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# Digital transformation of research and innovation roadmap



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## Deliverable identification

<b>Deliverable No. and Title</b>	<b>D2.2 Digital transformation of research and innovation roadmap</b>
Leader	University of Split
Related task(s)	Task 2.2 Development of a roadmap for digital transformation of research and innovation
Authors	Prof Nikša Alfirević, PhD (UNIST) Nikola Balić (UNIST)
Dissemination level	Public
Due submission date	31/12/2022
Submission (first version)	21/11/2022
Project number	101017454
Start date of the project	01/01/2021
Duration	36 months
<p>This study includes results from two focus groups on theme Assessment and Drivers of Research &amp; Innovation (R&amp;I) Digital Transformation at Higher Education Institutions (HEIs) of the SEA-EU Alliance and results of the survey SEA-EU Digitalization of research and innovation. Also, describing the current situation related to R&amp;I digitalization/digital transformation across the core SEA-EU alliance members along the eleven dimensions selected to describe the R&amp;I maturity levels. Results are presented as a roadmap for the digital transformation of research and innovation. The purpose of the survey is to recognize the presence of digital transformation among the six university members of the SEA-EU alliance.</p>	

## Versions and contributions history

Version	Date	Modified by	Reason
1.	21.11.2022.	Nikola Balić	Presentation of the deliverable to the RDIS



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## Introduction

Digital transformation is one of the key elements of the anti-fragility of the SEA-EU Alliance. Development of a roadmap for the digital transformation of research and innovation, a deliverable of task 2.2, explores the potential for the digital transformation of universities on the level of the Alliance.

Due to the different approaches of the universities to digital transformation, which are often fragmented and particular to specific departments or science fields, the first step of this task was an exploration of digital transformation elements of individual universities.

Related to that, after the task team meetings and data collection stage, two Focus groups were organized on the theme Assessment and Drivers of Research & Innovation (R&I) Digital Transformation at Higher Education Institutions (HEIs) of the SEA-EU Alliance in May 2022. The main goal was to identify digital transformation elements and indicators and gather background information and documentation on the digitalization and digital transformation of research and innovation activities at SEA-EU University Alliance HEIs.

The next step was developing a survey "SEA-EU Digitalization of research and innovation" which was presented and collected from July to September 2022. Respondents were recruited through the SEA-EU key informants, participating in the focus groups in May of 2022 through formal communication channels and individual university members. Results show the current situation regarding research and innovation digitalization/digital transformation of the SEA-EU Alliance members. Also, eleven dimensions are selected to describe R&I maturity levels.

All these steps helped to detect barriers and enablers and achieve a better overview of respective universities' experiences, strategic goals, and plans. Referring to the R&I digitalization/digital transformation roadmap for SEA-EU universities, the current study captures the starting point of the process. It describes the current state of maturity for eleven dimensions relevant to the process. The document will form a solid basis for attracting additional funding through applying for the projects at the international level for the Alliance and individually at the national level, depending on the stage of the university's digital transformation of research and innovation.



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## Research methodology and approach

In the study of the SEA-EU Research & Innovation (R&I) digitalization, we used a mixed methods approach by following the sequential exploratory strategy, starting with the collection and analysis of qualitative data, followed by a quantitative-type survey (Terrell, 2012). We utilized the internal database of relevant SEA-EU alliance contacts to identify individuals in charge of R&I activities at each of the six established SEA-EU university members (University of Cadiz, University of Bretagne Occidentale/Western Brittany – Brest, University of Gdansk, University of Malta, University of Split). The following information was initially requested from each of the contacts:

- to verify the name, position, and contact of the relevant management or advisory staff on the R&I topic,
- to advise on the existence (and deliver – if available) of a formal R&I digitalization strategy or action plan,
- to advise on the stage of the university's digital infrastructure readiness and the related background documents,
- to assess the stage of the university's researchers and support staff readiness for R&I digitalization, with a focus on training, up-skilling, and motivation, including the related background documents,
- to reflect on the open science orientation and development stage at their university, as supported by the relevant background documents,
- to reflect on the digitalization of collaboration processes with academic and company partners, funders, and other R&I stakeholders, including delivering relevant background documents.

Limited information was received at this data collection stage, which helped us to partially understand the current challenges and opportunities for R&I digitalization at SEA-EU member Universities. To deliver a more comprehensive understanding of the research topic, we continued the analysis in two parallel venues:

- a) Analyzing the theoretical determinants of R&I digitalization and digital transformation in the academic environment, both as an independent construct as well as a component of the general university digitalization and digital transformation trends;
- b) Developing the themes for a more comprehensive qualitative inquiry into the topic of R&I digitalization at the level of SEA-EU member universities.

The review of theoretical determinants was performed as a traditional structured theory review. We used the Elsevier Scopus and Clarivate Web of Science (WoS) to identify the sources, identified by the search results, using the following keywords: "*digital transformation*" or "*digitalization*," "*higher education*," "*research*," and "*innovation*." After reviewing the results of the initial science mapping of previous literature, indexed by Scopus and WoS, we developed an internal database of potential sources (journal articles and reviews, book chapters, etc.). We used the innovative Scite (<https://scite.ai>) tool to evaluate the identified sources in terms of university R&I digitalization critical success factors, barriers and enablers (see Appendix I for the finally selected body of literature). The same tool was used to identify additional studies,



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supporting or contradicting the studies from our internal database, which is one of its primary usage scenarios (Khamsi, 2020). In addition, a similar research methodology and a research instrument focused on fostering innovation in EU Small and Medium Enterprises (SMEs), i.e., Digital Maturity Assessment (DMA) tool & the Innovation Radar Methodology (IR), developed by the Joint Research Center Seville (2022) were consulted and used as a benchmark.

Based on the identified theoretical studies and the initial findings obtained using the e-mail queries from the SEA-EU member university contacts, the research themes for a more comprehensive qualitative analysis of the research topic were developed (see Appendix II). It was decided to explore them using a semi-structured focus group format, as it ensures a consensus- and agreement-free, non-threatening environment for discussing topics whose understanding is widely shared across the focus group participants (Krueger & Casey, 2014).

Two focus groups, with sub-samples of the previously identified, relevant SEA-EU university representatives, were held online, with 14 representatives of SEA-EU member universities, in early May 2022, using the Zoom platform. Both sessions were recorded and -transcribed, with the initial qualitative analysis conducted in QSR International's NVivo<sup>1</sup>. According to the recommendations by Skokic, Lynch & Morrison (2016), the initial (first-order) codes for key R&I university issues were developed using the focus group participants' own terminology. They were further clustered in nVivo, using the Pearson correlation coefficient as a metric of word similarity, which was used as an exploratory tool. Along with the analysis of transcript segments grouped according to the first-order codes, clusters obtained in such a simplistic manner were used to assist the researchers in developing second-order codes. They were obtained by grouping descriptive, first-order codes into the analytical 'master codes' during the second-order coding. Further synthesis of second-order ('master') codes into meta-codes (categories) was not pursued since the obtained second-order coding provided adequate information to structure the research instrument (questionnaire) for the last stage of this research.

The final structure of the questionnaire is based on: (a) theoretical themes, based on desk research; (b) benchmark research instrument – EU Digital Maturity Assessment (DMA) tool for SMEs (JRC Seville, 2022) and (c) topics, emerging from the qualitative analysis of the focus group data. Survey items and measures were aligned with the EU DMA tool, as the users of our tool/approach might be already familiar with the topic of SME digital maturity and involved in the SME digital transformation and open innovation processes (Crupi et al., 2020), facilitated by EU-funded Digital Innovation Hubs (DIHs). The questionnaire was drafted and piloted by a small group of researchers at the University of Split before a production version of the questionnaire was developed in June/July 2022 using the Qualtrics XM online platform<sup>2</sup>. The final version of the questionnaire, approved by the Ethical committee of the University of Split, is available in Appendix III.

Data collection was conducted during late August and September 2022, with 483 respondents accessing the questionnaire. Respondents were recruited through the SEA-EU key informants, participating in the focus groups in May 2022, and through the formal communication channels within the SEA-EU alliance and individual university members. However, the majority of the responses received (309) were either empty or contained responses to a single or a handful of

<sup>1</sup> We are grateful to the university library advisor, Ms. Mirta Matošić, PhD. candidate, for research assistance.

<sup>2</sup> Available at: <https://www.qualtrics.com/>



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questionnaire items. The remaining 174 questionnaires were usable, with 171 respondents from the six initial/established SEA-EU university members and only three from the new SEA-EU university partners (Nord University, University of Algarve, The University of Naples "Parthenope"), which will be included into the study later. One of the questionnaires has not been completed fully, which brings the final sample to N=171 respondents.

## Results

### Review of literature and initial qualitative research stages: Setting the landscape

In the first research stage, we found Elsevier Scopus to be a much more informative source for identifying previous research in the field of R&I digitalization (i.e., digital transformation) in higher education than the Clarivate Web of Science (WoS). During the final writing of this research report (early November 2022), we performed new bibliometric searches of Scopus and WoS reference databases to report on the most current state of literature in the analyzed field. The following advanced bibliometric queries were used:

- WoS bibliometric query: (((ALL=("digital transformation")) OR ALL=(digitalization)) AND ALL=("higher education")) AND ALL=(research)) AND ALL=(innovation)
- Scopus bibliometric query: TITLE-ABS-KEY("digital transformation" or "digitalization") and "higher education" and research and innovation

Although the WoS query is less restrictive, it returned only 261 documents, while a more restrictive Scopus query identified 1.896 documents<sup>3</sup>. The resulting datasets were imported into the freely available science-mapping tool VOSviewer, produced by the Centre for Science and Technology Studies at the University of Leiden<sup>4</sup>. To provide a preliminary mapping of the higher education's R&I digitalization/digital transformation literature, a VOSviewer-based map of keyword co-occurrences has been produced for both datasets. In both cases, the science mapping exercises resulted in several easily identifiable clusters (see Figures 1 and 2), which could not be used to identify specific factors driving the R&I digitalization/transformation. Therefore, we continued our analysis by manually selecting a subset of the documents in this field of research and evaluating the additional studies that supported or contradicted their research results with the evaluation provided by the already mentioned Scite.ai tool.

The analysis has led to the development of the body of knowledge, consisting of 43 previous studies, which were classified into three broad groups (see Appendix I for bibliography):

1. Principles and critical factors of university/higher education digitalization/digital transformation (DIGI/DT) - consisting of 23 previous studies,
2. Barriers and obstacles to HE DIGI/DT – consisting of 10 previous studies,

<sup>3</sup> Both datasets are freely available from the Zenodo repository, with the following DOI: <https://doi.org/10.5281/zenodo.7274288>

<sup>4</sup> Available at: <https://www.vosviewer.com/>



3. Enablers of HE DIGI/DT – consisting of 10 previous studies.

Along with the previous studies, we consulted the *Practical guidelines on the use of the Digital Maturity Assessment (DMA) tool & the Innovation Radar Methodology (IR) 10/01/2022* (JRC Seville, 2022), as well as the digital strategy document developed by the University of Western Brittany (*Schema directeur du numérique 2019-2022*), in its concise version<sup>5</sup>, as directed by a response, received in the first stage of research<sup>6</sup>.

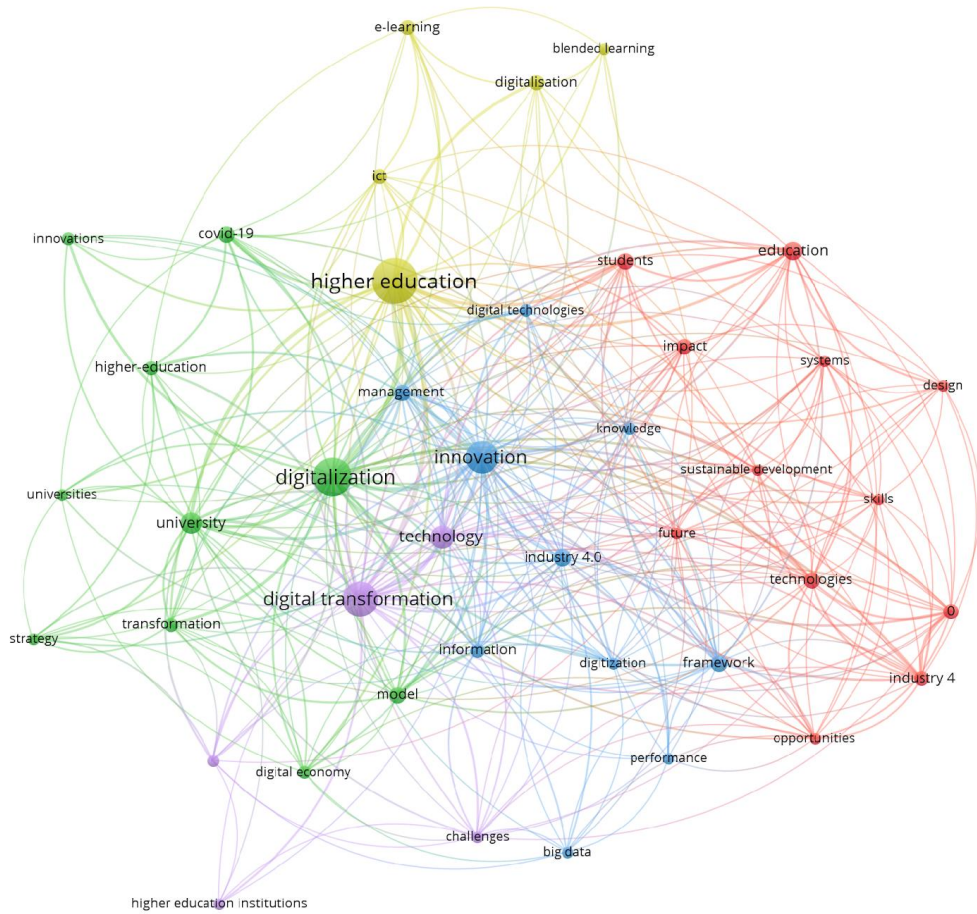


Figure 1. WoS keyword co-occurrence map for the university R&I digitalization/digital transformation research

Based on the previously described inputs, an orientational guide to discussions to be held at focus groups (see Appendix I) was developed, with the following provisional topics/potential dimensions of the R&I digitalization research construct:

<sup>5</sup> Available at: [https://www.univ-brest.fr/digitalAssets/77/77945\\_SDN-UBO-2019-2022-DocumentSynthese.pdf](https://www.univ-brest.fr/digitalAssets/77/77945_SDN-UBO-2019-2022-DocumentSynthese.pdf)

<sup>6</sup> We used a version of the document, which was machine-translated to English, by using the official EU translation service, available at: <https://webgate.ec.europa.eu/etranslation>



- stakeholders' perception of the university R&I digitalization/digital transformation field and practice,
- university regulations and reporting relationships,
- formal strategic planning of the R&I digitalization/digital transformation,
- digital infrastructure maturity and contribution to the R&I digitalization/digital transformation,
- the human side of the R&I digitalization/digital transformation, with a focus on training, up-skilling, and motivation,
- usage and regulation of open data and open science construct and their contribution to the R&I digitalization/digital transformation,
- digitalization of collaboration initiatives and processes with the external stakeholders of the university R&I,
- environmental sustainability dimension of the university R&I.

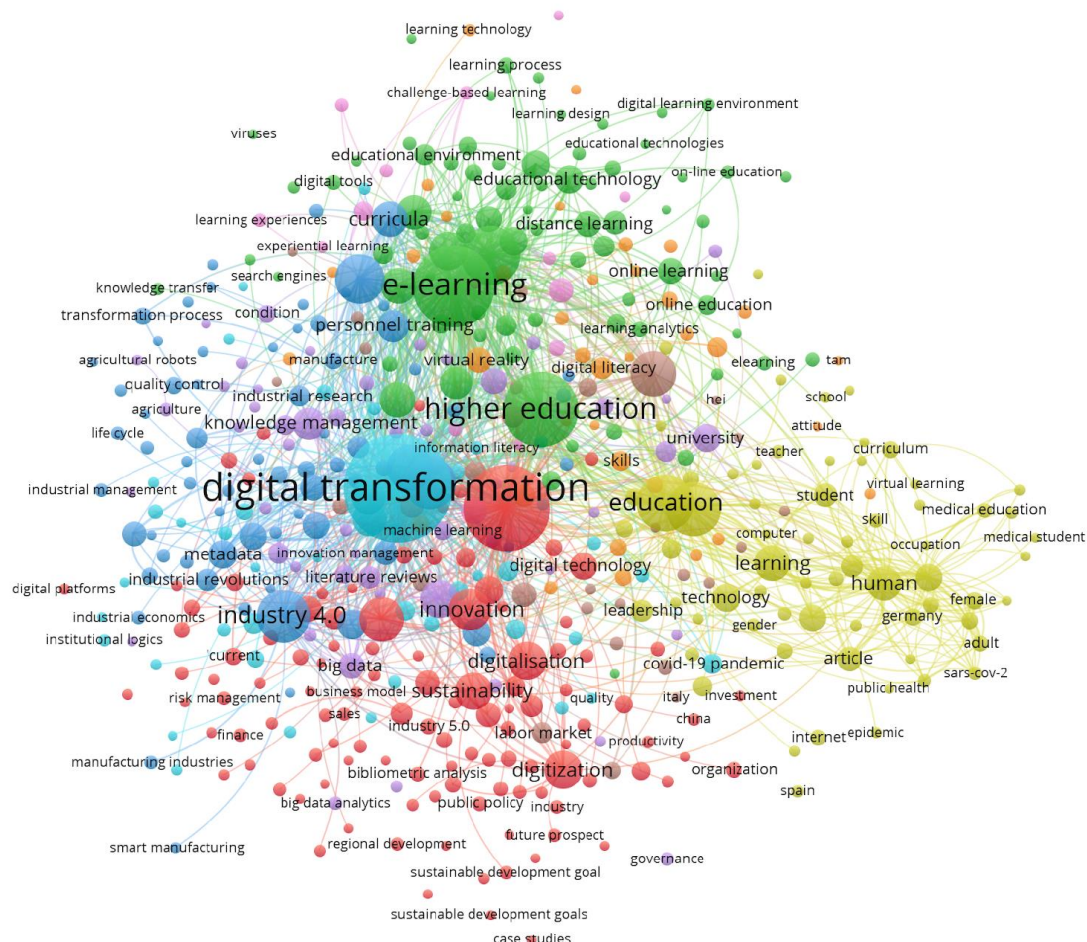


Figure 2. Scopus keyword co-occurrence map for the university R&I digitalization/digital transformation research<sup>7</sup>

<sup>7</sup> Multiple forms of the keyword *digitalization* appear in Figures 2 and 3. They are automatically retrieved from the WoS and Scopus bibliographic data, as specified by authors, and included into visualizations, produced by the VOS Viewer science mapping software.



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The focus groups were transcribed, with the transcripts analyzed by QSR International's NVivo software package. As described in the methodology section, we developed 17 first-order codes for the topics arising from the participants' discussions of the eight selected drivers relevant to R&I digitalization/digital transformation (DIGI/DT) at the SEA-EU universities:

1. Readiness for digitalization
2. Considerations before digitalization strategy
3. Digitalization limitations
4. Ecology and sustainability
5. Incentives for digitalization
6. (No) incentive for using Open Access (OA)
7. OA policies
8. Open data and data management
9. Remotization of R&I work
10. Staff training
11. Digitalization in communication
12. Digitalization in administration
13. Digitalization in teaching
14. International research infrastructure
15. National research infrastructure
16. IT tools & functionalities for digitalization
17. University roles and positions for digitalization

Relevant quotes were selected around the 17 first-order codes<sup>8</sup>, and key terms were clustered by NVivo, using the Pearson correlation to group terms by similarity. The obtained dendrogram (see Figure 3) was used as an exploratory tool and a starting point for developing five second-order ('master') codes:

1. Support and incentives for digitalization
2. Digitalization drivers (digital infrastructure and employee resources, institutional & other enablers)
3. Institutional digitalization assessment (benefits vs. limitations)
4. Employee acceptance of digitalization

Further development of meta-codes (categories) was not pursued since the four identified second-order codes were considered satisfactory for the preliminary questionnaire structuring, which also considered the categories obtained by analyzing the theoretical body of knowledge related to the university R&I digitalization, as well as the categories, represented in the benchmark EU survey (*Practical guidelines on the use of the Digital Maturity Assessment (DMA) tool & the Innovation Radar Methodology (IR) 10/01/2022 - JRC Seville, 2022*).

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<sup>8</sup> Available upon request from the report authors.

### Nodes clustered by word similarity

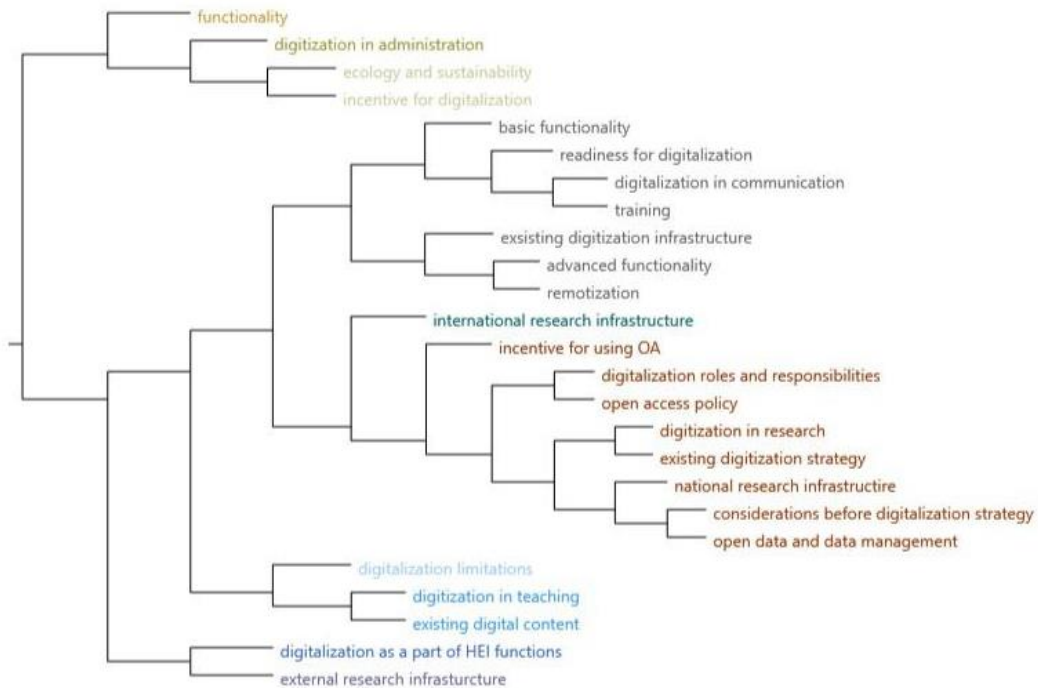


Figure 3. Initial clustering of first-order key terms by NVivo

### Quantitative research stage: The SEA-EU R&I DIGI/DT Scoreboard

The resulting dimensions of the quantitative research instrument (questionnaire) have been formulated as follows:

1. Dimension 1. University strategy for R&I digitalization
2. Dimension 2. Perception of Critical Success Factors (CSFs) for university R&I digitalization
3. Dimension 3. Perception of university R&I digitalization incentives
4. Dimension 4. Perception of university R&I digitalization barriers
5. Dimension 5. Digital technologies/solutions for university R&I digitalization
6. Dimension 6. Advanced digital technologies/solutions for university R&I digitalization
7. Dimension 7. Staff training & up-skilling for university R&I digitalization
8. Dimension 8. Staff engagement & empowerment for university R&I digitalization
9. Dimension 9. Data management for university R&I digitalization
10. Dimension 10. Data & systems security for university R&I digitalization
11. Dimension 11. Sustainability and university R&D digitalization

Survey items and measurements were either based on the focus group participant feedback or the benchmark EU survey (JRC Seville, 2022), which has also been a starting point for developing the scoring/evaluation procedure. Each dimension is scored relatively on a scale from 0 to 100, with all items (questions) equally weighted, by a coefficient (W), calculated as follows:

$$W = 100 \text{ points/number of items in a dimension.}$$



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Individual option scores are typically assigned 1 pt for an affirmative answer (Yes) and 0 pts for a negative (No). If a participant could not evaluate the proposed item (Not sure/Don't know), it was not included in the analysis, i.e. treated as unanswered. In case of partial agreement, a score of 0.5 pts is assigned. Likert-type scales, with values ranging from 1 to 5, are converted to: 0.2, 0.4, 0.6, 0.8, and 1 pts (for each scale value point, respectively). All participants' answers are averaged, by using the conventional arithmetic average function in Microsoft Excel or by using an Excel formula, taking into account the actual number of responses, in the case of survey items, where:

- the alternative 'Not sure'/'Don't know' was included, or
- an optional answer (such as 'Other') has been offered to the participants.

The resulting scales are based on a single number, on a 0-100 scale, denoting the level of R&I university maturity for each identified dimension. Tentatively, the obtained score can be compared to a traditional percentage.

The empirical relevance of the collected data and the research instrument used was evaluated, based on the simple internal consistency analysis, measured by the conventional Cronbach alpha indicator:

1. Dimension 1:  $\alpha = 0.84$  (N=11 items),
2. Dimension 2:  $\alpha = 0.85$  (N=9 items),
3. Dimension 3:  $\alpha = 0.84$  (N=9 items),
4. Dimension 4:  $\alpha = 0.85$  (N=10 items),
5. Dimension 5:  $\alpha = 0.72$  (N=11 items),
6. Dimension 6:  $\alpha = 0.88$  (N=7 items),
7. Dimension 7:  $\alpha = 0.82$  (N=8 items),
8. Dimension 8:  $\alpha = 0.81$  (N=8 items),
9. Dimension 9:  $\alpha = 0.78$  (N=6 items),
10. Dimension 10:  $\alpha = 0.80$  (N=6 items),
11. Dimension 11:  $\alpha = 0.79$  (N=6 items).

All values could be considered acceptable (Tavakol & Dernick, 2011), except for Dimension 5 of the R&I digitalization instrument (Digital technologies/solutions for university R&I digitalization). However, since this part of the research instrument intended to capture the level of conventional Information & Communication Technologies (ICTs) used by a university in pursuing R&I digitalization, it wasn't easy to eliminate individual items or seek other ways of improving the internal consistency.

As previously mentioned, only 174 participants (36.02%) filled in the quantitative survey, 483 accessing the questionnaire, with only three questionnaires from the new SEA-EU member universities. We used non-probability sampling, based on the snowball sampling strategy (Handcock & Gile, 2011). We asked the key informants, participating in the focus groups, about the university employees, knowledgeable and informed about the topic of R&I digitalization. We also used personal invitations via the existing SEA-EU contacts and mailing lists to receive further recommendations from knowledgeable and informed individuals. The convenience sample was considered adequate for the initial verification of the research instrument and measurement of

maturity scores. Major limitations of the available sample, to be corrected in later research stages, are related to

- The unbalanced number of respondents across the participating SEA-EU universities,
- Further focusing toward the university roles, which will be selected as most relevant for the assessment of R&I digitalization.

The current sample consists of an uneven number of participants across the SEA-EU core partner universities, with the largest number of respondents from the University of Split, who were easiest to reach through a range of key informants, contributing to the snowball sampling. The number of respondents is available in Table 1. We acknowledge that the initial results could be skewed by a limited and somewhat unbalanced sample, especially for University of Malta and University of Kiel, who had a small number of respondents.

Number of respondents	Frequency	Percent	Cumulative Percent
University of Split	55	32,2	32,2
University of Brest (Western Brittany)	21	12,3	44,4
University of Malta	16	9,4	53,8
University of Cadiz	40	23,4	77,2
University of Kiel	12	7,0	84,2
University of Gdansk	27	15,8	100,0
Total	171	100,0	

Table 1. Structure of the sample per participating SEA-EU universities

To further explore the sample, available for this initial study, we also analyzed the roles and fields of research, specified by the participating SEA-EU researchers. The majority of respondents belong to the mid-career (37,4%) and the senior staff (44,4%), which seems to be relevant to the topic of the research (see Table 2 for details).

Number of respondents	Frequency	Percent	Cumulative Percent
Junior staff	20	11,7	11,7
Mid-career staff	64	37,4	49,1
Senior staff	76	44,4	93,6
Close to retirement	11	6,4	100,0
Total	171	100,0	

Table 2. Structure of the sample per participant seniority level

As expected, the majority of respondents (81, i.e. 47,4%) belong to the STEM (Science, Technology, Engineering and Mathematics) teaching and research fields, followed by 43 research participants (25,1%) from social sciences, 21 respondents (12,3%) from the field of humanities and 26 (15,2%) from other fields. We further cross-tabulated the seniority levels ( $\chi^2=19.708$ , Sig. =0.183) and teaching/research fields ( $\chi^2=22.730$ , Sig.=0.90) with the affiliation of the participating respondents and have not established any empirically significant relationships.





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The obtained maturity scores of R&I digitalization/digital transformation (DIGI/DT) are presented in Table 3, showcasing the level of R&I digitalization maturity of each six core SEA-EU universities, per each dimension, as well as the overall R&I digitalization maturity score (averaged across the 11 dimensions)<sup>9</sup>. According to the results of the quantitative stage of this study, the highest level of R&I digitalization maturity has been achieved by the University of Malta (with a score of 70,5), closely followed by a group of three universities (University of Kiel, University of Cadiz and University of Split), with scores in 57,1 – 60,9 range. A group of two universities with somewhat lower levels of R&I digitalization maturity consists of University of Gdansk and University of Western Brittany (UBO), with scores in 53,3 – 55,1 range.

While the conventional ICT-based digital infrastructure for R&I digitalization seems to be highly developed (with the highest average score of 84,0 pts), the advanced ICT infrastructure involving technologies, such as simulations, virtual/augmented reality, blockchain technology, High-Performance Computing, etc., scores as the least mature dimension of R&I digitalization (with the average score of 33,1 pts). Incentives for R&I digitalization (with an average score of 68,6 pts) are perceived as more developed than the perceived barriers (with an average score of 60,4 pts). The overall capacity of SEA-EU universities to manage the R&I digitalization process is also perceived as high (with an average score of 67,9 pts).

However, university R&I digitalization strategy (average of 64,1 pts), staff training and up-skilling (average of 61,6 pts), and, especially, staff engagement and empowerment (average of 57,0 pts), call for further improvement across the SEA-EU alliance. The security of SEA-EU university data and systems is adequate (with an average score of 69,7 pts). In comparison, the contribution to sustainability (average of 57,8 pts) and, especially, data management practices (average of 45,0 pts) need to be improved.

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<sup>9</sup> The entire dataset and scoreboard are freely available at: <https://doi.org/10.5281/zenodo.7294131>





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	Dim 1.	Dim 2.	Dim 3.	Dim 4.	Dim 5.	Dim 6.	Dim 7.	Dim 8.	Dim 9.	Dim 10.	Dim 11.	Average score
<b>UNIVERSITY OF SPLIT</b>												
<b>SCORE (0-100)</b>	55,2	69,8	73,4	61,2	78,2	19,6	51,8	49,4	47,2	59,8	62,1	<b>57,1</b>
<b>UNIVERSITY OF WESTERN BRITTANY (UBO)</b>												
<b>SCORE (0-100)</b>	58,2	57,7	61,8	60,8	83,3	33,1	55,6	44,2	35,7	69,7	46,0	<b>55,1</b>
<b>UNIVERSITY OF MALTA</b>												
<b>SCORE (0-100)</b>	73,3	74,7	76,2	59,7	93,7	27,9	84,8	83,3	53,4	88,2	60,4	<b>70,5</b>
<b>UNIVERSITY OF CADIZ</b>												
<b>SCORE (0-100)</b>	66,9	68,7	74,3	68,6	81,8	35,9	57,2	48,7	36,3	63,8	63,6	<b>60,5</b>
<b>UNIVERSITY OF KIEL</b>												
<b>SCORE (0-100)</b>	67,1	68,5	57,4	51,5	82,8	48,7	58,3	59,4	52,6	67,0	57,0	<b>60,9</b>
<b>UNIVERSITY OF GDANSK</b>												
<b>SCORE (0-100)</b>	54,7	60,8	61,4	56,4	72,0	19,1	55,5	49,3	32,7	71,2	53,5	<b>53,3</b>
<b>DIMENSION AVERAGE</b>	<b>64,1</b>	<b>67,9</b>	<b>68,6</b>	<b>60,4</b>	<b>84,0</b>	<b>33,1</b>	<b>61,6</b>	<b>57,0</b>	<b>45,0</b>	<b>69,7</b>	<b>57,8</b>	

**Note:**

Dim 1. University strategy for R&amp;I digitalization

Dim 2. Perception of Critical Success Factors (CSFs) for university R&amp;I digitalization

Dim 3. Perception of university R&amp;I digitalization INCENTIVES

Dim 4. Perception of university R&amp;I digitalization BARRIERS

Dim 5. Digital technologies/solutions for university R&amp;I digitalization

Dim 6. Advanced digital technologies/solutions for university R&amp;I digitalization

Dim 7. Staff training &amp; up-skilling for university R&amp;I digitalization

Dim 8. Staff engagement &amp; empowerment for university R&amp;I digitalization

Dim 9. Data management for university R&amp;I digitalization

Dim 10. Data &amp; systems security for university R&amp;I digitalization

Dim 11. Sustainability for university R&amp;I digitalization

*Table 1. R&I digitalization/digital transformation scoreboard for core SEA-EU universities*

## Discussion

Referring to the R&I digitalization/digital transformation roadmap for SEA-EU universities, the current study captures the starting point of the process. It describes the current state of maturity for eleven dimensions relevant to the process. Many different maturity models could be used to discuss the current and the projected R&I DIGI/DT maturity levels, although the initial CMM (Capability Maturity Model) model, developed by the Carnegie Mellon Software Engineering Institute, might be the simplest and the most appropriate to use since it has served as a basis for the development of multiple maturity frameworks in the ICT field (Proença & Borbinha, 2016). According to the CMMI maturity terminology, each process/field enabled by ICTs can be classified into one of the following maturity categories as related to the level of its development and manageability (Dayan & Evans, 2006):

- Initial stage – characterized by informal processes, reactive management, and poor managerial controlling,
- Managed stage – the first stage, featuring formalized, (somewhat) manageable, and predictable processes, although still based on reactive management,
- Defined stage – further development of manageable processes, becoming more formalized and standardized, with the management becoming proactive,
- Quantitatively managed stage – characterized by the formal measurement and controlling of processes,
- Optimized stage – with a focus on process and management improvement.

Figure 4 depicts those generic maturity stages and the implied dynamics of maturity development. The higher levels are typically attained as an entity progresses through a series of developmental steps, leading it from lower to higher maturity levels.

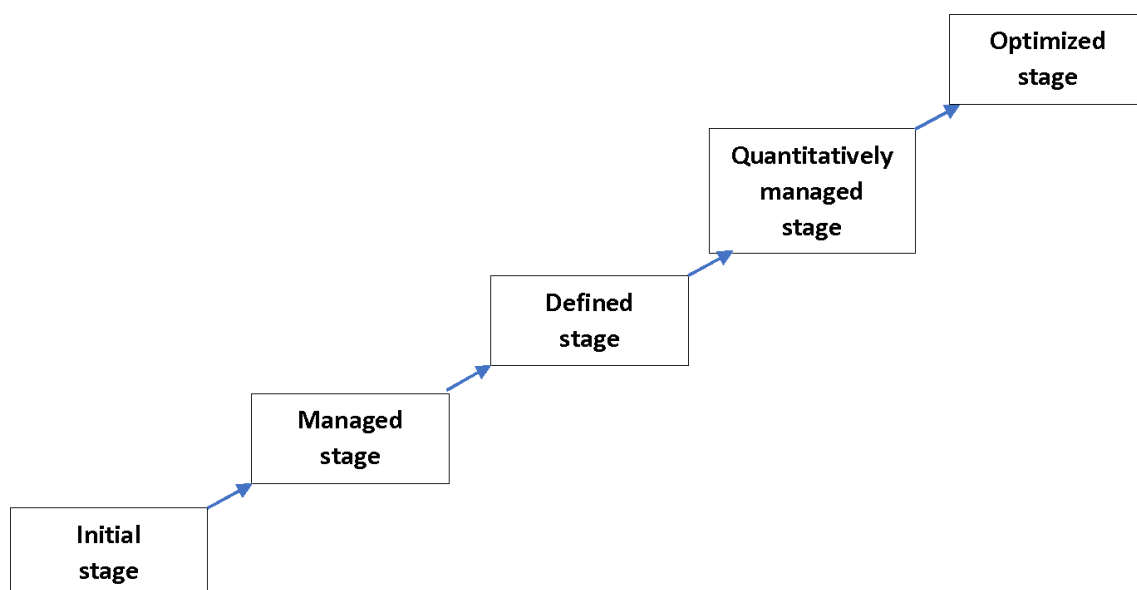


Figure 4. Generic maturity levels



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All the studied core SEA-EU universities could be positioned as transitioning from the managed to the defined maturity stage of R&I digitalization, except for the University of Malta, which could be described as transitioning from the defined to the quantitatively managed stage. However, it is much more interesting to analyze the entire alliance from the viewpoint of R&I digitalization maturity dimensions, where the following might be suggested:

- SEA-EU core universities have built comprehensive ICT infrastructures by adopting mainstream/conventional ICT solutions and systems, while the advanced ('cutting edge') digital infrastructure remains poorly developed.
- University strategy, staff training & up-skilling, as well as staff engagement & empowerment, remain underdeveloped across the entire SEA-EU alliance and could be positioned as transitioning from the initial to the managed stage – much work remains to be done in these aspects of R&I digitalization.
- The same applies to the data management and security of data and university systems relevant to R&I digitalization.
- While the perception of the readiness for R&I digitalization and incentives remains high, it is being countered by an equally high level of perceived barriers, which might slow the progression toward higher levels of R&I digitalization maturity.

#### **EXAMPLE CASE 1**

The University of Split is coordinating Blue Digital Innovation Hub - BlueDIH. This initiative enables regional competitiveness through pan-European networking, digital transformation, advanced digital skills, and transfer of knowledge and technology in High-Performance Computing (HPC) and Artificial Intelligence (AI) while nurturing digital skills for the benefit of the whole society. BlueDIH is organized around contact points and competence centres which include regional higher education institutions such as universities and polytechnics. It provides services to SMEs and the public sector to facilitate digital transformation.

Through collaborations, with domestic clients and international partners, a strong connection is established with digital innovation hubs throughout Europe services.

BlueDIH is a good example of the presence of digital transformation in individual universities.



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## Conclusion and Roadmap

This study described the current situation related to R&I digitalization/digital transformation across the core SEA-EU alliance members along the eleven dimensions selected to describe the R&I digitalization maturity levels. The analysis refers to the maturity of individual SEA-EU universities and the maturity of the entire alliance across the chosen R&I digitalization dimensions.

To facilitate the progression of the individual SEA-EU universities and the entire alliance toward higher R&I digitalization maturity levels, attention should be paid to cutting-edge ICT infrastructures, university digitalization strategies, staff training & up-skilling, as well as staff engagement & empowerment. Data management and data and systems security also require similar attention.

According to this study, R&I digitalization maturity dimensions are starting point for R&I digitalization/digital transformation roadmaps for SEA-EU universities. We achieved a better overview of individual universities' experiences, strategic goals and plans. Developing this analysis, we managed to make progress towards exploiting the opportunities in R&I digitalization/digital transformation of SEA-EU universities. All Universities of the SEA-EU alliance have a certain space for improvement and development in R&I digitalization/digital transformation.

It is **recommended that a comparable evaluation effort is exercised annually** to determine the dynamics of R&I digitalization development and the effectiveness of actions performed at the SEA-EU university member level and the level of the entire alliance.

### EXAMPLE CASE 2

SEA-EU is jointly working on a Digital Skills proposal under the Digital Europe Programme (DEP) call. DEP aims to bring digital technology to businesses, citizens, and public administrations. With a budget of €7.5 billion, it aims to accelerate economic recovery and shape Europe's digital transformation, benefiting everyone, but especially SMEs. Universities play a critical role in implementing this ambitious action as knowledge centres, education providers, and digitalization lighthouses.

Based on the findings of this study, we propose the following digital transformation roadmap for the SEA-EU alliance:

1. Consolidation of existing digitalization learning resources and development of new ones to allow for staff training and upskilling.
2. Increasing collaboration and knowledge exchange on "cutting-edge" digital infrastructures available across the alliance.
3. Enabling interest group networking for increased digitalization capacity and learning.
4. Establishment of an alliance-level working group to coordinate, revise, and implement digitalization strategies.
5. Annual evaluation and benchmarking of digital transformation.

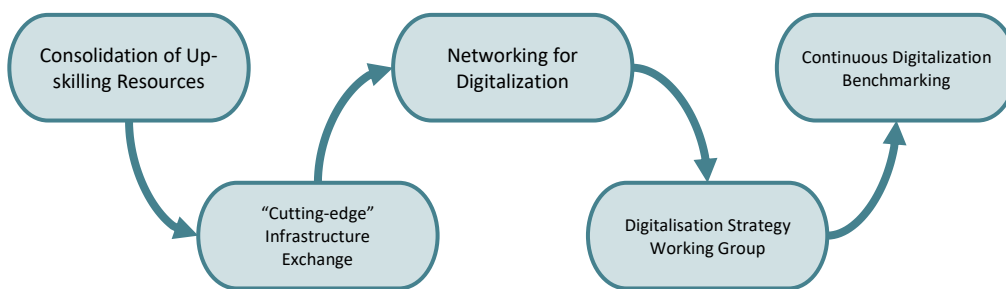


Figure 5. R&I digitalization/digital transformation roadmap for SEA-EU universities



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## References

1. Crupi, A., Del Sarto, N., Di Minin, A., Gregori, G. L., Lepore, D., Marinelli, L., & Spigarelli, F. (2020). The digital transformation of SMEs—a new knowledge broker called the digital innovation hub. *Journal of Knowledge Management*, 24 (6), 1263-1288. DOI: 10.1108/JKM-11-2019-0623
2. Handcock, M. S., & Gile, K. J. (2011). Comment: On the concept of snowball sampling. *Sociological Methodology*, 41(1), 367-371. DOI: 10.1111/j.1467-9531.2011.01243.x
3. JRC Seville (2022). *Practical guidelines on the use of the Digital Maturity Assessment (DMA) tool & the Innovation Radar Methodology (IR)*.
4. Khamisi, R. (2020). Coronavirus in context: Scite.ai tracks positive and negative citations for COVID-19 literature. *Nature*. DOI: 10.1038/d41586-020-01324-6
5. Krueger, R. A. (2014). *Focus groups: A practical guide for applied research* (5<sup>th</sup> Edition). Sage Publications.
6. Dayan, R., & Evans, S. (2006). KM your way to CMMI. *Journal of Knowledge Management*. 10 (1), 69-80. DOI: 10.1108/13673270610650111
7. Proença, D., & Borbinha, J. (2016). Maturity models for information systems—a state of the art. *Procedia Computer Science*, 100, 1042-1049. DOI: 10.1016/j.procs.2016.09.279
8. Skokic, V., Lynch, P., & Morrison, A. (2016). Hotel entrepreneurship in a turbulent environment. *International Journal of Hospitality Management*, 53, 1-11. DOI: 10.1016/j.ijhm.2015.11.008
9. Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, 2, 53. DOI: 10.5116/ijme.4dfb.8dfd
10. Terrell, S. R. (2012). Mixed-methods research methodologies. *Qualitative Report*, 17 (1), 254-280. DOI: 10.46743/2160-3715/2012.1819





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## Appendix I. Initial body of literature on university R& digitalization

1. Principles and critical factors of university/higher education digitalization/digital transformation (DIGI/DT) - consisting of 23 previous studies:
  1. Adedoyin, O.B., Soykan, E., 2020. Covid-19 pandemic and online learning: the challenges and opportunities. *Interactive Learning Environments* 1–13. <https://doi.org/10.1080/10494820.2020.1813180>
  2. Alenezi, M., 2021. Deep Dive into Digital Transformation in Higher Education Institutions. *Education Sciences* 11, 770. <https://doi.org/10.3390/educsci11120770>
  3. Almahasees, Z., Mohsen, K., Amin, M.O., 2021. Faculty's and Students' Perceptions of Online Learning During COVID-19. *Front. Educ.* 6, 638470. <https://doi.org/10.3389/educ.2021.638470>
  4. Benavides, L., Tamayo Arias, J., Arango Serna, M., Branch Bedoya, J., Burgos, D., 2020. Digital Transformation in Higher Education Institutions: A Systematic Literature Review. *Sensors* 20, 3291. <https://doi.org/10.3390/s20113291>
  5. Bond, M., Marín, V.I., Dolch, C., Bedenlier, S., Zawacki-Richter, O., 2018. Digital transformation in German higher education: student and teacher perceptions and usage of digital media. *Int J Educ Technol High Educ* 15, 48. <https://doi.org/10.1186/s41239-018-0130-1>
  6. Brooks, D.C., McCormack, M., 2020. Driving Digital Transformation in Higher Education. ECAR research report. Louisville, CO: ECAR.
  7. Burgos, D., Branch, J.W. (Eds.), 2021. Radical Solutions for Digital Transformation in Latin American Universities: Artificial Intelligence and Technology 4.0 in Higher Education, Lecture Notes in Educational Technology. Springer Singapore, Singapore. <https://doi.org/10.1007/978-981-16-3941-8>
  8. Bygstad, B., Øvrelid, E., Ludvigsen, S., Dæhlen, M., 2022. From dual digitalization to digital learning space: Exploring the digital transformation of higher education. *Computers & Education* 182, 104463. <https://doi.org/10.1016/j.compedu.2022.104463>
  9. Carvalho, A., Alves, H., Leitão, J., 2022. What research tells us about leadership styles, digital transformation and performance in state higher education? *IJEM* 36, 218–232. <https://doi.org/10.1108/IJEM-11-2020-0514>
  10. Cerdá Suárez, L.M., Núñez-Valdés, K., Quirós y Alpera, S., 2021. A Systemic Perspective for Understanding Digital Transformation in Higher Education: Overview and Subregional Context in Latin America as Evidence. *Sustainability* 13, 12956. <https://doi.org/10.3390/su132312956>
  11. Farias-Gaytan, S., Aguaded, I., Ramirez-Montoya, M.-S., 2022. Transformation and digital literacy: Systematic literature mapping. *Educ Inf Technol* 27, 1417–1437. <https://doi.org/10.1007/s10639-021-10624-x>
  12. García-Morales, V.J., Garrido-Moreno, A., Martín-Rojas, R., 2021. The Transformation of Higher Education After the COVID Disruption: Emerging



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- Challenges in an Online Learning Scenario. *Front. Psychol.* 12, 616059. <https://doi.org/10.3389/fpsyg.2021.616059>
13. García-Peñalvo, F.J., 2021. Avoiding the Dark Side of Digital Transformation in Teaching. An Institutional Reference Framework for eLearning in Higher Education. *Sustainability* 13, 2023. <https://doi.org/10.3390/su13042023>
  14. livari, N., Sharma, S., Ventä-Olkkonen, L., 2020. Digital transformation of everyday life – How COVID-19 pandemic transformed the basic education of the young generation and why information management research should care? *International Journal of Information Management* 55, 102183. <https://doi.org/10.1016/j.ijinfomgt.2020.102183>
  15. Luna, F.D.S., Breternitz, V.J., 2021. DIGITAL TRANSFORMATION IN PRIVATE BRAZILIAN HIGHER EDUCATION INSTITUTIONS: PRE-CORONAVIRUS BASELINE. *RAM, Rev. Adm. Mackenzie* 22, eRAMD210127. <https://doi.org/10.1590/1678-6971/eramd210127>
  16. Mergel, I., Edelman, N., Haug, N., 2019. Defining digital transformation: Results from expert interviews. *Government Information Quarterly* 36, 101385. <https://doi.org/10.1016/j.giq.2019.06.002>
  17. Mohamed Hashim, M.A., Tlemsani, I., Matthews, R., 2022. Higher education strategy in digital transformation. *Educ Inf Technol* 27, 3171–3195. <https://doi.org/10.1007/s10639-021-10739-1>
  18. Monteiro, A., Leite, C., 2021. Digital literacies in higher education: Skills, uses, opportunities and obstacles to digital transformation. *Red* 21. <https://doi.org/10.6018/red.438721>
  19. Nurhas, I., Aditya, B.R., Jacob, D.W., Pawlowski, J.M., 2021. Understanding the challenges of rapid digital transformation: the case of COVID-19 pandemic in higher education. *Behaviour & Information Technology* 1–17. <https://doi.org/10.1080/0144929X.2021.1962977>
  20. Posselt, T., Abdelkafi, N., Fischer, L., Tangour, C., 2018. Opportunities and challenges of Higher Education institutions in Europe: An analysis from a business model perspective. *Higher Educ Q* hequ.12192. <https://doi.org/10.1111/hequ.12192>
  21. Reis, J., Amorim, M., Melão, N., Matos, P., 2018. Digital Transformation: A Literature Review and Guidelines for Future Research, in: Rocha, Á., Adeli, H., Reis, L.P., Costanzo, S. (Eds.), *Trends and Advances in Information Systems and Technologies, Advances in Intelligent Systems and Computing*. Springer International Publishing, Cham, pp. 411–421. [https://doi.org/10.1007/978-3-319-77703-0\\_41](https://doi.org/10.1007/978-3-319-77703-0_41)
  22. Rof, A., Bikfalvi, A., Marques, P., 2022. Pandemic-accelerated Digital Transformation of a Born Digital Higher Education Institution 19.
  23. Rof, A., Bikfalvi, A., Marquès, P., 2020. Digital Transformation for Business Model Innovation in Higher Education: Overcoming the Tensions. *Sustainability* 12, 4980. <https://doi.org/10.3390/su12124980>

2. Barriers and obstacles to HE DIGI/DT – consisting of 10 previous studies:
  1. Aditya, B.R., Ferdiana, R., Kusumawardani, S.S., 2022a. A barrier diagnostic framework in process of digital transformation in higher education institutions. *JARHE* 14, 749–761. <https://doi.org/10.1108/JARHE-12-2020-0454>
  2. Aditya, B.R., Ferdiana, R., Kusumawardani, S.S., 2022b. A barrier diagnostic framework in process of digital transformation in higher education institutions. *JARHE* 14, 749–761. <https://doi.org/10.1108/JARHE-12-2020-0454>
  3. Aditya, B.R., Ferdiana, R., Kusumawardani, S.S., 2021. Barriers to Digital Transformation in Higher Education: An Interpretive Structural Modeling Approach. *Int. J. Innovation Technol. Management* 18, 2150024. <https://doi.org/10.1142/S0219877021500243>
  4. Alhubaishy, A., Aljuhani, A., 2021. The challenges of instructors' and students' attitudes in digital transformation: A case study of Saudi Universities. *Educ Inf Technol* 26, 4647–4662. <https://doi.org/10.1007/s10639-021-10491-6>
  5. Buchmann, R.A., Polini, A., Johansson, B., Karagiannis, D. (Eds.), 2021. Perspectives in Business Informatics Research: 20th International Conference on Business Informatics Research, BIR 2021, Vienna, Austria, September 22–24, 2021, Proceedings, Lecture Notes in Business Information Processing. Springer International Publishing, Cham. <https://doi.org/10.1007/978-3-030-87205-2>
  6. Kopp, M., Gröblinger, O., Adams, S., 2019. FIVE COMMON ASSUMPTIONS THAT PREVENT DIGITAL TRANSFORMATION AT HIGHER EDUCATION INSTITUTIONS. Presented at the 13th International Technology, Education and Development Conference, Valencia, Spain, pp. 1448–1457. <https://doi.org/10.21125/inted.2019.0445>
  7. Ramli, M.F., Majid, M., Badyalina, B., 2020. Impeding Factors Towards the Effectiveness of Online Learning During Covid-19 Pandemic among Social Sciences Students. *IJLD* 10, 37. <https://doi.org/10.5296/ijld.v10i4.17921>
  8. Rocha, Á., Gonçalves, M.J.A., da Silva, A.F., Teixeira, S., Silva, R., 2022. Leadership challenges in the context of university 4.0. A thematic synthesis literature review. *Comput Math Organ Theory* 28, 214–246. <https://doi.org/10.1007/s10588-021-09325-0>
  9. Rodríguez-Abitia, G., Bribiesca-Correa, G., 2021. Assessing Digital Transformation in Universities. *Future Internet* 13, 52. <https://doi.org/10.3390/fi13020052>
  10. Vicente, P.N., Lucas, M., Carlos, V., Bem-Haja, P., 2020. Higher education in a material world: Constraints to digital innovation in Portuguese universities and polytechnic institutes. *Educ Inf Technol* 25, 5815–5833. <https://doi.org/10.1007/s10639-020-10258-5>
3. Enablers of HE DIGI/DT – consisting of 10 previous studies:
  1. Agasisti, T., Frattini, F., Soncin, M., 2020. Digital Innovation in Times of Emergency: Reactions from a School of Management in Italy. *Sustainability* 12, 10312. <https://doi.org/10.3390/su122410312>



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2. Carvalho, A., Alves, H., Leitão, J., 2022. What research tells us about leadership styles, digital transformation and performance in state higher education? *IJEM* 36, 218–232. <https://doi.org/10.1108/IJEM-11-2020-0514>
3. Curaj, A., Deca, L., Pricopie, R. (Eds.), 2020. *European Higher Education Area: Challenges for a New Decade*. Springer International Publishing, Cham. <https://doi.org/10.1007/978-3-030-56316-5>
4. Eri, R., Gudimetla, P., Star, S., Rowlands, J., Girgla, A., To, L., ... & Bindal, U. (2021). Digital Resilience in Higher Education in Response to COVID-19 Pandemic: Student Perceptions from Asia and Australia. *Journal of University Teaching and Learning Practice*, 18(v5), 7. <https://doi.org/10.53761/1.18.5.7>
5. Farias-Gaytan, S., Aguaded, I., Ramirez-Montoya, M.-S., 2022. Transformation and digital literacy: Systematic literature mapping. *Educ Inf Technol* 27, 1417–1437. <https://doi.org/10.1007/s10639-021-10624-x>
6. Garcez, A., Silva, R., Franco, M., 2022. Digital transformation shaping structural pillars for academic entrepreneurship: A framework proposal and research agenda. *Educ Inf Technol* 27, 1159–1182. <https://doi.org/10.1007/s10639-021-10638-5>
7. Mohamed Hashim, M.A., Tlemsani, I., Duncan Matthews, R., 2022. A sustainable University: Digital Transformation and Beyond. *Educ Inf Technol* 27, 8961–8996. <https://doi.org/10.1007/s10639-022-10968-y>
8. Ralph, B.J., Woschank, M., Pacher, C., Murphy, M., 2022. Evidence-based redesign of engineering education lectures: theoretical framework and preliminary empirical evidence. *European Journal of Engineering Education* 47, 636–663. <https://doi.org/10.1080/03043797.2021.2025341>
9. Sánchez Ruiz, L.M., Moll-López, S., Moraño-Fernández, J.A., Llobregat-Gómez, N., 2021. B-Learning and Technology: Enablers for University Education Resilience. An Experience Case under COVID-19 in Spain. *Sustainability* 13, 3532. <https://doi.org/10.3390/su13063532>
10. Sousa, M.J., Marôco, A.L., Gonçalves, S.P., Machado, A. de B., 2022. Digital Learning Is an Educational Format towards Sustainable Education. *Sustainability* 14, 1140. <https://doi.org/10.3390/su14031140>



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## Appendix II. Research themes for discussions at semi-structured focus-groups (conducted in May 2022)

- What are your general experiences with digitalization/digital transformation of the university, as you experienced them during the Covid crisis?
- Who is the relevant management or advisory staff on the topic, or under whose remit digitalization belongs (e.g. vice-rector for business development or other)? Who participates in the focus group and what is their relationship to the digitalization theme?
- Is there any formal R&I digitalization strategy and action plan (formal document drafted or officially adapted; at the informal discussion stage; non-existent). Which areas of university activities are considered in your university, when discussing formal R&I digitalization strategy?
- What is the stage of digital infrastructure readiness? (Are there any strategies/action plans and assessments, or working papers/notes on IT infrastructure development and its readiness?) Which IT services (e.g. Website, live chat on the Website, integration of social networks, e-learning, remote collaboration tools, Intranet, virtual reality, blockchain...) are considered by your university to be: (A) essential for the digitalization of R&I? (B) advanced (nice-to-have, but not essential) of the R&I digitalization?
- How ready are researchers' & support staff for R&I digitalization, with a focus on training, up-skilling and motivation initiatives? (Are there any strategies/action plans and assessments, or working papers/notes on researcher & support staff development and readiness for digitalization?)
- Which training and up-skilling activities (e.g. skill assessment gaps, training plans, internal and external training sessions, formal education of key persons, state subsidies for required education and training...) does your university consider to be essential for R&I digitalization? What about motivation and empowering activities to get the R&I digitalization going (e.g. creating staff awareness, communicating digitalization topics, measuring staff acceptance levels of digitalization, involving staff, setting up new work activities, allowing flexible work arrangements...)?
- Please assess the digitalization of research data and its usage at your university. What dimensions of digitalizing and using research data should be considered, when considering R&I digitalization?
- What is the state of digitalization of collaboration with academic and company partners, funders and other R&I stakeholders (Are there any strategies/action plans and assessments, or working papers/notes on digital collaboration in HEI R&I activities?)
- Do you consider R&I digitalization to contribute to environmental sustainability of the university? What dimensions should be considered, when thinking about this topic?



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## Appendix III. Questionnaire for quantitative data collection (conducted from June to September 2022)

Q1 Is digitalization present in your research and innovation, and how are our universities managing it? These are just some questions that we need your help with for us to prepare a SEA-EU roadmap for the digital transformation of research and innovation.

**It is important to note that when answering questions, you should always have research and innovation activities in mind as education is already well studied.**

This survey is part of an ongoing research initiative led by the University of Split. Inquiries may be addressed to PI: Nikša Alfirić at [nalf@efst.hr](mailto:nalf@efst.hr). This survey is being distributed amongst the six universities of the European University of the Seas (SEA-EU) alliance and their associated partners.

### Technical details:

The survey takes up to 9 minutes to complete. We are collecting responses up to 30 September 2022.

### Legal details:

**Consent for storing your answers for data collection and treatment purposes (only summarized aggregated results will be published; no individual answers will be published). All responses are anonymized.**

All interested participants will be informed of the outcomes of the research. The research results will also be published on the project website <https://sea-eu.org/researcheu/>.

Giving your consent to taking part in this survey, you give consent to the details described above. You have the right to revoke your consent within 90 days after the research by the project ends, without specifying reasons for doing so. This revocation only affects the future, i.e., processing up to the revocation date remains valid. Contact for revoke: [marko.vuckovic@unist.hr](mailto:marko.vuckovic@unist.hr).

If you believe that your data's processing violates the legal provisions, you can lodge a complaint with the supervisory authority. If you wish to exercise a right, please contact the relevant university office or the UNIST Data Protection Officer ([maja.mijatovic@unist.hr](mailto:maja.mijatovic@unist.hr)).

1. What is the name of your (SEA-EU member/partner) university?

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2. If you wish to be notified about our research results, please write your e-mail (optional):

\_\_\_\_\_

3. What is your role at the university? (optional):

\_\_\_\_\_





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4. How would you describe your seniority level at the university?

- Junior staff (1)
- Mid-career staff (2)
- Senior staff (3)
- Close to retirement (4)

5. What is your primary research and teaching field?

- Science, Technology, Engineering & Mathematics (STEM) (1)
- Social Science(s) (2)
- Humanities (3)
- Other (please specify): (4) \_\_\_\_\_



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6. How has your university been preparing for the digitalization of research & development processes? <b>(Dimension 1)</b>	Yes (1)	No (2)	Not sure/ Don't know (3)
We have established the formal roles and responsibilities for digitalization at the university and the department (faculty) levels. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We have identified our digitalization needs and aligned them with our university strategy and objectives. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We have a formal planning document (such as the digitalization roadmap). (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We have identified or secured financial resources for research & development digitalization. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We have established the Information & Communication Technology (ICT) infrastructure for research & development digitalization. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We have access to the required, specialized ICT staff for implementation of digitalization and introduction of new ICT solutions. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We have access to the required, specialized ICT staff for training and supporting our employees. (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
University management is ready to lead the required organizational changes. (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



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This university already offers some digital services to its students and other users. (9)

We use surveys, or other tools, to assure the quality of digital services and user satisfaction. (10)

We have considered the risks of digitalization. (11)



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7. How important do you assess the following <b>critical elements</b> for the university digitalization? <b>(Dimension 2)</b>	Not important (1)	Slightly important (2)	Moderately important (3)	Important (4)	Very important (5)
University becoming a digitalization leader. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enhancing experience of our students, researchers and partners. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Fostering innovation. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Leveraging modern technologies. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Incremental upgrade of universities offerings. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reskilling the researchers and other staff. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Organizational culture change. (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Enabling better management and business processes. (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify): (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



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8. How would you rate the following incentives for digitalizing research & development at your university?  
**(Dimension 3)**

Not important (1)      Slightly important (2)      Moderately important (3)      Important (4)      Very important (5)

Compliance with EU-level and other international digitalization strategies and initiatives. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Compliance with national digitalization strategies and initiatives. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Using EU-level projects and other international funding opportunities. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Using national project and funding opportunities. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Open science (open research data, open access) requirements at the EU- or the international level. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Open science (open research data, open access) requirements at the national level. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Achieving a higher level of environmental sustainability. (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



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Unforeseen external circumstances (such as the COVID-19 pandemic) (8)

Other (please specify): (9)

<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>







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9. How would you rate the following <b>barriers</b> to the digitalization of research & development at your university? <b>(Dimension 4)</b>	Not important (1)	Slightly important (2)	Moderately important (3)	Important (4)	Very important (5)
Lack of strategic vision and planning at your university. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inadequate policies and operational planning at your university. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inadequate human resources' knowledge or expertise. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of organizational leadership at your university. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Researcher and staff acceptance of digital transformation at your university. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Inadequate funding. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Weak or unsupportive digital infrastructure. (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of technical support to researchers and staff. (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Limitations of the digital technology (e.g., cannot substitute the actual lab work). (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



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Other (please specify): (10)





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10. Which <b>digital technologies/solutions</b> are already used/applied at your university? <b>(Dimension 5)</b>	Yes (1)	No (2)
University and department (faculty, organizational unit) Websites. (1)	<input type="radio"/>	<input type="radio"/>
Connectivity infrastructure (high-speed Internet, remote access to the office systems, located at the university/department) (2)	<input type="radio"/>	<input type="radio"/>
Licensed teleconferencing infrastructure (including audio & video equipment, licenses for Zoom, WebEx, MS Teams, etc.). (3)	<input type="radio"/>	<input type="radio"/>
Digital teaching infrastructure (such as Moodle and other Learning Management Systems and similar software solutions). (4)	<input type="radio"/>	<input type="radio"/>
Remote access to research infrastructure (such as servers, specialized software, remote collaboration capabilities, the full text of subscribed journals, etc. - located at the university/department, or in the cloud). (5)	<input type="radio"/>	<input type="radio"/>
Open research data portal with remote access. (6)	<input type="radio"/>	<input type="radio"/>
Solution(s) for digital communication with students, clients, and other stakeholders (via the Website or another digital solution). (7)	<input type="radio"/>	<input type="radio"/>
Outreach and digital communications with students, clients, and other stakeholders via social networks. (8)	<input type="radio"/>	<input type="radio"/>
Digital communication with the government institutions, including public e-procurement procedures. (9)	<input type="radio"/>	<input type="radio"/>
Internal employee portal (Intranet) for provision of administrative and other (self) services. (10)	<input type="radio"/>	<input type="radio"/>
Cybersecurity and compliance with Personal Data solutions. (11)	<input type="radio"/>	<input type="radio"/>

11. Which <b>advanced digital technologies</b> are already used/applied (not just a subject of research) at your university? <b>(Dimension 6)</b>	Not used (1)	Consider to use (2)	Testing (3)	Operational (4)	Not sure/ Don't know (5)
Simulation & digital twins (i.e., real-time digital representations of physical objects/processes). (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Virtual and augmented reality. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Blockchain technology. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
High-Performance Computing (supercomputers and computer clusters). (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Internet of Things. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Advanced robotics and cognitive automation. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify): (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



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<p>12. Which <b>training and up-skilling activities</b> have been performed as a part of your university's research &amp; development digitalization efforts? <b>(Dimension 7)</b></p>	Yes (1)	No (2)	Not sure/ Don't know (3)
<p>We have performed the digital skills assessment for our researchers and staff. (1)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We have created a plan for digital re-skilling and up-skilling at our university. (2)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We organize short, in-house training sessions (including e-learning) and provide digital training content to our researchers and staff. (3)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We facilitate on-the-job learning and learning from peers. (4)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We use academic mobility programs (such as Erasmus+), make use of the internships and other opportunities for digital re-skilling and up-skilling at our university. (5)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We use EU- and internationally funded projects and other opportunities to financially support training, re-skilling, and up-skilling at our university. (6)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We use nationally funded projects and other opportunities to financially support training, re-skilling, and up-skilling at our university. (7)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We facilitate and finance support training provided by external organizations and providers. (8)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



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<p>13. Which of the following activities have been performed as a part of your university's research &amp; development digitalization efforts? <b>(Dimension 8)</b></p>	Yes (1)	No (2)	Not sure/ Don't know (3)
<p>We have actively presented and communicated the digitalization incentives, plans, and activities to our researchers and staff. (1)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We have made all efforts to include all stakeholders, including external, into our communications. (2)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We monitor acceptance of the digitalization initiatives and make sure that employee and stakeholder concerns are addressed. (3)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We have consulted users of the digital infrastructure and services about their needs and included them in the design and development of ICT systems and solutions to be implemented at our university. (4)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>Our researchers and staff have a high level of autonomy and appropriate ICT tools available when it comes to performing research and development activities. (5)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>Our researchers and staff can negotiate changes of their jobs/roles, formal procedures, and workflows to support their preferred way of work and use the digitalization opportunities. (6)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



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Our university makes it possible for researchers and staff to negotiate flexible work hours and arrangements, including remote and hybrid work, even when COVID-related measures do not mandate it. (7)

We have a specialized ICT team, or a department, available to efficiently support our researchers and staff.

(8)







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Q14. How do you manage your research and other university data?

**(Dimension 9)**

Yes (1)

No (2)

We digitally store the majority of our data, although there is no central integration – data is distributed across different systems. There are differences in remote accessibility and interfaces used. (1)

The majority of our data is digitally stored and integrated with a unified system for remote access. (2)

The majority of our data is available remotely, without the need to consult an IT expert or support service (e.g., via the Intranet, user portal/dashboard, or a similar ICT system). (3)

The majority of our data is available in real-time as soon as it is produced. (4)

Our university uses the Data Warehousing practice, i.e., we have created a centralized database, storing and integrating all relevant internal and external data. (5)

Our university uses the Business Intelligence practice, i.e., we are systematically analyzing all available data to support the university management and other decision-makers at the university. (6)



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<p>15. Which of the following activities related to cyber-security are regularly performed at your university? <b>(Dimension 10)</b></p>	Yes (1)	No (2)	Not sure/ Don't know (3)
<p>We have created formal plans for the data and cyber-security measures, including relevant university policies and procedures. (1)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We have in place a continuity plan, in case the university data, or the critical parts of the ICT infrastructure fail or become unavailable. (2)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We take special precautions for the security of students, clients and external stakeholders' data, stored at our university. (3)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We have been training researchers and staff in data and cyber-security issues. (4)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We have an ICT specialist, a team, or a department, formally in charge of assessing threats and responding to cyber-security issues. (5)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>We maintain regular backups of university data (off-site, in the cloud). (6)</p>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



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16. How would you assess the environmental consequences of digitalization at your university? <b>(Dimension 11)</b>	No (1)	Partially (2)	Yes (3)
Digitalization helps us achieve a more sustainable service to students, staff and other stakeholders. (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Digitalization helps us to reduce waste, energy consumption, and our carbon footprint. (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Digitalization helps us achieve paperless work processes. (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We use the sustainability criteria when selecting digital technology and its vendors. (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We monitor and manage the energy usage of digital equipment. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
We recycle the old digital equipment. (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>