considerable potential for improvement. The current STPUAS solutions have an excellent average satisfaction rate, so it can be a best-practice model for the consurtiumconsortium.
- ViA could be a good example, alongside STPUAS, in the field of laboratory equipment.
- IPS respondents are significantly dissatisfied with laboratory equipment, desktops and notebooks, and research support software. With higher averages, the situation is similar for MATE, although computer access is not a major problem there.

Table 4 presents a comparison of various research fields. This table also highlights that Field Research Equipment requires the most improvement, followed by Data and Computing Centers, Research Support Software, and Laboratory Equipment. Considering the research fields, Geography, Earth, and Environmental Sciences enjoy the highest level of satisfaction, with no pressing need for improvement. The other research areas are quite similar, showing no significant differences.

Table 4. – Satisfaction with different infrastructure categories by research field branches

Research filed branch	Laboratory equipment	Field research equipment/ station	Data and computing centre	Desktops and notebooks	Analytical, scientific or engineering software	Digital and traditional libraries	Online access to scientific journals	Total
Engineering	3.18	2.86	3.14	3.42	3.14	3.69	3.96	3.34
Computer Sciences and AI	3.27	2.80	3.16	3.43	3.22	3.56	3.60	3.29
Applied Life Sciences and Agriculture	3.20	2.84	3.08	3.33	3.17	3.77	3.76	3.31
Economics, Business and Management	2.90	2.82	2.82	3.31	3.10	3.81	3.61	3.20
Social Sciences and Arts	3.19	2.94	3.05	3.41	3.05	3.61	3.50	3.25
Natural Sciences and Mathematics	3.22	2.96	3.18	3.36	3.09	3.48	3.55	3.26
Geography, Earth and Environmental Science	3.43	3.27	3.48	3.52	3.32	3.96	4.07	3.58
Total	**3.20**	**2.93**	**3.13**	**3.40**	**3.16**	**3.70**	**3.72**	**3.32**

Notes: (i) Respondents were asked to indicate their satisfaction on a Likert scale, where 1 = inadequate, 5 = very good. (ii) The table shows the average of responses by institution and by infrastructure category. (iii) The shade of green represents the proportion of respondents belonging to a discipline within a given HEI (darker shade = higher proportion)

3.3.1 Cross-reference and correspondence-check with D2.2

At this point, we refer again to a WP2 report entitled "1st R&I survey report: internal scientific community", D2.2. It presents the results of a survey of a sample of 245 people to identify research activities. One of the sections of the survey (3.2.2, Table 2) deals with the level of satisfaction of researchers with certain elements of the R&I framework conditions, including the infrastructure. In that survey, the mean of respondents' satisfaction was 3.24, which is very close to our mean of 3.32. In addition, the institutional differences shown in Table 2 of the D2.2 report are almost identical to the differences measured in our own survey (see Table 4). So, again, our averages are reliable, at least in line with the results of another sample survey conducted by WP2.

3.4 Analysis of researcher's personal demand

Researcher satisfaction levels alone cannot describe their needs. Therefore, we will separately examine issues related to the use of research infrastructure and attitudes towards future research collaboration.

3.4.1 Percentage of daily use of various categories of infrastructure

The questionnaire inquired about the usage of research infrastructure. It asked respondents what research infrastructure elements are necessary for daily research activities. The frequency of daily use of each infrastructure category by institution is presented in Table 5.

Table 5. – Percentage (%) of respondents using different categories of infrastructure on a daily basis /by institutions/

HEI	Laboratory equipment	Field research station / equipment	Data and computing centre	Desktops and notebooks for workplace use	Analytical, scientific or engineering software	Digital and traditional libraries	Online access to scientific journal articles
IPS	37.93	23.28	39.66	66.38	50.86	46.55	77.59
MATE	24.24	33.33	42.42	83.33	53.03	65.15	84.85
STPUAS	11.76	5.88	52.94	100.00	82.35	88.24	100.00
UCLL	13.85	15.38	16.92	86.15	40.00	53.85	75.38
UPT	70.46	31.65	29.54	63.29	66.24	49.79	76.79
ViA	5.26	26.32	21.05	57.89	63.16	68.42	84.21
Consortium	**45.96**	**26.92**	**32.31**	**70.38**	**58.27**	**53.46**	**78.85**

Note: multiple choice was available

For both the consortium and individual institutions, the most commonly used research resources are online full-text databases (79%) and computers (70%). However, it is interesting to note that some respondents did not mention desktop and notebook computers as their daily research tools. This can be explained by several factors, including the widespread use of personal computers for home office work, the sufficient capacity and use of standard non-research office computers for research purposes, and the fact that computers are considered basic infrastructure and therefore not worth mentioning.

Research support software (58%) and library services (53%) are also frequently used tools for research support. However, there are significant differences in usage between institutions. In both cases, STPUAS stands out, with over 80% of researchers utilizing these categories. The use of software is below 50% among researchers at UCLL, while the use of library services is below 50% at IPS and UPT.

It's important to note the use of laboratory equipment, which is commonly used daily by almost half of the respondents. However, a significant proportion of this is linked to UPT researchers (70%). Nearly forty percent of IPS researchers and about a quarter of MATE respondents also use laboratory equipment in their work. Conversely, only a small fraction of respondents at the other three institutions require laboratory equipment.

Frequent use of data and computing centers is common among 32% of respondents. STPUAS is the most intensive user (52%), followed by MATE (42%) and IPS (40%). The category is least used by UCLL (16%).

Let's now discuss field research tools, which are the least frequently used category. Only one quarter of the total sample reported using these tools on a daily basis. STPUAS researchers barely use them (6%), whereas the other institutions have significantly higher proportions, with between a quarter and a third of respondents indicating daily use of these tools.

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In Table 6 the frequency of use of each infrastructure category is presented by research areas. We do not repeat the previous interpretations, but instead, concentrate on the differences among research fields that are not clearly visible in the Table 5.

Table 6. – Percentage of researchers using different categories of infrastructure on a daily basis /by research field branches/

HEI	Laboratory equipment	Field research station / equipment	Data and computing centre	Desktops and notebooks for workplace use	Analytical, scientific or engineering software	Digital and traditional libraries	Online access to scientific journal articles
Engineering	72.20	34.08	29.15	67.71	71.30	46.64	74.44
Computer Sciences and AI	44.76	23.81	50.48	81.90	70.48	50.48	79.05
Applied Life Sciences and Agriculture	47.00	42.00	37.00	74.00	55.00	51.00	85.00
Economics, Business and Management	11.76	11.76	29.41	77.65	55.29	71.76	91.76
Social Sciences and Arts	6.74	14.61	21.35	73.03	37.08	67.42	83.15
Natural Sciences and Mathematics	70.00	17.14	38.57	75.71	64.29	61.43	87.14
Geography, Earth and Environmental Sciences	65.52	34.48	27.59	68.97	68.97	51.72	81.03
Consortium	**45.96**	**26.92**	**32.31**	**70.38**	**58.27**	**53.46**	**78.85**

There are significant differences between the types of research equipment used by researchers across different disciplines. Laboratory equipment is predominantly used by researchers in Engineering, Natural Sciences, Geography, Earth and Environmental Sciences. However, it is interesting to note that in Economics, Business and Management, almost 12 percent of researchers also use laboratory equipment. In Social Sciences and Arts, the usage rate is of course lower.

Another unexpected result is that only ~50% of researchers in Computer Science and AI rely on data and computing centers.

The largest user of research support software is Engineering, Computer Sciences and AI. Surprisingly, in Social Sciences and Arts, only slightly over a third of researchers use this type of software for their research, which is a low proportion given the nature of the field. Indeed, modern social science research very often employs quantitative (sociometrics, cross-sectional multivariate statistics, etc) and qualitative (e.g. content analysis, text mining, q-method) methods that require software support. The appropriate target software (e.g. SPSS, nVivo, etc.) is also available. One explanation for the low rate may be that there is a stronger tradition of social science research based on case studies, in-depth interviews and focus groups in the participating institutions. Demand for single infrastructure elements (currently in use).

Respondents were given the opportunity to give a free-word answer to indicate the infrastructure elements they use regularly in their work. Responses were received from 481 researchers. Aggregating the free-word responses is not an easy task and the methods chosen were word cloud

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analysis, simple word statistical analysis and qualitative evaluation. The word cloud for the currently used research infrastructure is presented in Figure 12.

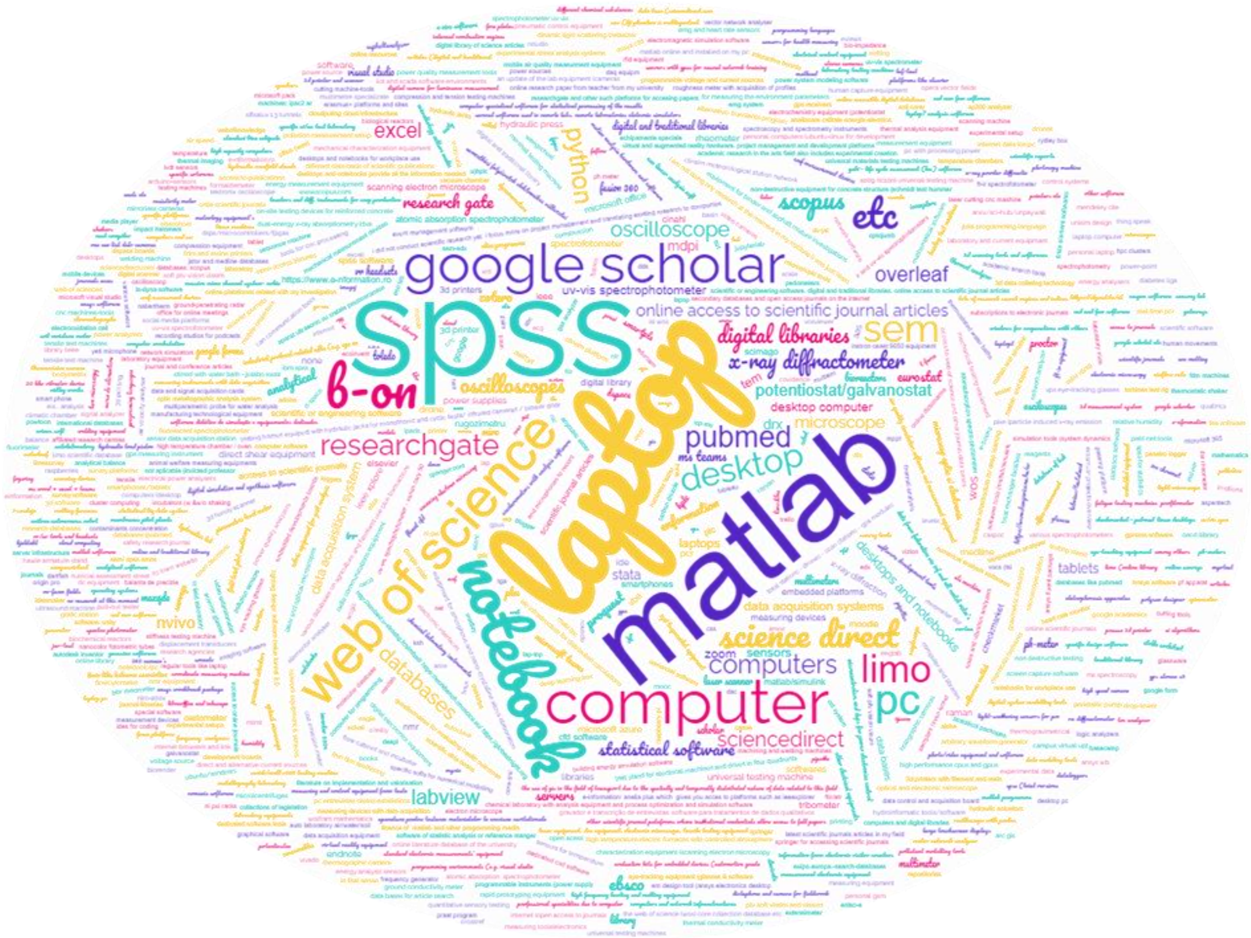

Figure 12. – Instruments, tools, equipments or platforms regularly used in research – Wordcloud

The researchers' responses mention the words laptop, notebook or computer a total of 55 times. Among the software used to support quantitative research, SPSS is mentioned 33 times and MATLAB 28 times. Additionally, Google Scholar, Web of Science, and b-on are online libraries and scientific full-text databases that are mentioned more than 10 times each. The responses for IPS and MATE are almost entirely similar to the full sample, with the exception that ScienceDirect appears in the latter's list of online databases instead of Web of Science.

Among the 17 STPUAS respondents, Overleaf was the most frequently mentioned tool. Overleaf is an online collaboration service and writing system that is specifically tailored to creating, editing, and sharing mathematical and scientific documents.

Researchers at UCLL utilize multiple research support software including SPSS, a statistical analysis tool used for quantitative data, LIMO, an online library and scientific database application and NVivo, a specialized software for qualitative data analysis that allows researchers to analyze complex data sets and uncover patterns and insights.

At UPT, MATLAB is the most commonly mentioned tool, followed by computers and the Web of Science database. Engineering measurement tools such as oscilloscopes and X-ray diffractometers, as well as programming languages like Python, receive more attention at this institution than at others.

Out of the nine ViA respondents, a majority of them reported using online libraries and full-text databases for their research needs. Additionally, SPSS was mentioned as a commonly used statistical software tool among the respondents.

According to the research field analysis, respondents mentioned a high number of infrastructure elements, with statistical software being the most commonly repeated answer (10-20 times). This indicates that MATLAB is the dominant software in Engineering, Computer Science, and Natural Sciences, while SPSS is the most frequently mentioned software in other fields.

3.4.2 Demand for infrastructure elements (currently not available but to be used in the near future)

The questionnaire included an open question asking researchers about any equipment or asset they need in the near future that is not currently available at their institution.

Out of all the respondents, 221 (42.5%) chose not to answer the question. Another 18 (3.5%) stated that they did not require additional research tools at the moment. This means that nearly half of the respondents either couldn't or didn't want to answer the question about their future needs. The answers were widely dispersed, with no emerging patterns at the consortium or institution level. The majority of the responses were quite specific since the most frequently mentioned tools were less than five in number.

3.5 Use of external infrastructure and openness to international collaborations

3.5.1 Current use of external infrastructure in research

In this section, we analysed researchers' frequency of use of external infrastructure. According to Figure 13, around 43% of the participants in the study rely solely or primarily on resources within their institution. However, a high proportion of researchers, 42.5%, partly use external infrastructure. Another 14.6% exclusively or mostly use external tools and resources for their research. Overall, more than half of the respondents use external infrastructure to some extent in

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their research activities. These results indicate that there is a demand and a research culture and practice in partner institutions to use external research infrastructure.

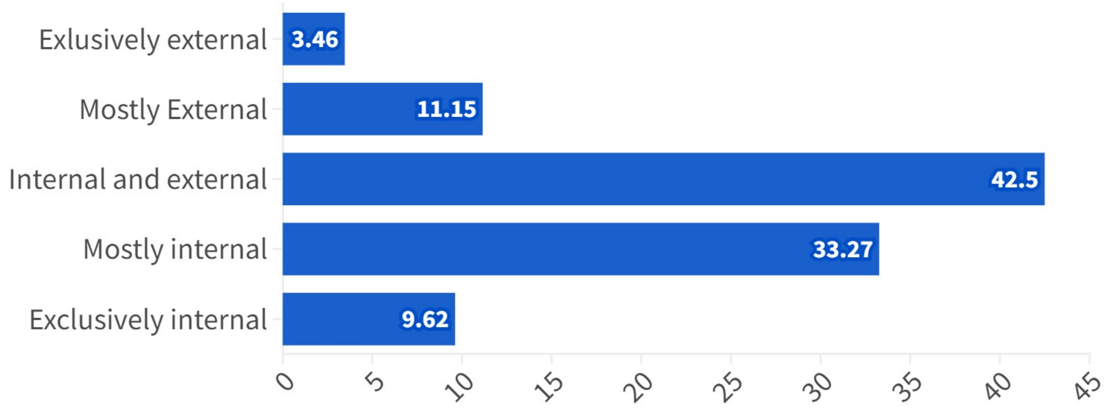

Figure 13. – Distribution (%) of reliance on internal and external infrastructure (%) among respondents

The proportions by institution are shown in Figure 14.

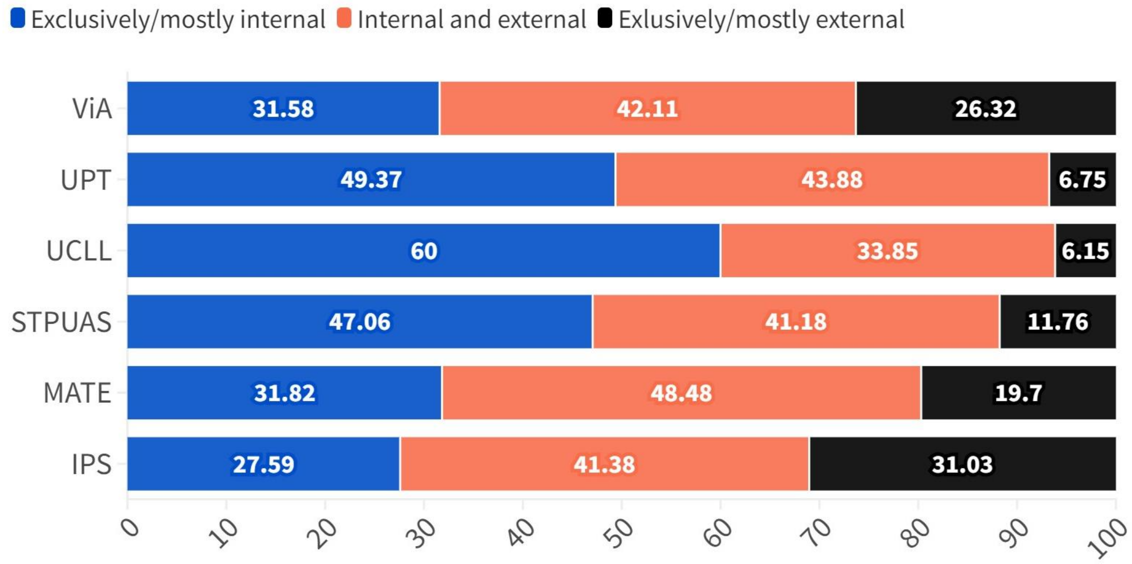

Figure 14. – Distribution (%) of reliance on internal and external infrastructure by institution

In all institutions except for UCLL, more than 50% of researchers use external resources to some extent. Among the respondents, UPT and UCLL have the lowest proportion of researchers who use only or mainly external infrastructure. On the other hand, IPS and ViA have the highest demand for external resources. Sharing infrastructure between institutions can help meet the needs of researchers in these institutions the most. To summarize, there is a significant internal demand for infrastructure sharing among partner institutions.

In Figure 15, a breakdown by research field is presented. It is evident that the STEM (Science, Technology, Engineering, and Mathematics) fields tend to use external infrastructure slightly less compared to the fields of economics, management, and social sciences.

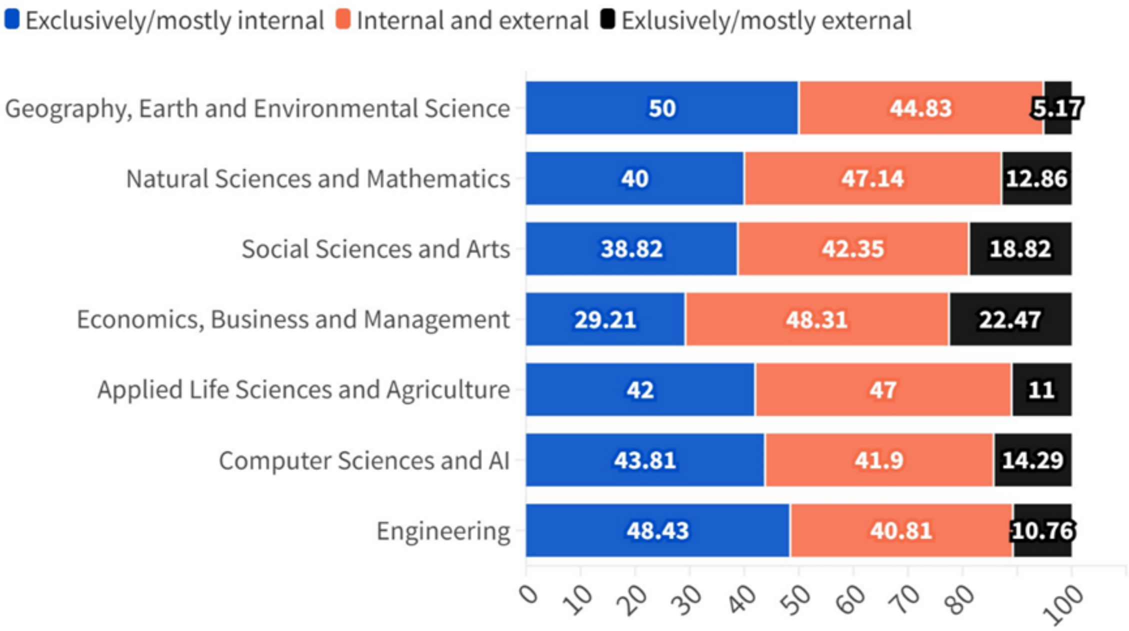

Figure 15. – Distribution of reliance on internal and external infrastructure (%) by research field

3.5.2 Interest in infrastructure-sharing cooperation within the E³UDRES² alliance

Regarding international research collaboration based on infrastructure sharing, researchers were asked the following question: “If you would have the possiblity to gain access to the research infrastructures of other E³UDRES² partner institutions, would you be interested in conducting your research as part of an international team?". The answers to this question are summarised in Figure 16.

The graph speaks for itself: less than four percent of researchers reject international cooperation based on infrastructure sharing at the consortium level. Three quarters of researchers are willing to participate in this type of collaboration, while the remaining 20 percent answered “Maybe I will become interested in the foreseeable future”. This indicates a strong interest from researchers for the infrastructure sharing and research collaboration strategy envisaged under the Entrenovators project, both currently and in the future.

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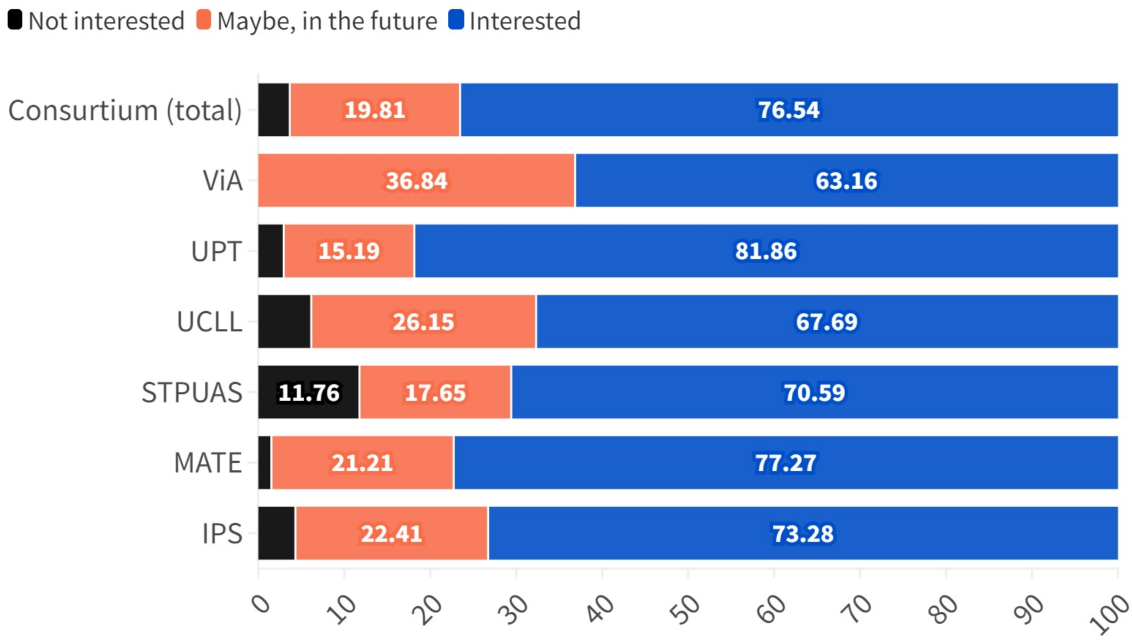

Figure 16. – Interest in international cooperation among respondents (%)

It is important to know how much information researchers have about the cooperation initiatives that takes place in their field. To assess this, we asked a question to the respondents: "Does your organisation have any initiatives to ensure external researchers' access to research infrastructures?" This question is interesting because the E³UDRES² alliance and its projects are considered such initiatives, and it can be said that all participating institutions have initiatives in place. Figure 17 presents the respondents' perceptions.

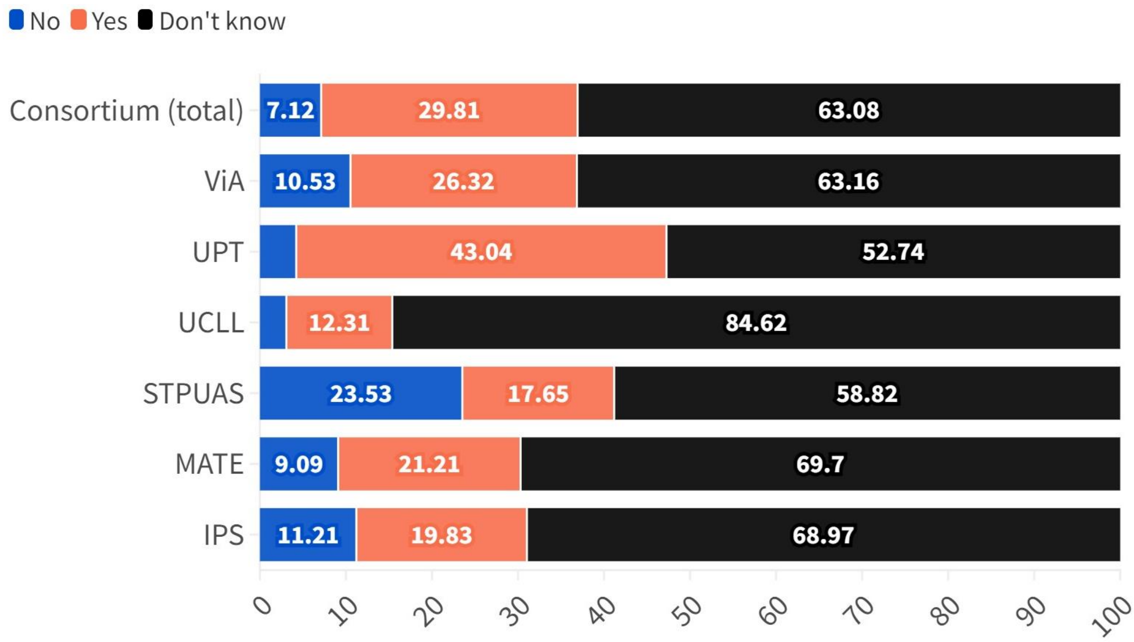

Figure 17. – Is there any research infrastructure sharing initiative at the institution? - Repondents' perception (% of all respondents)

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7% of all respondents answered that there was no infrastructure sharing initiative at their institution, which is a quite low proportion. However, it is concerning that the majority of respondents (over 60%) are unaware of the initiatives, especially at the consortium level. Among this group, UPT has the most informed respondents, while UCLL has the least informed respondents. It is essential to improve this situation by actively communicating and disseminating the E^3UDRES^2 projects to make sure everyone is informed.

4 Analysis of infrastructural datasets

This section provides a summary of the infrastructure strengths and weaknesses of each institution based on their self-assessment. The methodology section has already presented the self-assessment criteria and template. Here, we present a textual interpretation of the results.

Also a very important result of the analysis is the aggregated dataset of research infrastructure items. The anonymized[5] spreadsheet is available at:

https://e.pcloud.link/publink/show?code=XZvpssZ52954CRMbY0vm69kd7vuyYAhGmjy.

For the full Excel spreadsheet, please use "download" → "direct download" options.

4.1 IPS

The main strengths of IPS include well-equipped laboratories. Their most remarkable special equipment consists of biological testing equipment; cutting-edge technologies in automation and robotics; 3D printing of biomaterials, carbon fiber and metal; special designed machine for two-axis fatigue testing; climatic chambers for ageing testing.

IPS's exceptional facilities are as follows:

- Lu Ban workshop (industrial automation and robotics lab in collaboration with the Government of the Chinese province of Tianjin) – several companies signed the Lu Ban collaboration protocol, with an impact on social communication.
- Mechanical testing laboratories (durability/fatigue, wear, stress, strain, vibrations).
- IPS has important laboratories dedicated to structuring issues for the future, such as Additive manufacturing laboratory (3D printing materials and technologies); Marine ecosystems laboratory (several companies develop their economic activity in the estuary of the Sado and Mira rivers benefit from collaboration with IPS), as well as Mobility laboratory.
- A320 flight simulator.
- Sense&Motion: Pain and Movement Research Lab.
- Sport Sciences Lab.
- Advanced Vocal Function Laboratory.

[5] Sensitive data including "Lab or Equipment Manager", "Manager's email", "Info & Specs" are deleted from the public dataset

- COVID Lab (During Covid pandemic IPS was helping population with Covid tests).
- Logistics lab (certified lab for COVID analysis).

Their relationships are diverse, since IPS collaborates with external companies, institutions and individuals. IPS cooperates with external companies in Lu Ban Workshop collaboration protocols, water analysis, while pilots use the flight simulator; athletes benefit from the analysis of human movement in order to analyse their pain and increase sports performance, besides, various professionals (singers, actors, teachers, etc.) can get assistance by voice analysis. Assessment of physical and mechanical behaviour of materials for organizations of public and private sectors. Furthermore, IPS assess physical and mechanical behaviour of materials for organizations of public and private sectors.

Some of their work have been developed with external companies and research results covering the following topics: Seismic Engineering, Marine ecosystems, 3D printing, Vibration analysis, Voice analysis, Renewable energies, energy production and storage energy, Energy efficiency, Electric mobility, Sustainability, Logistics, Automation and robotics, Materials and structures behaviour, Biotechnology and Biology analysis.

However, laboratories have been modernised with special investments in equipment and human resources in recent years, shortcomings also appeared regarding this issue. The two main concerns are budgetary difficulties and lack of human resources.

Financial resources were very limited for several years, which led to limited resources for updating equipment, and purchasing consumables – hence, some equipment became outdated. IPS lacks more expensive equipment (in some cases, researchers need to go to external R&D infrastructure for some types of analysis with specific equipment). Some laboratory equipment is only used by students in some types of classes, which causes timetable compatibility issues. On the other hand, some special equipment cannot be used by students, because the research needs to have certified equipment, incompatible with students use. Besides, National Funding for R&D projects is difficult to obtain. Legislative restrictions that make all acquisition and contracting processes are difficult, even when funds are available.

Difficulties also appeared in hiring human resources: new laboratory technicians and professors/researchers. They lack of human resources to support the laboratories activities; the lack of staff in the laboratories forces the researchers to develop support work that does not require as much qualification, limiting their availability. The lack of renewal of the professors/researchers has led to the loss of lines of research due to the departure of senior researchers. Almost all of the

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R&D is produced by professors who give also 10 to 12 hours of classes per week. The retirement of senior professors/researchers causes a discontinuity in research areas, which has not always been able to be recovered.

Besides, changes in the IPS's strategic policies for research, motivated by changes in society's standards or new challenges that arise and are important to resolve. Legislative changes that require the existence of accredited centers and which require changes in research lines.

4.2 MATE

MATE's strength is that they have a very good infrastructure in molecular genetics, aquaculture, environmental sciences, excellent animal experiment facilities such as thematic research units (poultry and swine performance testing unit, swine metabolism unit, in situ rumen degradation studies) in animal nutrition, laboratories in molecular genetics, cytogenetics, embryo manipulation, NGS sequencing, CRISPR, etc.

They have good cooperation with the economic sector and social organisations, as well as good international relationships in certain fields as they participate in more H2020 and Horizon EU projects in the fields of aquaculture, animal nutrition, environmental sciences and food science.

Most equipment and facilities are used both for education and research, and also to offer services for stakeholders. Some of the laboratories have ISO quality management certification. Hence, MATE is open to cooperation, has a good infrastructure and high level of professional knowledge.

New and/or well-maintained infrastructure with growth potential includes biotechnology, food science, ecotoxicology, and aquaculture.

The institution has acknowledged research teams which is seen in Web of Science and Scopus databases.

On the other hand, MATE faces knowledge transfer and innovation barriers as there is less practical use (patent, know-how etc.) than expected.

MATE has a complex organizational structure, as institutes operate at locations geographically far from each other. They also face a bureaucratic operation, overcomplicated regulations.

The most important uncertainties the institution faces regarding technology is that new investments and the renewal of existing ones are a financial burden. Besides, public procurement is incompatible with the nature of research.

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4.3 STPUAS

STPUAS have institutes for creative media technologies, IT security research, health sciences, integrated mobility research, social inclusion research, innovation systems. They also host some focused research centers, such as artificial intelligence, digital health and social innovation, blockchain technologies & security management, and sustainable mobility.

As a strength, unique infrastructures of STPUAS consist of a state-of-the-art equipment, including a whole TV studio, MakersLab, AudioLab, Interactive Media Lab, and the usabilityLab, as well as their healthcare department with health labs and the motion caption lab: MotionCapturingLab, BodyCompositionLab, HealthLab, PhysioLab. Their most advanced technology includes the MotionCapturingLab and MakersLab and the Cyber Defence Center (CDC).

Marketable infrastructure STPUAS contain an industry 4.0 lab, railLab, kitchen lab, and their media facilities, including an open radio station, their print magazine, and campus-tv team. Besides, the recognition ”Baupreis NÖ” for sustainability was awarded for the recently opened new building – and therefore their new, modern building as infrastructure itself can be also marketed.

They consider their healthcare facilities such as the HealthLabs and MotionCapturingLabs as well as the Cyber Defence Center as strategic infrastructure. This claim is backed by the strong increase in funded study places for this university by the Austrian government. The Cyber Defence Center is also considered as strategic infrastructure since its relevance in teaching will be crucial in the context of recent and upcoming EU legislations.

STPUAS also maintains numerous connections with industry partners and there are dedicated funding/mentoring programs/activities for start-ups/spin-offs for young entrepreneurs.

STPUAS sees a lot of growth potential in their partnership with the state hospital Mauer where they have a new site. They also see potential in the partnership with the “Zukunftsakademie Mostviertel” with whom they launched some continuous education programs. They also started implementing micro credentials (see EU 9237/22 LIMITE).

They are already coordinating their cross-discipline AI activities with the Center for Artificial Intelligence (https://cai.fhstp.ac.at/en), and they expect further opportunities arising from e.g. the EU's AI-Act, etc.

STPUAS is proud of their high-quality education, which is supported as a National prize winner for good teaching. They are also researching new teaching paradigms such as the inverted classroom model and successfully integrate remote teaching approaches, etc. Their strategic alignment of the

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curricula enables their students to further their career based on recent EU legislation, such as EU GDPR, ePrivacy, AI-Act, Cyber Resiliance Act, NIS2 Directive, etc.

Weaknesses mainly include limited physical space; teaching is limited not only by the contingent of assigned university study places, but also by the physical space, e.g. in their labs. At their current growth rate scaling the infrastructure could become a barrier. On the other hand, they compensate for their weaknesses with their expertise in modern teaching approaches, such as InvertedClassroomModel and remote teaching. Especially remote teaching could be a great opportunity for the European University Alliance and is backed by infrastructure for teachers to reduce the technical barriers. This weakness is also addressed by the new site at Mauer.

4.4 UCLL

UCLL has a robust set of strengths that positions it as a notable institution in the educational landscape. They have well-equipped research infrastructures in creative media, immersive and robotics technology, digital health technology and biotechnology.

UCLL has also some focused research centers for certain domains in nutrition and dietetics, sustainability and transition management, waste streams management, artificial intelligence, digital health and welfare.

One of its standout features is its excellent Nutritional Assessment Center, equipped with state-of-the-art tools like DXA, bioimpedance meters, and indirect calorimeters. This advanced infrastructure not only enhances the learning experience but also supports cutting-edge research in fields like health and nutrition. Furthermore, UCLL is known for a recommendable international reputation, marked by its membership in esteemed networks such as E³UDRES² and Businet. These affiliations not only validate the institution's academic standing but also contribute to a diverse range of collaborations and opportunities. The university's research center XP Lab or ‘Experience Lab’ underscores its commitment to staying at the forefront of technological advancements, particularly in immersive technologies, adding a marketable edge to its profile.

The depth of expertise at UCLL is evident in its various research groups and initiatives:

- The CIMIO research group is specialized in sustainability and transition management and navigates companies and institutions through organizational change.
- UCLL has experts in technology that are specializing in cooling technology and waste stream management. Through a well-equipped laboratory with a bioreactor they help farmers convert milk whey waste streams into other marketable products.

- Experts from our Welfare department endeavour in conflict management and are often consulted by national victim assistance.
- To transform the entire primary care system, Flanders also calls on their experts in health promotion.
- The collaboration with the business sector, notably by the XP Lab, CIMIO, Sustainable Resources, and Health Innovation, further strengthens UCLL's ties with real-world applications and industry needs.

The anticipation of growth through partnerships with the Health Campus, an upcoming innovation and research center that is scheduled to open in five years' time, will position UCLL as a hub for collaborative research, fostering connections between academia and the health economy.

However, like any institution, UCLL faces challenges. One notable weakness is a perceived lack of marketing effectiveness. Despite its impressive offerings, UCLL struggles to communicate its expertise to the wider community and the industry. This gap in marketing strategy could potentially hinder the institution's reach and impact.

Limited resources, both in terms of funding and personnel, pose another challenge. The dual use of resources for content creation, marketing, and coordination might strain the institution's capacity to leverage its potential fully. Additionally, bureaucratic hurdles, particularly in administration, slow down processes and hinder agility.

In summary, UCLL stands as a formidable institution with a robust infrastructure, international acclaim, and a diverse array of expertise. Addressing weaknesses in marketing, resource allocation, and bureaucracy will be crucial for unlocking the full potential of UCLL and ensuring it continues to thrive in the ever-evolving landscape of education and research.

4.5 UPT

UPT's strength is a very good infrastructure such as 1. ICER (FT-IR Spectrophotometer, Thermal Analysis Instrument, Gas Chromatograph); 2. IMF (Electron microscope, X-ray diffraction, Ultrasonic plastic welding machine); 3. CMMC (Uniaxial shaking table, Reaction wall and strong floor for quasi-static and pseudo-dynamic testing, Reaction frame for quasi-static tests, Data acquisition systems, Actuators); 4. CCI (Passive-House & Ducts Blower door, Cyclic Corrosion Test Chamber, Pull-off tester, Hydraulic actuators); 5. MRM (Biaxial fatigue testing machine, Creep testing machine); 6. RCM (Multimedia lab with professional mobile TV studio and multimedia content editing equipment), etc.

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The infrastructure, including all equipment, is used on the free market to offer specialized services and consultancy. The current indirect costs of the university are quite low from the value of the contracts. All equipment (ICER / CMMC / MRM / IMF) are purchased in the last 10 years. Equipment is used mostly for educational and research activities, but can be used to offer specific services for stakeholders: some of the laboratories obtained a ISO certification in terms of quality, providing good and constant services for enterprises. Based on the research results UPT appeared in the international rankings as THE, QS, US News Classification. Multimedia laboratories with professional mobile TV studio and multimedia content editing equipment offers an important regional visibility too.

UPT has a very good reputation internationally, since they participate in different partnerships within EU Research Framework Programmes (FP6, FP7, Horizon, etc.). Research centers are recognised on national and international level, which is backed up by very high international visibility within the ranking of research.com. National and international research teams known and recognised cover the following domains: Automation and computers, Artificial Intelligence, Multimedia System Engineering, Energy storage and conversion, Hydropower Energy, Steel Structures and Reinforced Concrete Structures, Chemistry, Materials and Fabrication Engineering, Mechanical Characterisation of Materials. There is a very high visibility of the team members through the most important international Web of Science and Scopus databases.

One of the institution's weakness is that old equipment (with more than 15 years) with limited features are still in use.

They also have limited marketing activities; there is a low level of marketing actions regarding the institution offer for business environment. The educational staff also acts in the marketing and in the research activity.

Maintenance and upgrading can become an issue as the costs for maintenance and upgrading of existing infrastructure are not covered by the annual budget of the university. In the function of the purchasing year of the equipment collateral financing has to be obtained and could be used for maintenance or upgrade costs.

They lack of specialised technicians in some of the research laboratories. Although most equipment is new, but need to be calibrated before research investigations. Many equipment need checks of performances for yearly certification, but being used intensively, hence uncertainties regarding the correct measurements could occur and have to be corrected in the assessment process.

The inertia of the acquisition system might also appear. In the case of new investments in equipment and infrastructure, all the costs have to be presented in early stages of the projects due to a large number of documents needed for the acquisition procedures. An important delay could occur during the procurement due to the time allocated for challenging the results of procedures.

Institution faces technological barriers of limited interdisciplinary of using the existing infrastructure. A large number of small research centers (26) located within the departments with a limited access to the researchers from different groups. Research teams do not collaborate transdisciplinary. Distances between location of equipment without a possibility to use simultaneously.

4.6 ViA

One of ViA's strengths is that they have plenty of marketable features, e.g. they offer spatial research for economic sectors using geospatial data; they have software and data sets for spatial research in tourism; their infrastructure contains a Multimedia lab with professional mobile TV studio and multimedia content editing equipment (they have a set for video, audio recording, editing and live broadcasting, green screen and light board), and they also have a set of VR/AR equipment for creating interactive, multidimensional environment. Besides, ViA offers mechatronics training in PLCs in industrial process automation, SCADA systems, industrial robotic systems. ViA is equipped with UFV with multispectral camera for digital farming. Furthermore, they use new methods for active learning offered in an active learning classroom and multimedia lab.

The institution is an expert in VR/AR, spatial research for tourism, multimedia communication, mechatronics, sustainable construction and simulation modelling.

Their growth potential includes technologies where IT experts work together with social sciences experts. They are well connected to the national digital academic network, including high capacity data servers. ViA has prototype for accelerated mathematics learning as well as an Eye tracking device (glasses and desktop) and an analysis software.

On the other hand, limitations might appear as VR/AR technologies change very fast and can be outdated already in 3 years. They believe that the existing infrastructure could be wider used. Furthermore, due to limited financing, significant investments have been only with the support of EU funded projects. Also, ViA depends on the partnerships either at the regional level or national or international in order to introduce new significant technologies.

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4.7 Strengths and Weaknesses – a consortium-level summary

All the institutions within the consortium possess valuable infrastructure, including some extraordinary equipment and state-of-the-art tools. They have a high level of professional knowledge, as evidenced by their international rankings, and some team members are recognised in the most important databases such as Web of Science and Scopus. Each institution places great emphasis on cooperation, collaborating with external companies, industry partners, other institutions and individuals, and participating in numerous national and international projects such as FP6, FP7, H2020, and Horizon. Some partners even have experience in cooperation between different locations, which is one of the great advantages of the current project, as members can continue to cooperate to enhance transdisciplinary collaboration through further one-to-one and/or teamwork.

Despite the considerable diversity within the consortium, there are common bureaucratic obstacles and regulations that can be highly overcomplicated. However, these issues are outside the scope of the current project. The other two main concerns are financial difficulties and human resource challenges. Even when there are well-equipped laboratories, maintenance can be an issue, and technology can become outdated quickly, requiring financial resources for replacement or updating/upgrading. However, funding can be difficult to obtain. On the other hand, almost all agreed that a lack of human resources and the departure of senior researchers cause difficulties. Therefore, retaining current lecturers and researchers and making the professions attractive is paramount. As previously noted, “the dual use of resources for content creation, marketing, and coordination might strain the institution's capacity to leverage its potential fully". Therefore, strong, creative, and effective marketing communication is needed, not only at the institutional level but also at the consortium level, to communicate the expertise to the wider community. With a well-founded marketing strategy, the reach and influence of institutions could potentially increase.

A brief summary of strengths and weaknesses is presented in Table 7.

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Table 7. – General strengths and weaknesses of the research infrastructure

Strengths	Weaknesses
1. Valuable infrastructure: All the institutions within the consortium possess valuable infrastructure, including some extraordinary equipment and state-of-the-art tools. 2. High level of professional knowledge: They have a high level of professional knowledge, as evidenced by their international rankings, and some team members are recognized in the most important databases such as Web of Science and Scopus. 3. Emphasis on cooperation: Each institution places great emphasis on cooperation, collaborating with external companies, industry partners, other institutions, and individuals, and participating in numerous national and international projects such as FP6, FP7, H2020, and Horizon. 4. Experience in cooperation between different locations: Some partners even have experience in cooperation between different locations, which is one of the great advantages of the current project, as members can continue to cooperate to enhance transdisciplinary collaboration through further one-to-one and/or teamwork.	1. Bureaucratic obstacles and regulations: Despite the considerable diversity within the consortium, there are common bureaucratic obstacles and regulations that can be highly overcomplicated. 2. Financial difficulties: Even when there are well-equipped laboratories, maintenance can be an issue, and technology can become outdated quickly, requiring financial resources for replacement or updating/upgrading. 3. Human resource challenges: Even when there are well-equipped laboratories, maintenance can be an issue, and technology can become outdated quickly, requiring financial resources for replacement or updating/upgrading. 4. Marketing communication: Strong, creative, and effective marketing communication is needed, not only at the institutional level but also at the consortium level, to communicate the expertise to the wider community. With a well-founded marketing strategy, the reach and influence of institutions could potentially increase.

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5 Conclusions

5.1 Institutional research profiles and the importance of collaboration

The distribution of research areas across institutions provides valuable insights into each university's specialization and potential areas for collaboration. The results indicate that each institution is involved in almost all research fields, but there are notable variations in the relative importance of these fields across universities.

It's important to note that this distribution does not imply that any institution should disregard the development of research infrastructure in a particular field. Instead, the results highlight the need for a strategic consideration of which institutions have the most potential to benefit from developing research infrastructure in different areas. Collaboration among universities and the efficient allocation of resources are crucial for advancing successful research programs.

5.2 Researcher’s satisfaction with the research infrastructure

STPUAS stands out as the most satisfied institution across most categories, with UCLL and UPT following closely behind. ViA and MATE also exhibit similar levels of satisfaction. On the other hand, IPS has the lowest average satisfaction score, indicating the researchers’ demand for significant improvements.

Specifically, access to online full-text databases and journals, as well as library services, meets the expectations of researchers and does not require substantial improvements. However, the institutional infrastructure for field research equipment/stations falls short of expectations, highlighting the strong demand for improvements at all institutions. Data centers and computing capacity also offer room for improvement, with STPUAS serving as a best-practice model in this regard.

ViA and STPUAS could serve as examples for laboratory equipment improvements. IPS respondents express significant dissatisfaction with laboratory equipment, desktops, notebooks, and research support software, while MATE faces similar challenges, albeit with less concern regarding computer access.

The analysis provides a clear direction for enhancing research infrastructure and tailoring improvements to better meet researchers' expectations across various categories and research fields.

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5.3 Specific researcher demand for infrastructure

The frequency of daily use of various infrastructure categories has revealed that online full-text databases and computers are the most commonly used resources. There are differences in usage between institutions, with STPUAS having the highest utilization in research support software and library services. Laboratory equipment is regularly used by a significant proportion of respondents, primarily those from UPT.

The analysis also highlights the variations in usage across different research fields. For instance, laboratory equipment is more commonly used in Engineering and Natural Sciences, while data and computing centres are highly utilized by researchers in Computer Sciences and AI.

When asked about their future needs, a significant portion of respondents did not provide specific answers, while others mentioned various tools and assets they require in the near future, without clear patterns emerging.

This analysis sheds light on the diverse demands of researchers and their preferences in terms of research infrastructure, which will be valuable for addressing their specific needs in the future.

5.4 Interest in international collaboration and external infrastructure use

The data reveals that over half of the respondents utilize external infrastructure to some extent in their research activities, indicating a demand and established practice for external research resource utilization within the partner institutions.

When broken down by institution, it's evident that IPS and ViA have the highest reliance on external resources, while UPT and UCLL have the lowest proportion of researchers using primarily external infrastructure.

By exploring the reliance on internal and external infrastructure within different research fields, it becomes apparent that STEM fields tend to rely slightly less on external infrastructure compared to fields like economics, management, and social sciences.

Regarding openness to international cooperation based on infrastructure sharing, the data indicates a strong interest among researchers. Less than 4% reject the idea, with three-quarters expressing willingness to participate in such collaboration, and 20% considering joining joint projects in the future. This underscores the demand for the infrastructure sharing and research collaboration strategy envisioned under the Entrenovators project.

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However, there is room for improvement in communication and awareness. A significant percentage of respondents are unaware of infrastructure-sharing initiatives at their institutions, especially at the consortium level. Effective communication and dissemination of E^{3}UDRES^2 projects are necessary to ensure that all researchers are informed and can actively participate in collaborative efforts.

5.5 Infrastructural strengths and weaknesses of the consortium

The consortium boasts several strengths, including valuable infrastructure, high professional knowledge, a strong emphasis on cooperation, and active participation in national and international projects. Additionally, the experience in inter-location collaboration enhances its potential for transdisciplinary teamwork.

However, common bureaucratic obstacles, complex regulations, financial difficulties, and human resource challenges present notable weaknesses within the consortium. Addressing these challenges will be vital to optimize the strengths and ensure effective collaboration. Implementing a well-founded marketing communication strategy at both the institutional and consortium levels can play a pivotal role in improving the consortium's reach and influence, potentially alleviating these weaknesses and further capitalizing on its strengths.

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ANNEX I | Research infrastructure Survey

E^{3}UDRES^2 Ent-r-e-novators

Project ID: 101071317

Work package #3

Co-funded by the European Union

T3.1 Forecasting researchers' demand for RD&I resources on a sample representing the scientific human resources of partner organisations

*****DISCLAIMER*****

According to the European Commission, *research infrastructures* are facilities that provide resources and services for the research communities to conduct research and foster innovation in their fields.

These include

- major equipment or sets of instruments,
- knowledge-related facilities such as collections,
- archives or scientific data infrastructures,
- computing systems,
- communication networks.

The aim of this survey is to gather information on how best these research infrastructures could be shared among the E^{3}UDRES^2 partner institutions in the foreseeable future.

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Part 1. At first, please share some details about your job and affiliation.

Q1.1 At which University are you currently working or associated with?

a) IPS
b) STPUAS
c) MATE
d) UPT
e) UCLL
f) ViA

Q1.2 Please indicate the name of your department within your Institution. (if you belong to any)

____

Q1.3 How would you describe your affiliation with the University?

a) Full-time employee
b) Part-time employee
x) Other, please specify:____________________________________

Q1.4 Please indicate your primary role within the University you are associated with:

a) Scientific research
b) Education
c) Management / institutional leadership
d) Technical support
e) Administrative
x) Other, please specify: _________________________

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Q1.5 Do you belong to a research centre or specified research group?

a) Yes
b) No

If your answer is yes, please share the name of your research centre or group: ___________________________

Does your research centre or group has its own webpage? You may share its url here with us (optional): ___________________________

Q1.3 Does your organization have a clear definition for the concept 'scientific research infrastructure'?

a) Yes
b) No
x) Don't know

Part 2. Please give us some details about your scientific research interests.

Q2.1 What discipline(s) do you work in?

a) Agriculture and Forestry
b) Astronomy
c) Anthropology
d) Artificial Intelligence
e) Biology
f) Business
g) Chemistry
h) Computer Science
i) Earth Science

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j) Economics
k) Engineering and Technology
l) Environmental Sciences
m) Food Science
n) Genetics and Biotechnology
o) Geography
p) History
q) Languages and Literature
r) Law
s) Management Science
t) Marketing
u) Mathematics
v) Medicine and Health
w) Pedagogy
x) Performing Arts
y) Philosophy
z) Physics
aa) Political Science
bb) Psychology
cc) Robotics and Automatation
dd) Sociology
ee) Theology
ff) Visual Arts
gg) Other, please specify: ____________________

Q2.2 Please describe your exact research topic for us in a few words (optional):

____

Q2.3 Have you started your academic career at your current university?

a) Yes
b) No

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Q2.4 How many years of experience do you have in scientific research?

a) 2 years or less
b) 3-5 years
c) 6-10 years
d) 11-15 years
e) 15-25 years
f) more than 25 years

Q2.5 Do you have a scientific degree (PhD or equivalent?)

a) Yes
b) No

Part 3. Now please let us know your personal necessities regarding research infrastructure.

Q3.1 Out of the following research infrastructure elements, what are your day to day research activities require? (You may select multiple fields)

a) Laboratory experiments
b) Field research station
c) Data and computing centre
d) Desktops and notebooks for personal use
e) Analytical software (e.g. MATLAB, SPSS)
f) Digital and traditional libraries
g) Online access to scientific journal articles

Q3.2 For your regular scientific research activities, do you mainly use your Institution's internal infrastructure or external facilities?

a) Excusively internal
b) Mostly internal
c) Internal and external

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d) Mostly external
e) Exclusively external

Q3.3 Please mention some equipment, tools, instruments, platforms which you regularly use in your scientific research (please indicate at least one)

____

Q3.4 If you would have the possiblity to gain access to the research infrastructures of other E³UDRES² partner institutions, would you be interested in conducting your research as part of an international team?

a) Yes, absolutely interested.
b) Yes, somewhat interested.
c) Maybe I will become interested in the foreseeable future.
d) No, I am not interested.

Q3.5 Please share with us what kind of equipment or asset would you absolutely need in the near future to further your research activity? (And it it not available at your institution)

____

Q3.6 Does your organisation have specific initiatives in place to ensure access to research infrastructures for external researchers, either from your own country or abroad?

a) Yes
b) No
x) I don't know

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Part 4. As a next step, please indicate how satisfied you are with the existing research infrastructure available within your organisation, directly related to your own research activities.

Please rate your institution's existing research infrastructure on a scale of 1-5. /1='inadequate', 2='poor', 3='fair', 4='good', 5='very good'/

Q4.1 Laboratory equipment

1 2 3 4 5 not applicable

Q4.2 Field research station(s)

1 2 3 4 5 not applicable

Q4.3 Data and computing centre(s)

1 2 3 4 5 not applicable

Q4.4 Desktops and notebooks for personal use

1 2 3 4 5 not applicable

Q4.5 Analytical software (e.g. MATLAB, SPSS)

1 2 3 4 5 not applicable

Q4.6 Digital and traditional libraries

1 2 3 4 5 not applicable

Q4.7 Online access to scientific journal articles

1 2 3 4 5 not applicable

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Part 5. Please share some details about your demographics

Q1.1 Your gender:

a) Male
b) Female
c) Other / unspecified

Q1.2 Your age group:

a) less than 25
b) 25-34
c) 35-44
d) 45-54
e) 55-64
f) 65 or older

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EDUCATORS + INNOVATORS

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MATE HUNGARIAN UNIVERSITY OF AGRICULTURE AND LIFE SCIENCES

UPT Universitatea Politehnica Timişoara

UC Leuven Limburg MOVING MINDS

VIDZEMES AUGSTSKOLA

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