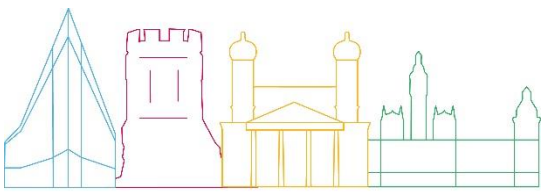
ARCH

ARCH D3.6

Report on co-creating the ARCH HUB and ARCH RAD



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Executive Summary

This deliverable has been prepared for the European Commission-funded research project *ARCH: Advancing Resilience of historic areas against Climate-related and other Hazards.* It is the key output of task 3.4.5 *'Co-create the Resilience Assessment Framework and Platform'* and describes the co-creation process for developing the ARCH HUB and ARCH Resilience Assessment Dashboard (RAD), which collectively constitute the *'ARCH management platform'* (also called *'ARCH data and information platform'*).

The co-creation of the HUB and RAD has followed an extremely flexible approach to account for changing needs of city partners as well as necessary development adjustments due to the COVID-19 pandemic. The split of the *'ARCH management platform'* into the HUB and RAD is a result of these processes. While the RAD provides an online self-assessment for decision makers in heritage management, disaster risk management, climate change adaptation, and resilience at regional, municipal, and historic area level, to collaboratively evaluate and monitor the resilience maturity of a historic area according to the ARCH Resilience Framework described in D7.3 [1], it allows these end-users to identify resilience weak spots, and supports the formulation of resilience action plans. The HUB provides a resilience knowledge base that gives end-users detailed information on how to apply the ARCH Resilience Framework, gives access to best practices in resilience building (as provided in D7.2 [2]), and provides a directory of tools, methods, handbooks, and other helpful resources for resilience building (from ARCH and beyond), linked to the steps of the ARCH Resilience Framework as well as the different topics covered by the RAD.

To achieve the goals of the co-creation process Fraunhofer employed combinations of different techniques: From guided group **interviews/questionnaires** in small groups, to dedicated update or working **sessions** at project meetings, to dedicated **workshops**, and guided remote **exercises.** Methodically, this co-creation process employed a four-pillar approach:

- Systematic elicitation, analysis, assessment, and consolidation of user needs and stakeholder requirements to inform the development process (see also D7.4 [3]);
- Frequent testing of prototypical results to gather feedback from project partners and end-users;
- Co-development of content with project partners;
- Application of (almost) final results by city partners and their local stakeholders.

Using these techniques and methodologies, the ARCH HUB and RAD have been designed, developed, tested, and successfully applied via a three-year process that did not only involve the four pilot cities of ARCH, but also the 12 other project partners, as well as 12 Foundation cities from ARCH's Mutual Learning Framework. In addition, 28 project external persons have been involved in the co-creation of the foundation of the HUB and RAD, the ARCH Resilience Framework, as part of the CEN Workshop Agreement development process. The approach allowed to involve a large number of diverse actors with different backgrounds in the co-creation process, ensuring the trans-disciplinary applicability of the HUB and RAD. This modular and agile approach also allowed to account for changing time and personnel availabilities and to clearly identify at every stage what was required by whom and what could be expected to result from the process.

Not only was this co-creation process able to include continuous feedback loops to transfer end-user needs and knowledge into the development of the HUB and RAD, but it also enabled successful knowledge transfer between research partners and end-users, as demonstrated by the example application of the RAD by the ARCH city partners.

This report describes the co-creation process of the RAD and HUB in detail, which feedback was acquired by different participants in the co-creation process, and how the feedback was used to enhance the HUB and RAD. It also provides some general lessons learned for the co-creation process to provide researchers, city officials and other professionals interested in co-creation with guidance on how to design their own process.

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List of Abbreviations

Abbreviation	Meaning
DoA	Description of the Action
DSS	Decision Support System
HArIS	Historic Area Information System
RAD	Resilience Assessment Dashboard
RMI	Resilience Measures Inventory
RPVT	Resilience Pathway Visualization Tool
THIS	Threats and Hazard Information System
WP	Work Package

1. Introduction

This deliverable has been prepared for the European Commission-funded research project *ARCH: Advancing Resilience of historic areas against Climate-related and other Hazards.* ARCH develops decision support tools and methods to improve the resilience of historic areas to climate change-related and other hazards. These tools and methods are developed with the pilot cities of Bratislava (Slovakia), Camerino (Italy), Hamburg (Germany), and València (Spain) in a co-creative approach, including local policymakers, practitioners, and community members. The resulting solutions are bundled in a resilience knowledge base that supports guided resilience building (the ARCH HUB), and include

- an information management system for geo-referenced properties of historic areas (HArIS);
- an information management system for geo-referenced data regarding hazards, risks and impact indicators (THIS);
- a Decision Support System (DSS) for risk and impact analysis of historic areas;
- an inventory of resilience building measures linked to appropriate financing sources (RMI);
- a visual planning tool for resilience pathways (RPVT); and
- a resilience assessment dashboard (RAD) to evaluate and monitor the resilience maturity of a historic area, identify resilience weak points, and formulate resilience action plans.

This report (D3.6) is the key output of task 3.4.5 '*Co-create the Resilience Assessment Framework and Platform'* and describes the co-creation process for developing the ARCH HUB and ARCH RAD, which collectively constitute the *'ARCH management platform'* (also called *'ARCH data and information platform'*) described in the Description of the Action (DoA) of the ARCH project. While task 3.4.5 primarily involved Fraunhofer IAIS as the leading partner as well as the city partners Hamburg, València, Camerino, Bratislava and the (local research) partners ICLEI, Tecnalia, DIN, UNICAM, UNIBA and MÚOP, the development of the HUB and RAD also involved all other project partners (via links to tasks 7.3, 7.4, 7.5, 7.6, and 7.7) as well as the ARCH Keystone cities via the Mutual Learning Framework of task 3.6.

The co-creation of the HUB and RAD has followed an extremely flexible approach to account for changing needs of city partners as well as necessary development adjustments due to the COVID-19 pandemic. The split of the *'ARCH management platform'* into the HUB and RAD is a result of these processes. It became clear that a single integrated system containing all the solutions offered by the different work packages (WPs) of ARCH would be too complex, hindering easy comprehension by end-users and integration with existing local processes as well as existing systems in the pilot cities. In addition, a deep integration of the different solutions would make exploitation of individual elements of the ARCH solution landscape more difficult (see also D7.5 [4]). Therefore, the *'ARCH management platform'* was split into

- the RAD, which provides an online self-assessment for decision makers in heritage management, disaster risk management, climate change adaptation, and resilience at regional, municipal, and historic area level, to collaboratively evaluate and monitor the resilience maturity of a historic area according to the ARCH Resilience Framework

described in D7.3 [1], allows these end-users to identify resilience weak spots, and supports the formulation of resilience action plans; and

- the HUB, which provides a resilience knowledge base that gives end-users detailed information on how to apply the ARCH Resilience Framework, gives access to best practices in resilience building (as provided in D7.2 [2]), and provides a directory of tools, methods, handbooks, and other helpful resources for resilience building (from ARCH and beyond), linked to the steps of the ARCH Resilience Framework as well as the different topics covered by the RAD.

Acknowledging the change explained above, this deliverable D3.6, originally titled *'Evaluation report of the ARCH management platform'* in the DoA, has been renamed to *'Report on co-creating the ARCH HUB and ARCH RAD'*. Regardless of the name change, this deliverable reports about the co-creation process for developing the ARCH HUB and the ARCH RAD, which partners and stakeholders were involved, which feedback was gathered and what lessons were learned for the development of the HUB and RAD.

1.1. Relation to other deliverables

As this deliverable reports on the co-creation process of the HUB and RAD, it is strongly related to D3.1 [5], the guideline on the ARCH co-creation approach. By its nature, this deliverable is also strongly related to D7.6, which will describe the methodological and technical background of the HUB and RAD in more detail and provides a user manual for the RAD as well as D7.4 [3], which provides a collection of the end-user requirements to the ARCH tools and methodologies. Lastly, this deliverable is also related to D3.7, the case studies report, which will contain the results of applying the RAD with the ARCH pilot cities.

1.2. Gender statement

This document has been developed taking into consideration the guidance on gender in research provided in the Project Handbook (D1.2 [6]) as well as State-of-the-Art report number 5 of deliverable D7.1 on *'Gender aspects in conservation and regulation of historic areas, disaster risk management, emergency protocols, post-disaster response techniques, and techniques for building back better'* [7].

Following these guidelines, the Fraunhofer team tried to ensure – to the best of its capabilities – equal participation of women in all co-creation activities and tried to also ensure that the voices of women and minorities received the required attention during the co-creation processes.

1.3. Structure of this report

This report is divided into four sections. Following this introduction, section 2 provides a general description of the co-creation process followed for the HUB and RAD. Section 3 follows with a detailed description of the individual co-creation steps, before section 4 provides a short conclusion and an outlook on the next steps.

2. General process description

Box 1 – The ARCH co-creation definition, D3.1 [5], p.8:

'Within the ARCH project, co-creation is the democratically governed creation and joint development of knowledge and solutions by the project partners and their stakeholders based on trust, accountability, credibility, inclusiveness, transparency and flexible communication. The co-creation process in ARCH takes an adaptive approach that responds to changing realities and endeavours to transfer results to local governments and communities.'

Following the co-creation definition of the project (see Box 1), the co-creation of the HUB and RAD has followed an extremely flexible approach with different intensity levels for end-user involvement (i.e., required amount of work by end-users), depending on the needs, availabilities, and capabilities of project partners and stakeholders at different times of the project. The overarching goals for this approach were:

- to include as many **feedback loops** with project partners and stakeholders as possible to keep results applicable;
- to include as many project partners and stakeholders in the process as possible, to ensure **trans-disciplinary applicability** of results and inclusion of **diverse viewpoints;**
- to **be mindful of time and personnel availabilities** of partners and stakeholders;
- to **clearly identify what is required** by partners during the co-creation process, **what they can expect** to result from the process, and **how inputs are being handled;**
- to give partners and stakeholders **early warning of required input;** and most importantly
- to **enable knowledge transfer** between participants of the co-creation process to ensure that research outputs are immediately transferred into practice.

To achieve these goals, the co-creation process of the HUB and RAD employed combinations of different techniques:

- Guided group **interviews/questionnaires** in small groups with up to ten participants**;**
- Update or working **sessions** at project meetings (e.g., 60-90 minute sessions with project partners at General Assembly meetings to inform about the status of the tool and to provide relevant background information, and to discuss about feedback);
- Dedicated **workshops** (e.g., regular online workshops to discuss prototypes in detail);

- Guided remote **exercises** ('homework')[1];

Methodically, the co-creation process for the HUB and RAD employed a four-pillar approach (see Figure 1):

- Systematic elicitation, analysis, assessment, and consolidation of user needs and stakeholder requirements to inform the development process (see also D7.4 [3]);
- Frequent testing of prototypical results to gather feedback from project partners and end-users;
- Co-development of content with project partners;
- Application of (almost) final results by city partners and their local stakeholders.

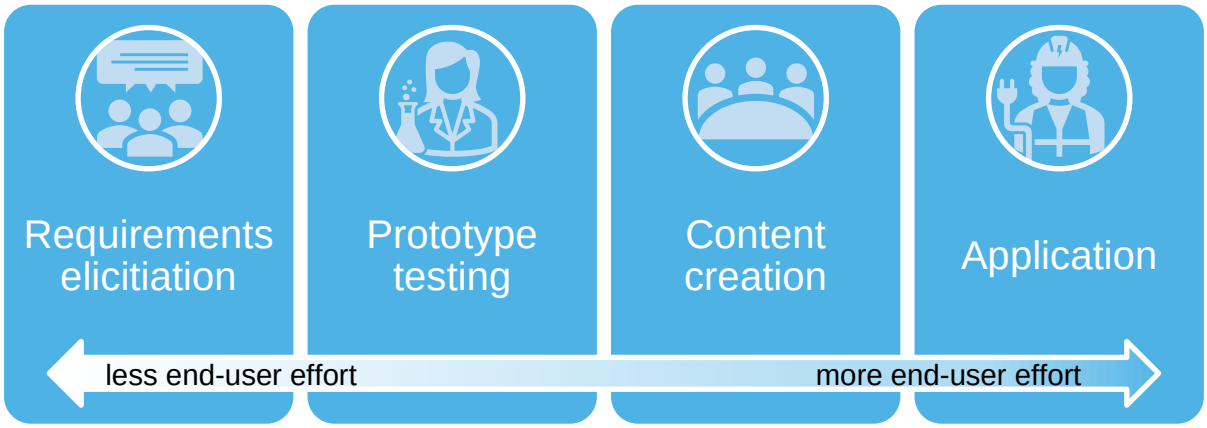

Figure 1: The four pillar-approach for co-creating the HUB and RAD

While the co-creation process started with the elicitation of requirements in connection with task 7.4 and ended with the application of results by city partners, the four pillars partially ran in parallel and influenced each other, following the ARCH co-creation approach of allowing for flexibility and using a reflexive / iterative process that allows for many feedback loops (see D3.1 [5]). For example, early prototype tests by city partners during project meetings resulted in the formulation of new usability requirements that were previously not identified, while the co-development of content in dedicated workshops brought in new ideas to the development process.

Which combination of techniques was employed for which pillar of development for the HUB and RAD was decided by Fraunhofer in coordination with ICLEI depending on the state of the project work and the required level of involvement from other partners. While interviews / questionnaires and update sessions at project meetings were used for activities where less effort from end-users was sufficient (e.g. gathering usability feedback, eliciting early information for requirements), dedicated (online) workshops and guided remote exercises

[1] These exercises usually comprised the development of an instruction document that summarised the then current state of developments before requesting specific inputs – sometimes by specific project partners – with dedicated deadlines and – where necessary – using predefined templates.

where used for activities where a very high amount of effort by end-users was required (e.g., co-development of content, prototype application of results).[2] In general, the required effort from other project partners and stakeholders increased over the duration of the project, with low effort activities mostly located at the early stage of development and high effort activities located in the last third of the project. For every stage and the correlated activities of the co-creation process Fraunhofer documented which partners and stakeholders participated, what input was provided, and how the input informed the developments. Figure 2 provides an overview of the co-creation activities arranged in chronological order. The co-creation activities are described in detail in the next section.

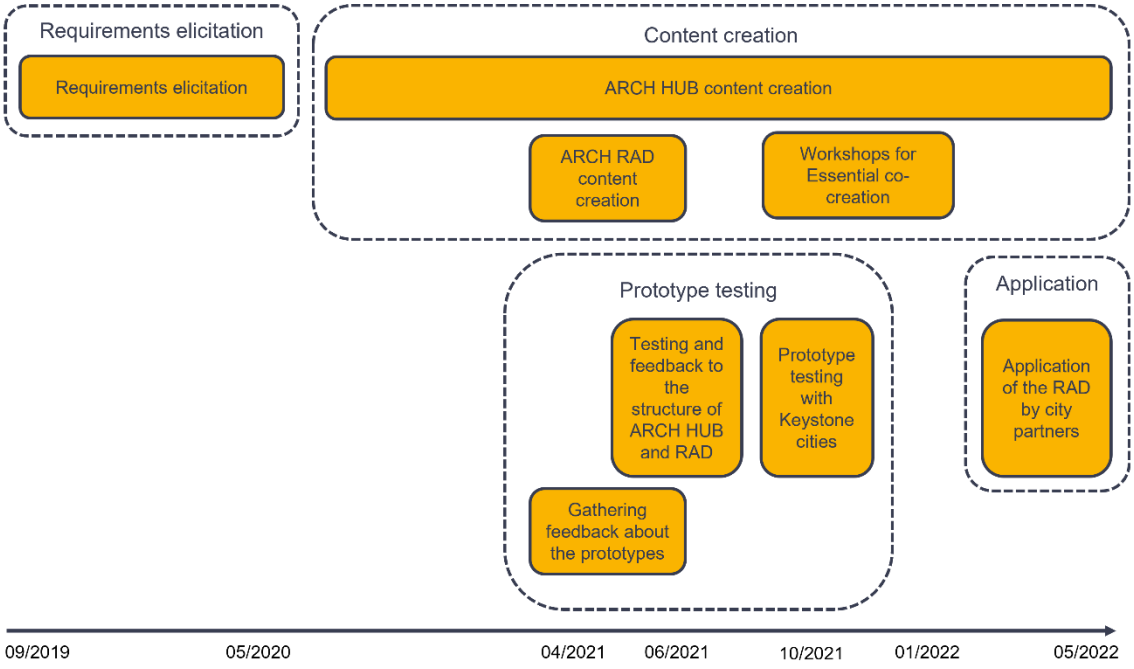

Figure 2: Timeline of co-creation activities classified according to the four co-creation stages

[2] A more detailed explanation of different co-creation approaches and related levels of end-user engagement can be found in RESIN D4.2 [20].

3. Detailed description of the co-creation process

This section reports on the different co-creation activities within task 3.4.5. and is structured according to the four co-creation pillars (requirements elicitation, prototype testing, content creation and application). For each of the co-creation activities in the task, it is documented how it was conducted, who was involved, when it was conducted and how long the partial process took place, what outcomes were achieved, what feedback was received from the participants as well as which lessons were learned.

3.1. Requirements elicitation

The co-creation process of the HUB and RAD started as part of the general requirements analysis process established for all ARCH solutions at the outset of the project. This ensured a common understanding among all involved stakeholders about the scope of the developed solutions and ensured that all solutions started from a common understanding of initial needs from end-users (see Figure 3).

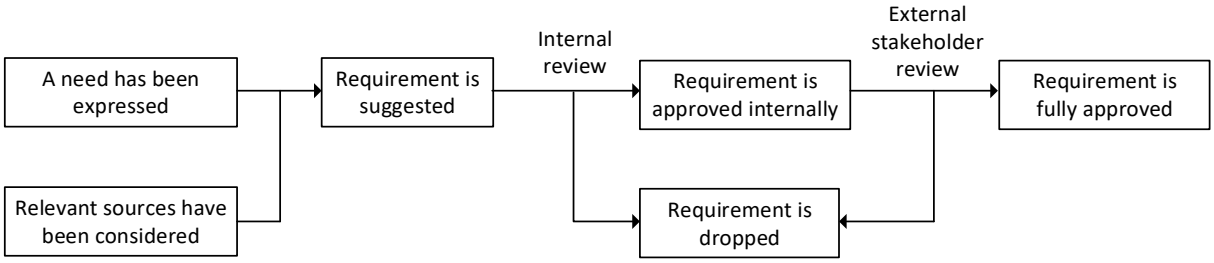

Figure 3: Process for requirements management, see D7.4 [3]

The requirements elicitation process was divided between tasks 3.4.5 (for end-user requirements) and task 7.4 (for technical requirements from other partners, literature, and other projects), involved all 16 project partners, and ran from November 2019 until April 2020, when the initial set of requirements was finished (see D7.4 [3]) and prioritised using the MoSCoW[3] priority classification method [8]:

- **Must have:** requirement is critical for the success of the system and must be delivered;
- **Should have:** requirement is important or even necessary, but not as time-critical;
- **Could have:** requirement is desirable but not necessary for overall project success;
- **Won't have:** requirement is least critical and may be realised at a later time, possibly never. Still, it is a legitimate requirement.

To obtain these requirements Fraunhofer followed three different approaches (cf. D7.4 [3], p. 12):

[3] Abbrevation for the priorities (M)ust have, (S)hould have, (C)ould have, (W)on't have

- Desk research was conducted for relevant documents from previous and ongoing research projects related to the topics of ARCH. Where these documents already contained requirements, these were adapted to the context of ARCH.
- Interviews and discussions were conducted with city partners in different constellations of project partners over several months. During these activities, city partners were asked to express their needs in terms of data, functionality or in general aspects and the lack thereof. These activities started at the 2nd General Assembly meeting in Brussels in November 2019 and continued in several bilateral and multilateral meetings of ARCH partners. Additional requirements resulted from real-world and virtual city visits of different partners (Hamburg in October 2019 and March 2020, Camerino in December 2019, Valencia in March and April 2020), where city needs were expressed while technical partners offered matching expertise for creating system features. When Fraunhofer was not present at the meetings to capture needs, as was the case for example in several meetings between Camerino, UNICAM, ENEA, and INGV, minutes of those meetings were made available to be analysed for needs, rephrased as requirements, and validated with technical and city partners afterwards.
- Informal discussions between the (technical) project partners on best practices and (technical) standards were held during meetings and conference calls, e.g., the need to comply with EU GDPR.

The resulting requirements (and their relevance for the project) were kept up to date by Fraunhofer over the course of the project. The following sub-sections list the original requirements relevant for the HUB and RAD as described in D7.4 [3] and provide short explanations regarding the actions taken for their implementation or why they were not relevant anymore and not implemented (if not relevant anymore due to changes from the co-creation process or due to time and resource limitations).

Lessons learned

While a formalized process to describe and prioritize requirements is helpful, the process requires an established mutual understanding of the (local) problems and (technical) capabilities of all involved partners, which often is only achieved after the first 12 months of a research project that heavily focuses on co-creation. As can be seen in the following sub-sections, several requirements for the HUB and RAD that were initially identified were later not pursued anymore, either due to changing / better understanding of the actual needs of end-users or due to limitations in time and personnel resources. In hindsight, additional city visits and more structured exchanges between city partners and technical partners regarding the technological capabilities of partners before starting the process of requirements elicitation and prioritization would have resulted in less frequent updates of the requirements (see also D3.4 [9] and the forthcoming D3.5). This exchange process was – at least partly – hindered due to the COVID-19 pandemic and the required changes in working modes (not just within the project but within many organisations), especially in early 2020. This prevented a number of early city visits and meant that some technical partners had to rely on virtual experiences to get a feeling for local problems in the pilot cities.

3.1.1. Usability requirements

ID	HUB	RAD	Priority	Description	Action taken
U-01	X	X	M	The user interface must support the main languages spoken in the ARCH pilot cities.	Translation of entire RAD content still in discussion due to time and resource constraints. Translation will be provided either directly inside the web tool or via downloadable Excel files. Information on this will be found in D7.6.
U-02	X		M	The system must memorise the user's personal settings (language, notification settings, GUI settings).	Not applicable anymore as the HUB does not require an account
U-03	X	X	S	The system should follow accessibility guidelines outlined by the W3C.	Implemented
U-04	X	X	S	During a session involving several ARCH tools, the user should be required to enter login credentials only once (Single Sign-On).	Not applicable anymore, due to loosely coupled system approach, see also D7.5 [4]
U-05	X	X	S	The system should be usable on smartphones and tablet computers.	Implemented
U-06	X		S	The system should use human-readable URLs to retrieve pages.	Implemented

3.1.2. Technical requirements

ID	HUB	RAD	Priority	Description	Action taken
T-01	X	X	M	The system must be a publicly available web application with a restricted section for sensitive data that requires authorisation.	Implemented
T-02	X	X	S	System services that are adapted or created for ARCH should follow the representational state transfer (REST) paradigm for communication with other services (excludes already established platforms).	Implemented
T-03	X	X	C	The system could provide backend functionality to avoid entering redundant information into the databases of ARCH systems (only for data where ARCH systems are the data master).	Implemented for RAD, not applicable for HUB anymore

3.1.3. Security requirements

ID	HUB	RAD	Priority	Description	Action taken
S-01	X	X	M	The hardware running the ARCH tools must be located within EU jurisdiction.	Implemented
S-02	X	X	M	The system must comply with the EU GDPR.	Implemented
S-03	X	X	M	Logging into the system must be protected by password.	Implemented for RAD, not applicable for HUB anymore
S-04	X	X	M	The system must allow the user to re-set lost passwords.	Implemented for RAD, not applicable for HUB anymore
S-05	X	X	M	The system must provide encrypted communication with the user client device (e.g. HTTPS).	Implemented
S-06	X	X	M	The system must log and record access to potentially security critical data and functions.	Implemented for RAD, not applicable for HUB anymore

3.1.4. Organisational requirements

ID	HUB	RAD	Priority	Description	Action taken
O-01	X	X	M	The system must allow new users to register.	Implemented for RAD, not applicable for HUB anymore
O-02	X	X	M	The system must allow users to delete their accounts.	Implemented for RAD, not applicable for HUB anymore
O-03	X	X	M	The system must provide role-based authorisation and rights management.	Implemented for RAD, not applicable for HUB anymore
O-04	X	X	M	The system must provide the user role ‘system administrator’ with maximum privileges.	Implemented for RAD, not applicable for HUB anymore
O-05	X	X	M	The system must provide the user role ‘group user’ with defined group-related privileges.	Implemented for RAD, not applicable for HUB anymore
O-06	X	X	M	The system must provide the user role ‘user’ as the default role for newly registered users with access only to public resources.	Implemented for RAD, not applicable for HUB anymore
O-07	X	X	M	The system must allow the administrator to assign rights and roles to users.	Implemented for RAD, not applicable for HUB anymore
O-08	X		M	The system must allow the creation of group workspaces (e.g., for each city)	Implemented for RAD, not applicable for HUB anymore

3.1.5. Functional requirements

ID	HUB	RAD	Priority	Description	Action taken
F-01	X	X	M	The system must allow the user to export and download data sets (assuming compliance with licensing agreements and access restrictions).	Implemented for RAD, not applicable for HUB anymore
F-08	X		M	The system must guide the users among the different ARCH tools.	Implemented via resource hub on ARCH HUB
F-09	X		M	The system must allow to share resilience scores with other users. The default is not sharing with anybody.	Implemented via joint workspaces in RAD instead of HUB
F-10		X	M	The system must allow users to write suggestions and comments about issues related to CH resilience.	Implemented
F-14	X	X	S	The system's functions should be complementary to existing tools, indicators, policies and procedures that are currently being used for the heritage sites.	Implemented
F-26	X		S	The system should give information about which chemicals and exogenous agents have corrosive effects on the materials used in CH objects to users with appropriate security clearance.	Not applicable for HUB anymore, but can be found in ARCH D5.2 [10] via project website
F-35	X		S	The system should provide best practices for resilience building for CH.	Implemented
F-36	X		S	The system should provide an FAQ section which is editable by users with appropriate rights.	Not applicable anymore due to changing co-creation needs
F-37	X		S	The system should allow users to publish information about their ongoing resilience work in the city.	Implemented in RAD via joint workspaces, not applicable for HUB anymore
F-38	X		S	The system should allow users to publish best practices for their local context.	Possible via submission of best practices to dedicated email address for Fraunhofer to include in HUB
F-39		X	S	The system should allow users to subscribe to ongoing resilience assessments to receive change notifications.	Not implemented due to changed user priority. However, users of the same historic area can always see the current status of ongoing resilience assessments
F-40		X	S	The system should allow the user to enter information about the local governance and organisational structure related to CH and DRM.	Implemented
F-41		X	S	The system should be able to identify resilience weak points.	Implemented
F-46	X		C	The system could provide access to publicly available contingency plans (if existing) for	Implemented via resource hub on ARCH HUB (only

				securing CH in conjunction with extreme weather events.	best practice guidelines, no actual contingency plans)
F-51	X		C	The system could allow to contact other users (e.g., cities with similar issues but better resilience score) given appropriate rights.	Not implemented due to lower priority for end users
F-52	X		C	The system could provide the user with a search function to find relevant information.	Implemented via filter function in resource hub and best practice directory on ARCH HUB
F-53		X	C	The system's resilience assessment could be aligned with ASTM E 3032 (Standard Guide for Climate Resiliency Planning and Strategy).	Not implemented due to time and resource limitations
F-54		X	C	The system's resilience assessment could be aligned with ISO 14090 (Adaptation to Climate Change).	Not implemented due to time and resource limitations

3.2. Content creation with project partners

3.2.1. ARCH RAD content creation

Based on the state-of-the-art reports from task 7.1, as well as intermediary results of tasks 7.3 (ARCH Resilience Framework) and task 7.4 (requirements analysis), Fraunhofer started to develop an Excel-based version of the questionnaire for the RAD. This prototype assessment contained an Excel sheet with questions and answers for each of the ten topics (i.e., Essentials) covered by the RAD. It also contained fields with additional information (e.g., explanations for each question, categorisations of each question into the different steps of the ARCH Resilience Framework, as well as classifications of each question into different topics and resilience dimensions). The Excel-based version allowed partners to provide comments for each question and make adjustments to questions and answers. It also allowed partners to propose additional questions.

To facilitate the content co-creation process, Fraunhofer produced a ‘concept sheet’ that summarised the state of the RAD and explained the specific tasks needed from different partners. To not overload each individual partner with an extremely extensive questionnaire of more than 150 questions, Fraunhofer divided the work by pre-designating specific Essentials to specific partners, based on their expertise and previously discussed interests. Thus, each partner worked on 1-3 Essentials to the best of their capacities. Specifically, every partner was asked to review the questions and answers regarding:

- their suitability for answering by a resilience team of a historic area;
- their topical fit within the scope of ARCH;
- their fit with other ARCH tools; and
- their general understandability.

In addition, partners had the opportunity to suggest changes to (sub-)topics and proposed additional content to be added to the questionnaire.

This first stage of content co-creation started in April 2021 and lasted over multiple iterations until August 2021. After each iteration, Fraunhofer reviewed the received feedback and took a decision on whether or not to implement the suggested change or addition. If a suggestion was

not implemented, this was communicated to the respective partner together with a justification. This ensured that every involved partner knew how their feedback was taken into account or why it was not taken into account at all times.

Process outcomes

Providing the first prototype version of the RAD questionnaire as Excel file to project partners with different expertise and viewpoints was an effective and successful method to co-create a multi-faceted first version of the questionnaire. Feedback from partners ranged from small change requests (e.g., misspelling in a question), to suggestions for new questions (e.g., inclusion of additional questions for knowledge about funding measures), to redistribution of questions among Essentials (e.g., moving all data handling related questions to Essential 01), and finally to additions of additional topics to further shape the content of one Essential. For example, due to the input of one partner, Essential 05 was restructured to not only cover ecosystem services, but Natural Capital, based on the Natural Capital Protocol [11]. The content creation process also helped to identify redundant or mismatching parts (e.g., redundant questions between Essential 01 and 09) in the questionnaire as well as to dismiss question that were not perceived as relevant.

Lessons learned

Besides the written instructions on how to handle and work with the prototype questionnaire, Fraunhofer offered additional meetings to discuss the exercise and the content of the questionnaire to individual partners, if required. This offer was taken up by a few partners and for the most part involved discussing issues revolving around language barriers or understanding the workflow of the questionnaire and how it might fit into the local workflow and organisation. Guided remote working of the consortium with optional discussion meetings proved to be a successful and useful method to create an initial version of the RAD questionnaire. This process also ensured that most project partners, and especially the city partners, were able to familiarise themselves with the RAD and its conceptual approach on their own terms, which encouraged knowledge transfer. A drawback of this remote exercise approach is that it can require additional feedback loops to avoid issues of ambiguity (e.g., due to a different understanding of the formulation of a question or a comment).

3.2.2. Workshops for Essential co-creation

After revising the questionnaire based on the written feedback from the consortium (see section 3.2.1), co-creation online workshops were organised and performed with the consortium. The workshops aimed to co-create the content of the questionnaire in detail, focussing in each workshop on one of the ten Essentials. This step of co-creation corresponds to the third pillar ‘Co-development of content with project partners’ (see section 2). Considering this pillar and the dedicated workshops as a technique for co-creation at a rather advanced stage of the overall project, the required effort from project partners can be rated high.

Workshop planning

The ‘ten weeks of co-creation’ were held from October 2021 until January 2022 and included ten scheduled co-creation workshops as well as one additional workshop for Essential 04, which required more extensive work as it was completely built from scratch, compared to the other Essentials, which could build on existing work from the Disaster Resilience Scorecard for Cities [12] and Buildings [13]. The sources that were considered in the development of Essential 04 mainly include the Management Plan [14] and Nomination Dossier [15] of the Speicherstadt in Hamburg, the Periodic Reporting of the World Heritage Convention [16] and the Historic Urban Landscape Approach [17]. One workshop was held each week for seven weeks, and three parallel workshops were held during the 6th General Assembly meeting (14-16 December 2021). The additional and final workshop was held in January 2022. Each workshop was scheduled for one and a half hours. Participants were invited to the workshops well in advance to facilitate planning for everyone involved. They were also sent the current status of each Essential approximately one week before the workshops so that they had the opportunity to comment in the Excel file in advance and / or prepare for the workshop. Invitations were sent to all project partners, with participation being open and voluntary for all interested parties.

Workshop workflow

Each workshop was attended by six to eleven persons, including technical partners, city partners and ICLEI team members. This compilation of different project partners ensured the inclusion of diverse perspectives and the transferability of the results into practice. The workshops were moderated by one member of the Fraunhofer team and included discussions with all attendees. The workflow was as follows:

1. Short presentation of the ARCH RAD and HUB development timeline (by Fraunhofer team member)
2. Recap of the objective and content of the Essential discussed in the respective workshop (by Fraunhofer team member)
3. Guidance through each question of the respective Essential, focussing on and discussing the following questions:
    - Are the questions understandable and answerable?
    - Are the terms and concepts clearly understandable?
    - Are the answers well formulated?
    - Are all relevant topics covered or are important topics missing?

Workshop outcomes

As a result of the co-creation workshops, both written and oral feedback could be obtained for all Essentials. Each question was reviewed and discussed (in detail) by the project partners present which allowed for a thorough review of the questionnaire in terms of content and methodology. The input provided during the workshops can be clustered into three broad subject areas: Language, content, and conceptual topics. In the following, each of these areas is specified and underpinned with examples.

A. Language

As a result of the workshops, it has emerged that the language of the questions and answers must fulfil some requirements to be optimally suitable. These requirements are specified below, although they cannot be considered separately, but are partly interconnected.

Language should…

… not be misinterpretable. Terms should be objectively interpretable and should therefore be specified in the explanation section provided for each question. This applies to technical terms as well as to non-technical terms that can be interpreted in different ways. Giving short explanations of these words facilitates the answering of the questionnaire. Examples of these terms and their respective description in the explanation section include:

- '*Critical staff*': Staff which is essential for the operation of the historic area (e.g., managing electrical power supply; irrigation of plants on an agricultural area). It also includes staff with decision making power.
- '*Financial plan*': The financial plan includes planning the budget, the necessary resources and contingency fund arrangements for resilience.
- '*Knowledge*': The term 'knowledge' describes having access to, for example, a record of historic events, reports, narratives from local population, maps, etc.

… be precise. The choice of words should be precise and cover exactly the intention of the question. If similar concepts / terms are used in an answer, their respective meanings should be clarified in the explanation section. Examples include:

- The difference between '*informing*', '*involving*', '*including*' and '*engaging*' people should be considered.
- The difference between '*skills*', '*experience*' and '*knowledge*' should be considered.
- The difference between '*media*' and '*channel*' should be considered.

… be neutral. Neutral words should be chosen instead of emotional words. This ensures that answers and / or questions do not incorporate any unconscious evaluation / bias.

- 'Impacts would be *observed*' should be chosen instead of 'impacts would be *felt*'.
- 'Meetings of a few *interested parties*' should be chosen instead of 'meetings of a few *enthusiasts*'.

… be sensitive to aspects of diversity. Language should use words that do justice to diversity and ensure that all people are addressed and included in the formulation of sentences.

- '*Linguistic diversity* in the provision of materials exists' should be chosen instead of 'Materials are comprehensible for most *linguistic minorities*'.
- '*People* in the historic area' should be chosen instead of '*citizens*'.

… be easy to understand. Generally, an easy-to-understand language should be chosen over complicated language / phrases.

- 'Are physical contributions *provided*?' should be chosen instead of 'Are physical contributions *co-opted*?'.

In addition to the use of appropriate terms in the questions and answers, special attention should be paid to the **wording of the scores**. The different scores must be clearly distinguishable from each other, making sure that the 'jumps' between answers are of equal size. Scores should be consistent across the Essentials when asked about similar aspects (e.g., amount of XY, adequateness of XY, extent of XY). In addition, it was discussed several times in the workshops that qualitative scores should be preferred to quantitative in most cases. It was argued that quantitative scores were too precise to be realistically answered by the people (the resilience team) working on the questionnaire. A qualitative formulation, which is easier to answer, would also lead to better motivation and self-efficacy of the resilience team. Finally, there was a general discussion about the best score that can be achieved: Should the best score represent a state which can realistically be achieved, or should it represent the 'perfect' state of resilience, which in some cases cannot realistically be achieved? There was no clear outcome to this discussion, and a middle ground was chosen in each case. Examples of the aforementioned aspects include:

- '*Not* considered – *not yet* considered – considered to a *very limited extent* – *partly* considered – *largely* considered – *fully* considered' should be chosen instead of 'major weaknesses – larger gaps'.
- '*Disastrous* loss – *significant* loss – *moderate* loss – *minor* loss – *insignificant* loss' should be chosen instead of 'loss factor of *xy %*'.
- 'Costs are *not estimated* – costs are *not estimated yet* – a *poor estimate* exists – a *fair estimate* exists – a *good estimate* exists – a *reliable estimate* exists' should be chosen instead of '*xy %* of the annual billed revenue'.

B. Content

In terms of content, it was discussed several times that a **common understanding** of the terms used in the questionnaire is crucial. To this end, the explanation section provided for each question should be used to define and explain terms so that they are understood equally by all respondents. Achieving a common understanding of content relates to the language-related aspects discussed above. One example term that needed to be explained is the term 'worst-case scenario' which is referred to in several questions.

Furthermore, the **number of different aspects covered within a question** was a point of discussion. On the one hand, the questionnaire aims to cover all necessary aspects of resilience. On the other hand, it is not feasible to go into any detail with a too extensive set of questions. One approach to this was to cover different, but not more than two aspects in one question, e.g. 'How often are […] meetings held and how many representatives are attending […]?'. The challenge is then to scale the scores in a meaningful way, fulfilling the requirements mentioned above. Depending on the perceived importance of the topic of the question and the practicability of answering the question, it was a case-by-base decision to either keep one question or split into two questions. The importance of a topic also played a role in deciding

whether a question should be part of a 'quick' or a 'detailed' assessment[4], which was discussed for several questions.

Another outcome of the co-creation workshops was that additional aspects came up in the discussion that had not yet been considered in the questionnaire. As a result, some **additional questions** or aspects were added (e.g., whether warnings not only reach the population but are also understood by them).

A final aspect that came up a few times was the **'answerability' of questions** by the resilience team. Some of the topics covered in the questionnaire do not fall within the remit of the resilience team, so the team has limited influence on the outcome. However, in most cases it was decided to keep these questions if they are essential for resilience building. This should not only encourage the involvement of relevant stakeholders in the assessment process, but also serve as an incentive to initiate a process even if the ultimate responsibility lies with another function/person.

C. Conceptual

From a conceptual point of view, it was emphasized that historic areas and their management can be very different depending on the context and the country. Thus, not every question applies in the same way to every historic area. One solution to this was the implementation of a '**Not applicable**' check box that removes the particular question from the assessment and scoring. Similarly, in some cases it may be impossible for the resilience team to answer a question appropriately due to limited access to information. For these cases, a '**Don't know**'-check box has been implemented which, however, will result in a lower score at the end of the assessment.[5] Another suggestion resulting from the workshops was the implementation of a '**collective working mode**' that allows several persons linked to the same historic area to work on an assessment and read each other's comments on the questions. Lastly, the implementation of **introductory texts for each Essential** was mentioned, which can be shown before the assessment begins and explain the key concepts and topics of that Essential. All these conceptual suggestions and solutions were subsequently implemented in the RAD.

Workshop feedback

The feedback on the co-creation workshops was positive. Although the detailed evaluation of each question in the questionnaire can be a dry task, project partners expressed their enjoyment / fun of participating. They also emphasised the good organisation of the workshops which might have contributed to their positive perception. From a moderator point of view, the workshop setting was successful for this task as it provided a suitable setting for exchange and facilitated interesting discussions. It provided a good basis for the subsequent revision of the questionnaire.

[4] The RAD allows to either conduct a 'quick' assessment, which can be finished within a few hours and currently consists of 128 questions, or a 'detailed' assessment, which can require several months for completion and currently includes 221 questions.

[5] Questions that are answered with 'Don't know', should be understood as aspects in the resilience score where a historic area might still have potential to increase its resilience, thus these answers should not be removed from the scoring. More detailed information on the scoring approach can be found in D7.6

Lessons learned

The co-creation setting was well suited to further improve the questionnaire in terms of content and methodology. Particularly, the complementary experience and different viewpoints of the project partners were useful for several aspects:

- Additional topics and questions on resilience were added that had not been part of the questionnaire before.
- Questions were adapted to be applicable in practice and to correspond to the local reality.
- Technical features were implemented for an improved user-friendliness and to provide room for individual handling.

For the development of a questionnaire to be used by local actors, it has proven crucial to involve local actors in particular (in this context the city partners) in the development process. Local knowledge is essential to design the questionnaire in a way that is practically applicable, as this is one of the main objectives.

In general, the format has been successful in obtaining feedback on individual questions and in deriving general guiding principles for the design of the questionnaire. However, no 'broader' feedback was gathered on one whole Essential or even the whole questionnaire across all Essentials (e.g., Is the order of the questions / Sub-Essentials / Essentials appropriate? Are the topics of the Essentials well suited?). The reason for this is that the questionnaire and the individual Essentials are very extensive, i.e., they contain many questions, which makes it difficult to get an overview quickly.

In terms of the co-creation method, it has proven useful to have various feedback loops before the individual questions were discussed in the workshops, i.e., the primary RAD content creation (chapter 3.2.1) and the provision of the Excel file for written comments prior to the workshops. This is helpful as it allows the participants to familiarise themselves with the questions and provides a better basis for discussion. Also, being able to give feedback both in writing and orally can be seen as a good approach. It allows personal preferences to be considered and people who could not attend the workshop can still give their feedback. However, due to the limited time resources of all partners, the possibility to provide written comments on the Excel file was not extensively used by all project partners. Lastly, the group size of eight persons on average has proven to be effective to give everyone the opportunity to express themselves.

3.2.3. ARCH HUB content creation

Content creation for the ARCH HUB relates to two of the sections of the knowledge base.

A. How to build resilience?

This section provides the definition of resilience as employed by ARCH, a step-by-step explanation of the ARCH Resilience Framework, and the ARCH project glossary.

Box 2 – Resilience of historic areas (original suggestion)

'The sustained ability of a historic area as a social-ecological system (that includes institutional, social, cultural, physical, economic and environmental dimensions) to cope with hazardous events by responding and adapting in ways that maintain and preserve the historic area's heritage values as well as cultural significance (including identity, integrity, authenticity) and functions.'

The **resilience definition** of ARCH was originally proposed by Fraunhofer as part of the development of the Resilience Framework in D7.3 [1]. As part of this process, Fraunhofer distributed a 'concept sheet' for the Resilience Framework to partners of task 7.3 (ICLEI, DIN, Tecnalia, ENEA, UNICAM, SOGESCA, and MÚOP) in July 2020. This concept sheet summarized the status of the work of task 7.3 and was used to gather specific input from partners. Among this was feedback on an initial suggestion for a resilience definition (see Box 2). Based on the received feedback, it became clear that the resilience definition should emphasise the need for socially just adaptation and rather use the term 'heritage significance' instead of 'cultural significance'. The resulting final definition of resilience is shown in Box 3.

Box 3 – Resilience of historic areas (final version)

'The sustained ability of a historic area as a social-ecological system (including its social, cultural, political, economic dimensions, as well as built and natural environments) to cope with hazardous events by responding and adapting in socially just ways that maintain the historic area's functions and heritage significance (including identity, integrity and, authenticity).'

In addition to the resilience definition the 'How to build resilience?' section of the ARCH HUB contains the **ARCH project glossary** (see D1.2 [6] and D7.1 [18]), which was created in collaboration of all authors of D7.1 as well as by all partners at the project outset.

Figure 4: The original ARCH Resilience Framework as proposed in D7.3

Figure 5: The adapted ARCH Resilience Framework from CWA 17727

Lastly, the ‘How to build resilience?’ section provides a **step-by-step explanation of the different steps of the ARCH Resilience Framework** that was originally proposed by Fraunhofer in D7.3 [1]. While the original framework was developed following a lightweight co-creation process based on the requirements elicitation process, as well as feedback rounds during the 3rd General Assembly meeting in September 2020, and bi-lateral discussions with selected project partners, the framework was adapted and extended significantly as part of the standardisation process in task 2.6 (see also D2.4 [19]). As part of this task, the ARCH Resilience Framework was turned into a CEN Workshop Agreement, which involved 42 persons, of which 28 were external to ARCH. As part of this process, each step of the Resilience Framework, which originally were only explained briefly in D7.3 [1], was extended with required actions that must be taken in each step, recommendations that might be taken in each step, tools and other resources that can support in conducting individual steps, as well as example indicators to measure progress in each step. In addition, the framework was extended with a description template that allows to characterise the relevant social-ecological aspects of historic areas. Figure 4 and Figure 5 show the evolution of the ARCH Resilience Framework from D7.3 to CWA 17727, with the major addition of the transition between steps 6 and 7 (colour gradient area).

The requirements and recommendations from CWA 17727 in turn were transformed into an easy to ready web format as part of the ‘How to build resilience?’ section in the ARCH HUB.

B. Resource hub

This section gathers methods, tools, handbooks, and other resources that can help with building resilience. The entries in the resource hub are filterable according to

- type of resource (e.g., software, hardware, handbook, game, other);
- step in the ARCH Resilience Framework in which they are applicable;
- RAD Essential which they might help to answer; and
- topics they related to (e.g., Disaster Risk Management, Climate Change Adaptation, Social Justice, or Heritage Management).

Fraunhofer started compiling these resources already as part of the work on the state-of-the-art reports in D7.1, extended this work during the framework development for D7.3 [1] and the early research of the RAD. This basis was then extended based on the input provided as part of the CWA development between May 2021 and May 2022. In addition, Fraunhofer asked all ARCH partners to provide input during a remote exercise between February and March 2022. For this exercise, Fraunhofer developed another ‘concept sheet’ with a summary of the current state of development for the HUB (and RAD) and asked partners to provide information on additional resources, as well as the necessary information to allow filtering of these resources in the ARCH HUB. The gathered information also included

- the name & optional acronym of the resource;
- a short description of the resource;
- the intended target users for the resource;
- the name of the developers / authors of the resource;
- a link to the resource (if available); and
- information on any conditions for use (if applicable).

Based on the partner feedback, Fraunhofer now has compiled a list of more than 30 resources (including the ARCH tools) for inclusion in the resource hub on the ARCH HUB. These resources will be further extended with solutions from ARCH's sister projects SHELTER[6] and HYPERION[7].

3.3. Gathering feedback and prototype testing

3.3.1. Gathering general feedback about the prototype from project partners

In April 2021, partners were asked general questions about the prototype of the RAD questionnaire and potential further development steps. The questions were provided in a 'concept sheet' and the feedback was gathered in addition to the first revision process of the questionnaire (see section 3.2.1) within a two-month period. Six partners, including all city partners, provided written feedback. Certain partners did not provide feedback because the questions did not apply or due to other allocation of resources in the task. The feedback was consolidated by Fraunhofer and presented at the 5th General Assembly meeting. In the following, the main topics and outcomes of the feedback form are listed.

Partners were asked about the **concept and scaling of answers**. In the prototype questionnaire each question had six distinct answers with scores from 0 to 5. However, feedback was required, if users prefer to have six distinct answers with text for each of them or to only have textual answers for the extreme scores 0 and 5 with 'blank space' in between (similar to a Likert scale). The latter would give more flexibility when choosing a resilience score, as answers would not be as fixed to certain pre-defined measures. 83 percent of the partners said that they prefer to have six distinct answers to each question with pre-defined answers. They stated it would be easier and more user-friendly for them to find answers to the questions and even better understand the questions when reading the different answers. Furthermore, this way of scaling would also lead to more comparable results and probably also simplify the process of answering questions as a group. There was only one partner arguing that fixed predefined answers might not always fit completely and can make it difficult to identify a matching answer. Based on this feedback and arguments it was decided to keep the answering concept that included the pre-defined answers.

The prototype questionnaire included a page where users could insert **general information about the historic area** (e.g., information about the built and natural environment, or the social and cultural aspects that are important for the historic area). Participants were asked to provide feedback if this page was clear and sufficient or if any information to be inserted was missing. Responses showed that the important basic points were already present, but that this section needed an additional revision. For example, there were responses that users would want to include more detailed and distinct information about parts of the historic area – parts of the socio-economic system – such information about the nature and environment or clearer instructions about organisational information about the historic area such as departments responsible for the historic area. The feedback form also showed that exchange with

[6] https://shelter-project.com/
[7] https://www.hyperion-project.eu/

colleagues from other departments in a city or historic area would be needed to gather information about hazards, vulnerabilities, and risks. In the further development of the RAD, this general information page about the historic area was integrated in the historic area workspace and identified topics were addressed.

Partners were also asked about the **comprehensiveness of the RAD** and if they missed any content. Most partners replied that the prototype questionnaire was already very extensive. Some gaps were indicated with regard to monitoring, assessment and learning related to climate change adaptation, certain links to other ARCH and non-ARCH related tools, and additional questions about intangible cultural heritage. The identified missing points were considered in the revision of the questionnaire.

In addition, feedback and input was asked about the **concept of Essential 04**. At that point, ideas for the concept of the Essential were formulated, but no questions were drafted. It was planned to further include additional expertise and input from partners. As an outcome of the feedback form, additional meetings with certain partners were arranged to discuss the concept of Essential 04 and its connection to the Historic Urban Landscape approach [17]. On the basis of these exchanges, the co-creation workshops for Essential 04 were conducted (see section 3.2.2).

Process outcomes

Based on the gathered feedback and the revision process of the whole questionnaire with the consortium (see section 3.2.1), the Fraunhofer team concluded that the ten Essentials as well as their content is well suited for the purpose of the RAD – assessing the resilience of historic areas. It was possible to include all the raised comments and suggestions in the frame of the existing ten Essentials and partners did not bring up any additional topic that should have been covered in an additional Essential.

Lessons learned

As previously stated, providing ‘exercises’ and gathering feedback via a ‘concept sheet’ in addition to the RAD questionnaire prototype as an Excel sheet (see section 3.2.1) worked very well, as it allows partners to work on their own terms in the time they have available.

3.3.2. Testing and gathering feedback to the structure of the ARCH HUB and the ARCH RAD from the project partners

At the virtual 5th General Assembly meeting in June 2021, a working session was held with the consortium. In this session the status of the ARCH HUB and the ARCH RAD were presented, the participants were instructed to use the tools and during a joint working session the tools were tested and an online survey was filled in by the participants to provide feedback on the general structure and setup of the tools.

For the ARCH HUB, feedback was collected on **the main functionalities, the structure of the menu, and the design**. In the online survey, partners were instructed to choose functionalities and information that are most relevant for the ARCH HUB. The following points were chosen by more than 50% of the participants and are listed with decreasing popularity: information about the ARCH solutions, information about the ARCH Resilience Framework,

overview and information about resilience building tools and additional resources (created in other projects), best practices of resilience building, shared resilience assessment scores[8]. The following functionalities were chosen by less than 25% of the participants and are listed with decreasing popularity: Information about the ARCH pilot cities, the glossary, information about the ARCH project. Participants also had the possibility to mention any missing functionalities or ideas for functionalities that should be included in the ARCH HUB. Answers showed that the main expected functionalities were already included in the early prototype. Ideas for extensions were for example design updates or the inclusion of videos for the best practice page.

Regarding the ARCH RAD, participants were instructed to use the tool and perform a resilience assessment on their own. In the survey, they were asked about the functionalities of the tool and especially about the concept of the historic area workspace and the overall workflow of the tool.

As a result, 41 % of the participants stated that the **concept of the historic area workspace** (for more information see the forthcoming D7.6) is clear to them while the rest stated that they understand it but would need more information about it to further work with it. Nobody indicated that the concept is not clear to them. Ideas for the extension of the historic area workspace included, that the menu of the historic area workspace could support the access to other ARCH tools, that the historic area workspace could be linked to risk profiling tools, and that the RAD could integrate an uploading function to share pictures, documents, reports etc. While the mentioned ideas are valid optional add-ons for the tool and the concept of the workspace, they turned out to be too complex and extensive for the implementation within the project.

76% of the participants ranked the **workflow of the ARCH RAD** (chose scope, answer questions, see scores, plan actions; see also the forthcoming D7.6) as (very) clear. Ideas for extending the tool included the following: a progress bar showing the number of answered questions for each essential, an overview/list with information about all Essentials, a separate page with information on what each step of the ARCH RAD contains and how much time / work it requires, and a graphical representation of the scores. All these points and ideas were implemented in later versions of the RAD.

Most participants stated that the planned **additional information provided for each question** (text with additional information and explanation to the question, list of stakeholders that might help in answering the question and eventually a list of related tools help in answering the question) seem to be sufficient. A participant raised the points that best practices could be updated in case of the publication of new regulations, new methods, new tools.

[8] During the further co-creation process, the focus of the ARCH HUB has slightly changed. As the HUB now is intended to be a resilience knowledge base, sharing of resilience scores is out of scope of the HUB. Instead, resilience scores can be shared by a resilience team with other colleagues and stakeholders of the historic area via a joint historic area workspace in the RAD.

Process outcomes

The working session and the survey verified, that all partners agreed with the main functionalities and structure of the ARCH HUB and the ARCH RAD. Additional suggested ideas were partially considered in the further development regarding their complexity and necessity.

Since at the time of the 5th General Assembly meeting some main functionalities were not fully implemented in the prototypes, some partners wished for more matured prototypes. Nevertheless, all partners understood the main planned functionalities and structure of the tools and were able to provide elaborated feedback. Therefore, gathering feedback from the participants based on presenting and testing of prototypes with additional explanations appeared to be a successful and useful method to involve the partners.

Lessons learned

The format of the joint online working session during the General Assembly meeting worked well. During the session, participants were able to test the tools, answer the survey and raise questions. In this way, problems were openly discussed, new ideas were raised, and an interactive and productive working atmosphere was created. The surveys enabled partners to provide input regardless of group dynamic and / or language proficiency. As the survey was not immediately closed after the meeting, it also allowed partners to provide feedback after the session and enabled also those partners to provide feedback who did not attend the prototype assessment session.

3.3.3. Prototype testing with Keystone cities

In addition to prototype testing with the ARCH pilot cities, a prototype of the RAD was also tested with the 12 Keystone cities during the 3rd Mutual Learning Workshop that was held online in October 2021. During this workshop, Fraunhofer introduced the then current version of the RAD to the Keystone cities and conducted guided assessment exercises in smaller clusters. Each cluster consisted of one ARCH Foundation city as well as its Keystone city partners and focused on a different Essential. The intention of these sessions was to give Foundation and Keystone cities time to test the RAD prototype, provide feedback, and discuss the local issues brought to the front by answering the RAD questionnaire within the smaller group.

The feedback from the Mutual Learning Workshop was generally positive, with all pilot and Keystone cities seeing the value in the RAD, and specifically its value for starting the process and conversation on local resilience building. Specific feedback for the RAD was covering issues like

- the user getting ‘lost’ in the tool, due to a too monochromatic user interface;
- some phrases and terms being not well understandable and needing to be rephrased or explained (e.g., ‘bed days loss factor’ in Essential 08, ‘vulnerable population groups’ in Essential 07);
- the need for involving experts from other departments (or higher governance levels) to answer certain questions; and
- the need for including a ‘I don’t know’ option for each question (see also section 3.2).

Following the Mutual Learning Workshop Fraunhofer reworked the resilience assessment questionnaire, which culminated in the 'ten weeks of co-creation' described in section 3.2 and further adjustments to the interface and workflow of the RAD, which will be described in more detail in D7.6.

3.4. Application of the RAD by city partners

This section describes the process of how the almost final version of the RAD was tested and applied by city partners on their own and what feedback was given on the assessment results as well as on the RAD itself.

The partners invited to test and apply the RAD were the pilot cities of ARCH, namely Bratislava, Camerino, Hamburg and València. It was recommended that their local stakeholders should also be involved in the assessment process, but it was left to the city partners to decide whether or not this was feasible. The overall workflow was organised and led by Fraunhofer and ICLEI.

Workflow

The original plan was to organise a workshop for each city with their local stakeholders and conduct the resilience assessment in this workshop format with support by Fraunhofer. This plan was communicated to the city partners during the 6th General Assembly meeting in December 2021. However, during the discussion, it became clear that engaging local stakeholders for the assessment would be a challenge for the city partners. The feedback from the city partners was used to transform the original 'workshop task' into a 'homework' that the city partners worked on independently. To prepare the city partners for their task, Fraunhofer conducted a webinar in March 2022, in which the RAD and its updated functions were presented to the city partners and the 'homework' was explained.

City partners were asked to select (at least) two Essentials of the RAD that best fit their specific needs, challenges, and interests. They were asked to perform a detailed assessment for these chosen Essentials and present their results as well as any challenges they encountered during the 7th and last General Assembly meeting in early May 2022 (i.e., the assessment process took place over the span of roughly 1.5 months to provide city partners sufficient time during a project period with myriad concurrent requests from several project partners). The questions of these Essentials should be answered according to the situation in the historic area and, if necessary, in consultation with relevant stakeholders who might have the necessary information. In addition, city partners were instructed to contact the Fraunhofer team, if they encountered any issues during the assessment process. After completing the assessment, partners were asked to save their scores and send the results to Fraunhofer. To finish the task, they were asked to prepare a short presentation of five to ten minutes about their results and possible feedback on the assessment and / or the process to present at the 7th General Assembly meeting. Fraunhofer did intentionally not provide any template for these results presentations to get a realistic picture of how a resilience team might process the resilience assessment results for presentation purposes.

During the 7th General Assembly meeting, the Fraunhofer team held a plenary workshop where city partners presented their achieved resilience assessment results and gave feedback on their results and the RAD. The session allowed city partner to express their feedback on

anything they wanted to share with the project partners. In addition, participants in the audience (other city partners, technical partners and ICLEI) had the opportunity to ask questions to the cities presenting their results. All feedback and discussion points were documented by the Fraunhofer team.

Process outcome

During the plenary workshop at the 7th General Assembly meeting, city partners were asked to provide feedback on their own assessment results ('Are the scores useful and realistic?'), on the possibility of comparing their current results with the results from the preliminary assessment carried out with the Disaster Resilience Scorecard for Cities [12], and how the RAD compares to the Disaster Resilience Scorecards for Cities and Buildings. All city partners perceived the assessment results as useful, and most assumed that they reflected an accurate state of the resilience of their historic area. Although, one city partner noted that the results might 'not reflect the actual strengths of the community', which might be a result of the selection of certain Essentials. All city partners stated that it would not be possible to compare the RAD results with the results of the Disaster Resilience Scorecard for Cities, as the questions differ significantly and the RAD provides a better focus on the actual issues of historic areas. The latter was also the common feedback when asked how the RAD compares to the Disaster Resilience Scorecards for Cities and Buildings: Its focus on historic areas and the combination of Disaster Risk Management, Climate Change Adaptation, and Heritage Management, makes the RAD exceptionally suitable for assessing the resilience of historic areas, when compared to the other Scorecards.

In addition to providing feedback on their own assessment results, city partners also provided feedback on the RAD, including its content, functions, and answering process. For the most part, city partners found the questions in their chosen Essentials to be clear and understandable, albeit a few questions were considered to be too vague. City partners also highlighted that some questions make reference to results from Essential 02[9] and if this Essential was not completed, questions in other Essentials might not be able to be answered properly. To address this issue, city partners suggested to either copy the relevant question from Essential 02 to the other Essentials, to make Essential 02 mandatory, or to make the relevant questions in other Essentials independent from the questions of Essential 02. City partners also remarked that some questions can be tricky to answer if the aspect referred to in the question does not fully correspond to your historic area. For example, if a city does not have 'a (long-term) strategy or action plan […] to increase […] the resilience' that is asked for in Essential 01 but instead 'a brief […] action plan [which] includes some (brief) references to resilience'.

Regarding the functions of the RAD, the city partners highlighted that the score representation and especially the colour coding of the final score visualisation was very good. In addition, the comment function for each question was highlighted as a very good feature, as it allows asynchronous communication between colleagues working on the same assessment. On the other hand, city partners pointed to some potential improvements for the RAD functions as

[9] This issue is related to the definition of 'worst case' and 'average case' hazard scenarios, which Essential 02 asks after.

well. For example, the inclusion of the standard deviation for individual Essential scores, the inclusion of a before and after view for assessments under different scenarios or for monitoring, the inclusion of a 'locking' mechanism for resilience assessments that would prevent further modification of the assessment, or the inclusion of additional information about the required steps before the start of an assessment.

None of the city partners consulted local stakeholders during their assessment process. For the most part this was because city partners perceived it as difficult to identify and contact the relevant stakeholders and were under the impression that stakeholders might not be as responsive as necessary for the resilience assessment. A particular issue for involving local stakeholders was the language barrier, as the RAD is currently only available in English and many local stakeholders can only communicate in their native language.

In more general terms, all city partners were of the impression that the RAD can help to talk with decisionmakers and convince them to invest resources in resilience building. It was also mentioned that the questions and corresponding answers provide a path on what to do to build resilience, so that the RAD can be a relevant tool to guide further steps in the resilience building process. In the same vein, city partners mentioned that answering the questions triggered an internal discussion on the different aspects of resilience and gave indications on aspects that had not been considered before.

Lessons learned

The independent application of the RAD by city partners worked very well. Except for some minor errors due to the still ongoing development process, no city partner ran into any problems while using the RAD. Similarly, all city partners were able to answer most of the questions in their chosen Essentials, although the process might have benefitted from the involvement of local stakeholders with expert knowledge in related topics.

The results of the assessment 'homework' allow to draw two major conclusions: 1) the frequent feedback loops and the strong involvement of end-users in previous co-creation steps for the RAD allowed city partners to easily conduct a partial resilience assessment on their own, i.e., the implemented co-creation process achieved its intended result of transferring sufficient knowledge between researchers and end-users to enable the end-users to complete a resilience assessment on their own; 2) co-creation with stronger involvement of local stakeholders and communities requires addressing language barriers early to make project outputs more easily accessible. The second conclusion proves to be a major barrier for text-heavy project outputs like the RAD, as adequate translations of such outputs require significant resources (in either personnel or money), which can often only be tackled at the end of the development cycle, once the project output is sufficiently stable.

4. Conclusion and next steps

The ARCH HUB and RAD have been designed, developed, tested, and applied via a three-year, agile co-creation process that started with a systematic requirements elicitation, continued with prototype testing and content co-creation, and ended with the successful example application of the RAD by the ARCH pilot cities. This co-creation process did not only involve the four pilot cities of ARCH, but also the 12 other project partners, as well as 12 Foundation cities from ARCH's Mutual Learning Framework. In addition, 28 project external persons have been involved in the co-creation of the foundation of the HUB and RAD, the ARCH Resilience Framework, as part of the CEN Workshop Agreement development process.

With the highly agile co-creation process that included small scale, guided group interviews / questionnaires, dedicated update or working sessions at project meetings, dedicated workshops, guided remote exercises ('homework'), Fraunhofer was able to involve a large number of diverse actors with different backgrounds in the co-creation process, ensuring the trans-disciplinary applicability of the HUB and RAD. This modular and agile approach also allowed to account for changing time and personnel availabilities and to clearly identify at every stage what was required by whom and what could be expected to result from the process.

Not only was this co-creation process able to include continuous feedback loops to transfer end-user needs and knowledge into the development of the HUB and RAD, but it also enabled successful knowledge transfer between research partners and end-users, as demonstrated by the example application of the RAD by the ARCH city partners.

From a co-creation standpoint, the applied process and the identified lessons learned allow to make a suggestion for the design of future co-creation processes. While co-creation processes need to acknowledge the need for flexibility in their design and the need to dynamically adjust the effort level required of end-users, it seems to be useful to include two fixed parts in this otherwise agile process: 1) The first 6-12 months of the co-creation process should be spent on problem definition with end-users and trust-building between researchers and end-users. Only after this part is completed successfully, the co-development process should start in earnest. 2) The last 3-6 months of the process should include an application phase for the co-developed outputs, ideally lead by the end-users with the researchers only consulting.

From a technical point of view, while the main part of the co-creation process of the HUB and RAD will be finished with the conclusion of task 3.4.5 at the end of May 2022, the development of the HUB and RAD will continue until the end of the project to allow the inclusion of the final feedback from end-users into the final versions of the tools. This will include

- the finalisation of the joint historic area workspace in the RAD, including user management options;
- the possibility to 'lock' or 'finish' a resilience assessment to disable the modification of resilience scores;
- the inclusion of a how-to section in the RAD as well as a user manual;
- a final review of the resilience questionnaire;
- the inclusion of ARCH-external resources in the HUB (including ca. 13 resources from SHELTER); and

- a final review of the step-by-step explanation of the ARCH Resilience Framework to be consistent with the final, published version of CWA 17727.

A description of the final version of the tools can be found in the forthcoming ARCH deliverable D7.6 ‘System design, realisation, and integration’.

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