

# D1.3: Lessons learnt repository of TIME4CS

Building the TIME4CS knowledge base framework

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## Table of Acronyms

### Research Performing Organisations

The next list contains the names and the acronyms used to identify the 38 Research Performing Organisations included in the QCA:

Research Performing Organisation	Acronym
University College London	UCL
Citizen Science Competence Centre- Zurich	CScCZ
Imperial College London	ICL
Aarhus University	AU
University College Cork	UCC
Leiden University	LU
Cornell University	CU
Oficina de Ciencia Ciudadana de Barcelona	OCCB
Arizona State University	ASU
Tallin University	TU
Durham University	DU
GFZ Postdam	GFZP
IRBLleida	IRBL
Czech University of Life Sciences Prague	CzU
University of Malta	UM
National Autonomous University of Mexico	UNAM
Adam Mickiewicz University	AMU
Delft University of Technology	DU-T
University of Natural Resources and Life Sciences	BOKU
University of Salzburg	USz
Israel Institute of Technology	IIT
University of Haifa	UHa
University of Turku	UT
Brandeis University	BrU



Thünen Institute	ThI
University of Gothenburg	UGth
Universidad de los Andes- Colombia	UAC
Corporación Universitaria Minuto de Dios	CUMD
The Open University	OU
Vita-Salute San Raffaele University	SRU
University Library of Southern Denmark	ULSD
University of Luxembourg	UL
Centre for Genomic Regulation	CGR
Kaunas University of Technology	KUT
Tyndall National Institute	TNI
Muenster University	MU
Citizen Science Competence Centre Berlin	CSCCB
University of Siena	US



## Conditions

Based on prior theory and substantive knowledge about the phenomenon of successful institutional transformation in support of citizen science, the next is a list of the causal conditions selected for the Qualitative Comparative Analysis:

Condition	Acronym
Institutional Integration	InIn
No CS project	NCS
Few CS projects	FCS
Lots of CS projects	LCS
Projects in the Humanities	DFH
Projects in Natural Sciences	DFNS
Projects in Biology/Ecology	DFBE
Projects in Social Sciences	DFSS
Projects in Engineering	DFE
Multifaculty projects	DFM
Local CS Networks	NLo
National CS Networks	Nna
International CS Networks	Nin
Trainings for Citizen Scientists	TCi
Trainings for Students	TSt
Trainings for Staff	TStf
Students CS Champions	StCh
Staff CS Champions	StfCh
Senior mgmt CS Champions	SMCh
Single CS Champion	SCh
CS Institutional Plan	InPI
Either CS coordinator or communicator funded	FuCo





Internal short term funding	ShF
Internal medium term funding	MeF
Internal long-term funding	LoF
External funding national	ExFN
External funding international	ExFI
External funding prestige	ExFCh
External funding charity	ExFP



## Executive Summary

The current document, titled “Lessons learnt repository of TIME4CS: Building the TIME4CS knowledge base framework” has been developed within the structure of the TIME4CS project funded by the European Union’s Horizon 2020 Research and Innovation Programme under Grant Agreement No 101006201.

This document synthesises the learnings of the case studies collected in Task 1.1 and the outcomes of D1.1 and D1.2, studying the Intervention Areas (IA) to define the key elements and drivers necessary for successful institutional transformation.

For doing this, the present document summarises some of the most important points made throughout the previous work of TIME4CS (such as D1.2 Best practices repository of TIME4CS front-runners); defines the tailoring of a methodology for understanding the successful institutional transformation in support of citizen science in Research Performing Organisations (RPOs); describes some of the pathways for such a success in RPOs by detailing the results of the Fuzzy sets Qualitative Comparative Analysis (FsQCA) and links the resulting minimal formula with IA and grounding actions (a section for each IA domain) including different combinatory models to support the generation of a knowledge-based framework in support of citizen science in RPOs.

The analysis shows that the path followed by RPOs with a higher level of Institutional Integration (InIn) of Citizen Science include the development of Citizen Science projects from different disciplines including but not limited to the Humanities, Natural Sciences, Biology/Ecology, Social Sciences and Multidisciplinary projects. In addition, having multiple Citizen Science champions seemed essential, this could be related to the fact that students and staff can provide the bottom-up pressure to push for institutional transformations; in addition, senior management citizen science champions can also influence the decision-making processes from top-down which would have a direct impact in modifying the structures in the organisations. Finally, the availability of an institutional plan that includes or considers Citizen Science and Public Engagement was a shared condition by those RPOs with higher institutional Integration. Having a Funded Coordinator appeared not to have a strong weight in supporting Institutional Integration and didn’t appear as part of the formula minimisation.

## 1. Introduction

In recent years, Citizen Science (CS) has gained popularity not only among the academic community but also with the general population (Schäfer & Kieslinger, 2016). As a research methodology characterised by a wide range of models and outcomes, it has steadily increased its number of supporters and practitioners. As a result, it has become a central topic of discussion among thematic associations and funding bodies who have developed guidelines, indicators, and quality criteria to support its wider implementation in research environments. Nonetheless, research institutions in Europe and around the world are just realising the potential of adopting a citizen-centered methodology and are yet to implement the necessary transformations to allow Citizen Science to proliferate and be used regularly by their researchers. The



development of Citizen Science requires a different approach to the design and implementation of research projects, and therefore require specific skills, which are not readily available in all research institutions.

Implementing and adopting citizen science as a methodology that allows engaging the public in the Research and Innovation (R&I) process and to embed R&I activities in society requires different institutional changes in the research environments. A combination of social and organisational transformations can allow to shape and change the internal regulations of Research Performing Organisations (RPOs) in response to all actors involved in the citizen science activities (researchers/staff, citizens, policy, and decision-makers), by creating the organisational structures, models of governance and modes of operations to allow citizen science to flourish (LERU, 2016, 2018). In practical terms, this might mean the creation of appropriate ethical procedures that can be used in citizen science projects, providing the professional support for working with volunteers, or providing the know-how in designing apps for citizen science projects.

Different factors can influence the pace at which institutional changes take place<sup>1</sup>. From a *social level*, reaching collective understandings and common values, and motivations to push for the employment of a citizen science methodology can be time-consuming and extenuating, requiring a constant and long-term commitment to dialogue within the institution and with the project participants. From an *organisational level*, each RPO can be constrained by its contextual conditions such as the local, national and international regulations in support or not of engaged research. Because each institution has different internal forces promoting and motivating its transformation, the success of any institutional changes in support of citizen science cannot be translated into a *one size fits all* solution. Yet, it is possible to learn from others' experiences and capture the elements of a transformational process which can be adapted to the specific requirements of each RPOs.

The League of European Research Universities (LERU) was one of the first education associations to provide guidance not only for scientists but also for institutions, such as universities, funding bodies, and policy-making organisms to 'promote excellence in citizen science' (LERU, 2016).

Understanding successful institutional change has also been the stepping point for TIME4CS. Different activities have taken place within the consortium for that aim during the first year which resulted in *D1.1 Collection of Case Studies of Institutional Adoption of Citizen Science* (Herrera & Haklay, 2022), mentioned here onwards as *D1.1*, included a Qualitative Comparative Analysis of 37 case studies from around the world to understand the different pathways that can lead to institutional change in Research Performing Organisations such as Universities and Research Centres. Also, *D1.2 Best practices repository of TIME4CS front-runners* (Mondardini & Roffler, 2021), mentioned here onwards as *D1.2*, analysed the experience of three leading organisations considered Front Runners (FR) undergoing a sustainable institutional transformation in support of citizen science. University College London (UCL), Aarhus University (AU) and the Citizen Science Competence Center Zurich (CCCS-Z), institutions with profound experience in the field of CS and Public Engagement in Science (PES), provided examples of fulfilment or partial satisfaction on

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<sup>1</sup> Mentioned previously in *D1.1 Collection of Case Studies of institutional adoption of CS* p6, stating that the *social approach* starts from the modification of social patterns such as cognitive, emotional, relational, etc., largely shared by the people within an organisation, while the *organisational approach*, which should be seen as a complementary to the social one, tries to modify the organisational structures (i.e. norms, procedures, protocols, etc.) which are the basis for the organisational day to day activities.

institutional intervention in support of citizen science. These changes in organisational structures and functions and in the internal support were aggregated under the term of Intervention Areas (IA)

This document is intended to provide an analysis of these recommendations by means of developing a broader pool of lessons learnt to support the achievement of sustainable institutional changes that assure the responsible involvement of society in science and innovation activities.

The proposed framework includes the different indicators analysed and the evidence collected in each area of analysis. It is expected that the resulting framework and examples can be used to inform further mutual-learning activities in support of citizen science in Europe and around the world.

## 2. Methodology

The present document is based on the analysis of the recommendations provided by LERU (2016) and the knowledge-exchange work developed as part of TIME4CS (see *D1.1* and *D1.2*) to extract a snapshot for the understanding of successful institutional changes that assure the responsible involvement of society in science and innovation activities by means of incorporating and incentivising the use of a citizen science-based methodology in RPOs.

Because of its potential for further developing the scope of public involvement in science, citizen science is high on the European research agenda. However, to be able to reach its full potential citizen science requires the support of the research institutions where they take place. In this sense, LERU (2016: 4) has set up a series of recommendations to help institutions effectively support citizen science:

1. Recognise citizen science as an evolving set of research methods, as well as its societal and educational benefits;
2. Consider creating, when viable, a single point of contact for citizen science within the institution, to advise scientists and ensure liaison with national and regional citizen science initiatives;
3. Raise awareness amongst researchers of criteria for successful citizen science, including community management, pedagogical practices, open science standards and social, intergenerational and gender diversity policies issues.
4. Ensure that proposals to granting bodies for citizen science projects include long-term commitment for infrastructures and data repositories, in line with other research projects with long-term scientific or societal benefits;
5. Ensure that project participants comply with ethical, legal and privacy regulations relevant to the scope of a given citizen science project, and have access to professional advice for this purpose;



6. Adapt research evaluation and reputation systems to include metrics that can characterise projects with a high societal impact, such as successful citizen science projects, and develop ways of assessing citizen participation.

These guidelines were based on experience from existing citizen science projects<sup>2</sup> which served to deliver actionable advice for researchers and organisations.

Based in these guidelines, TIME4CS identified 4 potential Intervention Areas (IAs) that alone or combined could stimulate the Institutional Changes necessary to promote Public Engagement in R&I activities:

**Research:** Acknowledgment by the RPOs ecosystem of CS as an evolving set of research methods and of its societal and educational benefits, through use of CS in research projects and creation of CS communities of practice;

**Education and Awareness:** Activities to raise awareness and build capacity amongst researchers, funders and civil society of criteria for successful CS activities in compliance with ethical, legal and privacy regulations. This includes events to promote CS and training programmes within the RPOs (also by establishing links with existing EU projects and training programmes on CS);

**Support resources and Infrastructure:** Creation within the RPOs of a single point of contact for addressing CS questions and of a system to support researchers implementing CS activities, including support to CS projects for long-term commitment for infrastructure and data repositories;

**Policy and Assessment:** Assessment of CS contributions and adaptation of research evaluation policies and reputation systems accordingly, taking into account incentives which could foster the implementation of CS activities.

For each of these IA, TIME4CS also identified a set of Grounding Actions (GAs), that were used for collecting relevant information and analysing case studies of institutional adoption of citizen science (D1.1), and when developing a repository of best practices of institutional change in support of citizen science (D1.2).

These GAs were considered key elements to stimulate the willingness of the institutions to perform changes in support of citizen science (Table 1. Intervention Areas and Grounding Actions for Institutional Change).

*Table 1. Intervention Areas and Grounding Actions for Institutional Change*

Intervention Areas	Grounding Actions (necessary/corresponding to Institutional Changes)
Research	To develop research projects using CS methodology
	To expand running research project using CS methodology

<sup>2</sup> LERU based such guidelines on its overview of how citizen science projects were evolving internationally and in particular at LERU universities and partner institutions, emphasising on 1) an increase in coordination/communication between projects and interdisciplinary collaborations, 2) the emergence of crowdsourcing platforms supporting a variety of citizen science projects, and 3) the growing of initiatives encouraging more prominent roles for citizens (LERU, 2016: 9).

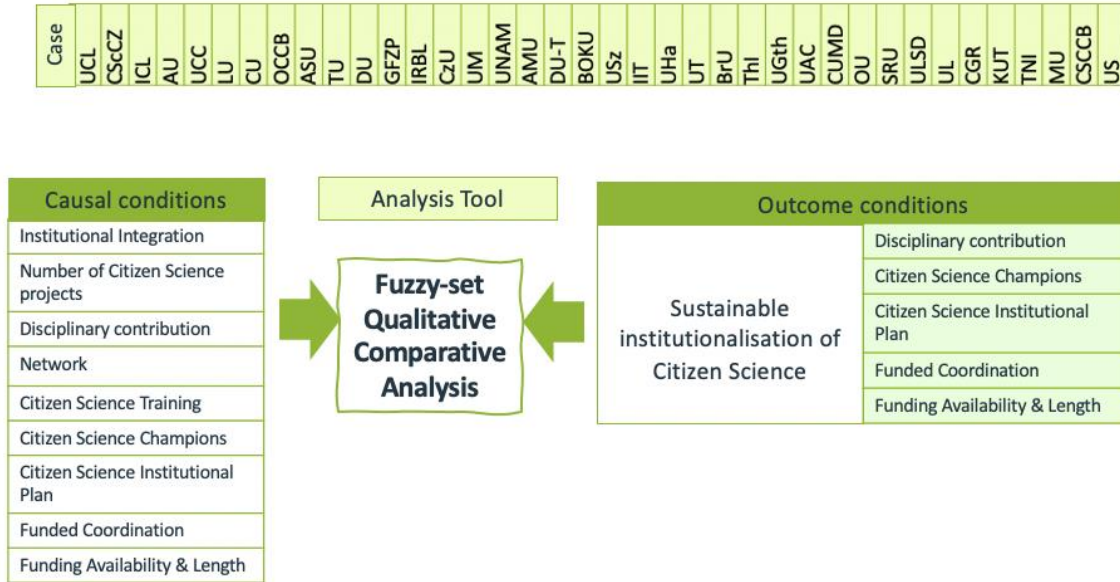
	To establish/belong to a CS network (international or national associations)
	To plan or implement changes in organisational structures or functions
<b>Education and Awareness</b>	To set up training programmes for researchers and citizen scientists
	To organise debates or public events to promote CS
	To establish or to link with working groups on CS
<b>Support resources and Infrastructure</b>	To identify an institutional contact point for CS
	To develop protocols on implementation of CS activities
	To foresee funds for CS activities
	To establish facilities to support CS activities
<b>Policy and Assessment</b>	To adopt evaluation criteria for researchers' evaluation that take into account CS
	To adopt explicit mission statements and strategies
	To develop new institutional norms, regulations, policies or agreements

Based on the IAs and GAs which seemed to play an important role in the adoption, maintenance, and consolidation of citizen science initiatives in RPOs, TIME4CS proceeded to analyse what is required for Institutional Change? How do institutions implement these Grounding Actions? What lessons can we learn from different stages of institutional change?

To provide an initial answer to these queries, in *D1.1* it was developed an initial questionnaire composed of 32 entries aiming to understand the role of different factors in supporting or undermining institutional changes (see *D1.1 Appendix A. Questionnaire Case Studies*). Later, and based on the initial responses it resulted evident that not all 32 elements played a central role in institutional change, so topics could be condensed into 8 conditions that were thought could give a sense of the Institutional Integration of citizen science: disciplinary contributions of the projects; collaboration with citizen science/public engagement networks; availability of citizen science trainings; the existence of citizen science champions; inclusion of citizen science in an institutional plan to support citizen science; the existence of a citizen science coordinator; and the availability of internal funding and external funding for citizen science projects.

The aforementioned information was collected from 38 cases of Research Performing Organisations around the world and was analysed using Fuzzy-set Qualitative Comparative Analysis (FsQCA) (Diagram 1).

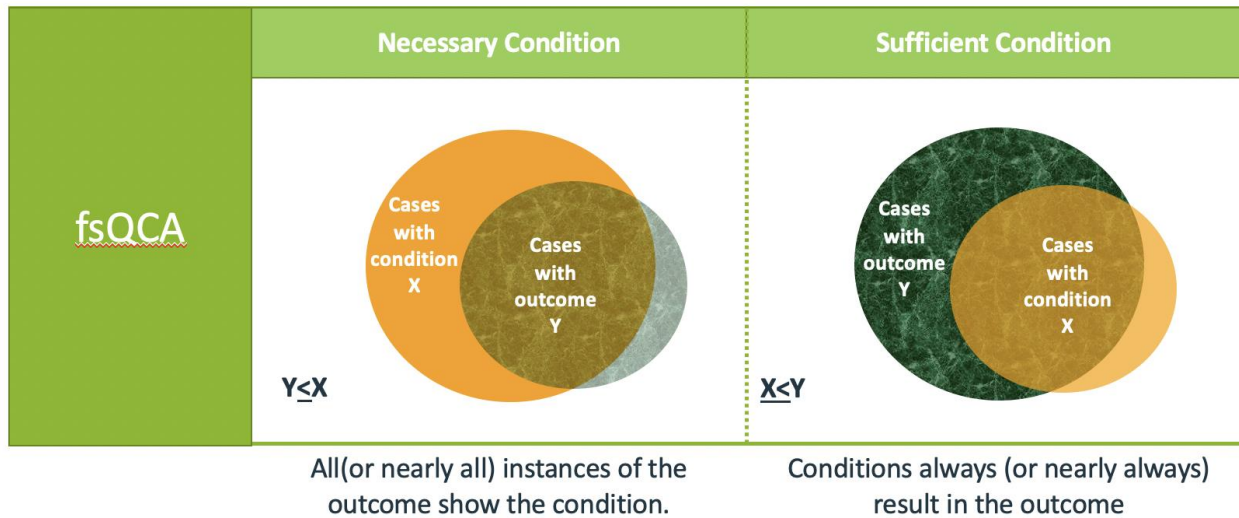
Diagram 1. FsQCA to understand sustainable changes in support of Citizen Science



As discussed in *D1.1* (Herrera & Haklay, 2022: 9-10), *FsQCA* is a method that allows developing case-oriented and variable-oriented quantitative analysis. It is based on the application of Qualitative Comparative Analysis (QCA), but applying *fuzzy-set theory*<sup>3</sup> (Ragin, 2000). It provides a quantitative assessment based on probable cause-effect & relations. The probable causes are called *Causal Conditions*. And when present within the effect analysed they become Outcome Conditions (Diagram 2).

<sup>3</sup> Fuzzy sets are those whose elements have degrees of membership.

Diagram 2. FsQCA Venn Diagram



A phenomenon such as Institutional Integration (represented by the variable *InIn*) of Citizen Science can rely on many complex causal configurations, although some may be more important than others. Necessary conditions are those required by the outcome to occur. Braumoeller & Goertz established that X is a necessary condition of Y if:

X is always present when Y occurs,

Y does not occur in the absence of X.

In terms of set theory, set X is a necessary condition of set Y if Y is a subset of X.

The analysis of sufficiency allows finding the minimal configurations that are enough to obtain the outcome (*InIn*). The definition of sufficiency is similar to the one of necessity. We say that X is a sufficient condition for Y when:

every time X is present, Y is present.

X does not occur in the absence of Y.

In terms of set theory, X is a sufficient condition for Y if X is a subset of Y

As can be appreciated from Diagram 1, when analysed independently it resulted evident that not all conditions initially considered presented a necessary relation to the outcome of Institutional Integration and only disciplinary contributions of the projects; the existence of multiple citizen science Champions; inclusion of citizen science in the Institutional Plan; the existence of a citizen science coordinator; availability external funding for citizen science projects did.

For the case of D1.2, the original GAs (Table 1) were expanded adding further GAs that the FRs have undergone (Mondardini & Roffler, 2021). Finally, the original and new GAs were evaluated based on the



empirical data provided by the Citizen Science Competence Center -Zurich, the University of Aarhus and the University College London from whom best practices were extracted and paired to the Intervention Areas they involved (Table 2).

*Table 2. Best practices based on the 4 Intervention Areas for Institutional Change*

Intervention Areas	Grounding Actions	Best Practices
<b>Research</b>	Develop research projects using CS methodology	<ul style="list-style-type: none"> <li>➤ Make sure to gain experience with CS projects. This can be at any level (i.e. designing and implementing projects from scratch or joining ongoing ones) and in any domain, as CS can be used throughout most disciplines in science and humanities.</li> <li>➤ Look around in your organization for existing projects. It may happen that their existence is not acknowledged as often researchers are not aware that what they are doing is already CS. Search for projects where CS and PES can naturally help.</li> <li>➤ Widen the interpretation of CS and PES, by taking advantage of the existing network of practitioners to provide inspiring examples. Join ECSA or your national CS association if it exists, or at least be aware of their resources and activities. Visit existing platforms that feature all kinds of existing projects.</li> </ul>
	Expand running research projects using CS methodology	
	Establish/belong to a CS Network(international or national association)	
	Plan or implement changes in organizational structures or functions	
<b>Education &amp; Awareness</b>	Set up training programmes for researchers and citizen scientists	<ul style="list-style-type: none"> <li>➤ Educate yourself first, by joining ongoing research work on the methodology, and sharing experiences with existing (network of) practitioners.</li> <li>➤ Build momentum by educating the other stakeholders, starting with the ones inside the 17rgization and easier to reach, i.e. researchers and</li> </ul>
	Organise debates or public events to promote CS	
	Establish or link with working groups on CS	

	<ul style="list-style-type: none"> <li>*Set up training programmes for students</li> <li>*Set up information sessions specifically for management</li> <li>*Set up informal occasions of interactions with researchers</li> <li>*Find and nurture CS champions bot at the management and at the student /researcher levels</li> <li>*Develop easily accessible materials (prints, web, media, etc...) about CS</li> </ul>	<p>students. To be on board and support change, they have to be fully aware of the methodology and what it implies at all levels.</p> <ul style="list-style-type: none"> <li>➤ Educate the management, it will require appropriate channels and tailored messages. Find champions at their level, so that they can be influenced by their peers.</li> <li>➤ Reach out to the public with attractive and clear material, and with the media they naturally use. Without “citizens” there is no CS!</li> </ul>
<p><b>Support resources &amp; Infrastructure</b></p>	<ul style="list-style-type: none"> <li>Identify an institutional contact point for CS</li> <li>Develop protocols on implementation of CS activities</li> <li>Foresee funds for CS activities</li> <li>Establish facilities to support CS activities</li> <li>*Participate in national or international CS projects</li> <li>*Make known and available open and free tools and/or existing tech solutions</li> <li>*Facilitate the set up of pilots/tests for the methodology</li> <li>*Provide ethic/legal protocols tailored to the institutions/national requirements</li> </ul>	<ul style="list-style-type: none"> <li>➤ Support adoption by providing simple and practical guidelines, checklists, easy protocols and procedures.</li> <li>➤ Provide technical solutions to the most common applications and projects. Educate yourself about the several open and free solutions that exist already and that can be adopted with very little or no development efforts.</li> <li>➤ Try to avoid frustration in early adopters by encouraging the implementation of pilots before they invest lots of time and resources. If possible, provide small grants to encourage and facilitate adoption. Explore local foundations and organisations for additional support.</li> <li>➤ Look for partnerships and collaboration, try to join EU consortiums in particular as they provide invaluable experience, connections and knowledge.</li> </ul>

<b>Policy Assessment</b>	Adopt evaluation criteria for researchers that take into consideration CS	<ul style="list-style-type: none"> <li>➤ Be aware of the professional and career related needs of researchers, and help them advocate for incentives at the relevant bodies in your institutions.</li> <li>➤ If possible, join working groups and task forces at your institution to document the presence and relevance of CS in official documents and strategies.</li> </ul>
	Adopt explicit mission statements and strategies in support of CS	
	Develop new institutional norms, regulations, policies, or agreements	
	*Install reward mechanisms for doing CS	

Those GAs that appeared with an asterisk (\*) were added by the Task Leader (CSCC-Z)

The next section will broaden and contextualise the results of the FsQCA to link the preliminary results of the analysis of necessity and sufficiency with the context in which those results could be originated.

### 3. Different pathways for successful Citizen Science integration

As it was mentioned in section 2, in order to identify the institutional changes in RPOs in support of Citizen Science, different variables were collected throughout 38 Research Performing Organisations<sup>4</sup> around the world (for more details see the table of Acronyms for RPOs) in order to run a FsQCA. In comparison to D1.1, we have identified an additional RPO and included it in the analysis. The analysis aimed to provide a better understanding of the complexity beyond the success of institutional change, for which a series of conditions were tested.

During the first stage of the FsQCA it was possible to identify as necessary conditions of the outcome of the different disciplinary areas of contribution; having multiple citizen science champions; counting with an Institutional Plan; having a Funded Coordinator, and receiving external funding for Citizen Science projects.

At the same time, it was possible to barre the remainders incompatible as necessary conditions from being used by the Quine-McCleskey algorithm as simplifying assumptions. That means that when Institutional

<sup>4</sup> As by the date *D.1.1* was submitted only 37 case studies had been received. Later the case study of the University of Siena was added and the FsQCA was computed again, and the results are reported on this document.



Integration (InIn) was tested by these conditions<sup>5</sup> their configuration was not a consistent subset of and sufficient for the outcome and therefore, any analysis of consistency and coverage wouldn't have provided a significant result.

As a next stage, the FsQCA was re-run now including: the different *disciplinary areas with Citizen Science projects* (Natural Sci, Social Sci, Humanities, Ecology/Biology, Engineering, Multidisciplinary), *single Citizen Science Champion* (these condition was computed as a negation [~] meaning that not having a single Citizen Science Champion would mean having multiple Citizen Science Champions and vice versa, which simplified the computing of the results), an *institutional plan* that includes Citizen Science and/or Public Engagement, and having a *paid CS coordinator*.

Table 3 shows the resulting truth table from the FsQCA. The raw consist column gives the measure of consistency. It means that the membership score on the outcome is consistently higher than the membership score of the causal combination, weighted by the relevance of each case. Consistency scores of less than 0.8 mean that there is considerable inconsistency. Scores should desirably be above 0.9. The frequency threshold for cases to be included in the truth table was set at 2 (Fiss, 2011; Ragin, 2008).

Table 3. Truth Table

DFH	DFNS	DFBE	DFSS	DFE	DFM	SCh	InPl	FuCo	number	InIn	cases	raw consist.	PRI consist.	SYM consist
1	1	1	1	1	1	0	1	0	3	1	UCL (0.67, 1.00) ASU (0.67, 0.80) UGth(0.67, 0.80)	<b>1</b>	1	1
1	1	1	1	1	1	0	1	1	2	1	AU(0.67, 0.80) OCCB(1.00, 0.80)	<b>0.880239</b>	0.84252	1
0	0	1	0	0	0	0	0	1	3	0	CU (1.00, 0.80) DU (1.00, 0.60) Bru(1.00, 0.60)	0.666667	0.5	1
0	1	1	0	1	0	0	0	0	3	0	GFZP (1.00, 0.40) IIT (1.00, 0.40) OU (1.00, 0.60)	0.466667	0.111111	0.333333
0	0	1	0	0	0	0	0	0	2	0	CzU (1.00, 0.40) Thi (1.00, 0.40)	0.4	0	0
0	0	1	0	0	0	1	0	0	2	0	UM (1.00,0.20) AMU (1.00,0.40)	0.3	0	0
0	0	0	1	0	0	1	0	0	2	0	UAC (1.00,0.20) CUMD (1.00,0.20)	0.2	0	0

Bold text indicates configurations that are sufficient for the outcomes of high life expectancy

FsQCA software also calculated the *PRI consistency*, which stands for 'Proportional Reduction in Inconsistency' and is an alternate measure of the consistency of subset relations. PRI consistency allows to avoid simultaneous subset relations of configurations in both the outcome and the absence of the outcome

<sup>5</sup> A good and established number of Citizen Science projects, the participation in a local or national network, having different CS training, nor internal were found as necessary conditions for the success of institutional integration in support of CS.



(i.e., negation). PRI consistency scores should be high and close to raw consistency scores (e.g., 0.7), while configurations with PRI scores below 0.5 indicate significant inconsistency (Greckhamer et al., 2018).

The last column on the truth table corresponds to SYM consist or Symmetric Consistency which can be used when examining both the presence and negation of the outcome and wants to use the same consistency standard for both analyses (i.e., presence and its negation). A low consistency threshold leads to the identification of more necessary conditions, which can help reduce false negatives but risks increasing false positives, and vice versa (Dul, 2016).

### What combination of conditions is usually sufficient for Institutional Integration [InIn]?

With the nine conditions, the truth table would have more than 512 (i.e.  $2^5$ ) logically possible combinations of causal conditions. Table 1 displays the 7 combinations that had at least two cases with greater than 0.8 membership in the configuration. The minimum acceptable consistency for the solutions was set at 0.8. A consistency value above 0.8 indicated that the cases in the given configuration could be considered as strong subsets of the outcome. Two configurations with consistency scores greater than 0.8 were considered as the subsets of the set of RPOs with successful Institutional Integration (see rows 1 and 2 of Table 1).

Using FsQCA 3.1b (Ragin and Davey, 2016) three solutions were computed: complex solution, parsimonious solution, and intermediate solution. By 'solution' we are referring to a combination of configurations supported by a high number of cases.

The *complex solution* presents all the possible combinations of conditions when traditional logical operations are applied (Figure 1). Because the number of identified configurations can sometimes be very large, the number of complex solutions can also be extremely large and including configurations with several terms, making the interpretation of the solutions rather difficult and in most cases impractical. For this reason, they are shown simplified later into parsimonious and intermediate solution sets.

For the case of out FsQCA on Institutional Integration of Citizen Science there was only one complex solution presented  $DFH*DFNS*DFBE*DFSS*DFE*DFM*\sim Sch*InPI$  which meant that from all conditions analysed (disciplinary contributions from the Humanities[DFH], Natural Sci[DFNS], Biology/Ecology[DFBE], Social Science[DFSS], Engineering[DFE], Multidisciplinary[DFM], Multiple Citizen Science Champions [ $\sim Sch$ , as this condition was computed as the negation of a Single Citizen Science Champion], inclusion of Citizen Science in the Institutional Plan[InPI], and a Funded Citizen Science Coordinator[FuCo]) the absence or presence of a FuCo appeared to make little to no difference for a successful integration of Citizen Science in the RPO. This formula offered a *solution coverage* of 0.162617, indicating that 16.26% was covered by the solution term; while the *raw coverage* of 0.945652 indicated that 94.56% of the outcome was explained by this alternative path; and the *unique coverage* of 0.162617 indicated that 16.26% of the outcome was exclusively explained by the complete solution, each term of the solution, and each individual solution term (memberships that are not covered by other solution terms).

Within the consortium a good example of this formula could be traced down to the cases of University College London and Aarhus University, but also the Oficina de Ciencia Ciudadana de Barcelona, the Arizona State University and the University of Gothenburg who have followed a similar path for successful Institutional Integration of Citizen Science.



Figure 1. Complex solution

```

*****
*TRUTH TABLE ANALYSIS*
*****

File: /Users/abrilh/Desktop/TIME4CS-DataMatrix.csv
Model: InIn = f(DFH, DFNS, DFBE, DFSS, DFE, DFM, SCh, InPl, FuCo)
Algorithm: Quine-McCluskey

--- COMPLEX SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.880239

                raw      unique
                coverage  coverage  consistency
                -----  -----  -----
DFH*DFNS*DFBE*DFSS*DFE*DFM*~SCh*InPl  0.162617  0.162617  0.945652
solution coverage: 0.162617
solution consistency: 0.945652

Cases with greater than 0.5 membership in term DFH*DFNS*DFBE*DFSS*DFE*DFM*~SCh*InPl: OCCB
(1,0.8),
  UCL (0.67,1), AU (0.67,0.8), ASU (0.67,0.8),
  UGth (0.67,0.8)
    
```

The *parsimonious solution* presents a simplified version of the complex solution, and simplifies assumptions, presenting the core conditions (Fiss, 2011) which cannot be left out of any solution (Figure 2). The parsimonious solution includes any counterfactual combination that can contribute to a logically simpler solution.

For the case of this FsQCA, the parsimonious solution indicated seven paths to Institutional Integration. RPOs with membership in the set of Disciplinary Contribution in Humanities [DFH], or in the set of Multidisciplinary Contribution [DFM], or in the set of Institutional Plan[InPl], or in the set of Disciplinary Contribution Social Sciences and not Single Champion[DFSS\*~SCh], or in the set of Disciplinary Contribution Natural Sciences AND Disciplinary Contribution Social Sciences [DFNS\*DFSS], or in the set of Disciplinary Contribution Biology and Ecology AND Disciplinary Contribution Social Sciences [DFBE\*DFSS] or in the set of Institutional Plan[InPl], all exhibit Institutional Integration. The overall consistency of this combination was found to be 65.47%. The recipe covered about 74.43% of the outcome.

The Parsimonious solution showed us that different disciplinary contributions and their combination could play an important role for successful Institutional Integration. Acknowledging that the disciplinary contributions of Citizen Science projects can be diverse is important as from all case studies of Research Performing Organisations around the world collected and analysed, not all of them came from Universities. Some of the cases received were either from specialised research centres or specialised universities that don't have all different disciplinary areas in their curricula. That logic applied to some of the Multidisciplinary cases such as IRBLleida, specialised on clinical and epidemiological research that is just starting its way towards Institutional change; or the University of Natural Resources and Life Sciences[BOKU] with a focus on biology and ecology topics but where multidisciplinary work also takes place;



Figure 2. Parsimonious Solution

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*****
*TRUTH TABLE ANALYSIS*
*****

File: /Users/abrilh/Desktop/TIME4CS-DataMatrix.csv
Model: InIn = f(DFH, DFNS, DFBE, DFSS, DFE, DFM, SCh, InPl, FuCo)
Algorithm: Quine-McCluskey

--- PARSIMONIOUS SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.880239

      raw      unique
      coverage  coverage  consistency
-----
DFH      0.448598      0      0.8
DFM      0.588785      0.0434579  0.7
InPl     0.521028      0.0901869  0.902103
DFSS*~SCh 0.429907      0      0.613333
DFNS*DFSS 0.345794      0      0.672727
DFBE*DFSS 0.420561      0      0.642857
DFSS*DFE  0.28972      0      0.688889
solution coverage: 0.744392
solution consistency: 0.654747

Cases with greater than 0.5 membership in term DFH: UCL (1,1),
CScCZ (1,1), AU (1,0.8), LU (1,1),
OCCB (1,0.8), ASU (1,0.8), UNAM (1,0.4),
USz (1,0.8), UGth (1,0.8), ULSD (1,1),
KUT (1,0.6), MU (1,0.6)
Cases with greater than 0.5 membership in term DFM: UCL (1,1),
CScCZ (1,1), ICL (1,0.6), AU (1,0.8),
UCC (1,0.6), LU (1,1), OCCB (1,0.8),
ASU (1,0.8), TU (1,0.4), IRBL (1,0.2),
UNAM (1,0.4), BOKU (1,1), UHa (1,0.4),
UT (1,0.6), UGth (1,0.8), ULSD (1,1),
KUT (1,0.6), MU (1,0.6)
Cases with greater than 0.5 membership in term InPl: CScCZ (1,1),
OCCB (1,0.8), ULSD (1,1), CSCCB (1,0.8),
UCL (0.67,1), ICL (0.67,0.6), AU (0.67,0.8),
ASU (0.67,0.8), UNAM (0.67,0.4), DU-T (0.67,0.6),
BOKU (0.67,1), USz (0.67,0.8), UT (0.67,0.6),
UGth (0.67,0.8), KUT (0.67,0.6)
Cases with greater than 0.5 membership in term DFSS*~SCh: UCL (1,1),
AU (1,0.8), UCC (1,0.6), OCCB (1,0.8),
ASU (1,0.8), TU (1,0.4), UNAM (1,0.4),
USz (1,0.8), UT (1,0.6), UGth (1,0.8),
SRU (1,0.2), ULSD (1,1), UL (1,0.2),
MU (1,0.6), US (1,0.2)
Cases with greater than 0.5 membership in term DFNS*DFSS: UCL (1,1),
AU (1,0.8), UCC (1,0.6), OCCB (1,0.8),
ASU (1,0.8), UNAM (1,0.4), USz (1,0.8),
UT (1,0.6), UGth (1,0.8), MU (1,0.6),
US (1,0.2)
Cases with greater than 0.5 membership in term DFBE*DFSS: UCL (1,1),
AU (1,0.8), UCC (1,0.6), OCCB (1,0.8),
ASU (1,0.8), TU (1,0.4), UNAM (1,0.4),
USz (1,0.8), UT (1,0.6), UGth (1,0.8),
ULSD (1,1), UL (1,0.2), MU (1,0.6),
US (1,0.2)
Cases with greater than 0.5 membership in term DFSS*DFE: UCL (1,1),
AU (1,0.8), UCC (1,0.6), OCCB (1,0.8),
ASU (1,0.8), UGth (1,0.8), SRU (1,0.2),
ULSD (1,1), US (1,0.2)

```

The *intermediate solution* (Figure 3) is based on a subset of simplifying assumptions used to compute the complex and parsimonious solution, which should be consistent with theoretical and empirical knowledge.

The intermediate solution on our FsQCA provided a similar formula than the one already presented as a complex solution. In this sense, other than the information already explained in the complex solution, it can be said that a good mix of disciplinary contributions AND having multiple Citizen Science Champions AND incorporating in some degree Citizen Science and/or Public Engagement in the Institutional Plan can be required steps for achieving successful Institutional Integration of Citizen Science. However, RPOs aiming to achieve Institutional Integration should be cautious as there may be a temporal order in which conditions occurred. That been said, according to the parsimonious solution it appears as an indicative that no matter the degree of Institutional Integrations of the organisations it is important to generate projects in different



disciplines. This can also mean that if temporal relationships exist between the different conditions, then causal combinations could be interconnected.

Figure 3. Intermediate solution

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*****
*TRUTH TABLE ANALYSIS*
*****

File: /Users/abrilh/Desktop/TIME4CS-DataMatrix.csv
Model: InIn = f(DFH, DFNS, DFBE, DFSS, DFE, DFM, SCh, InPl, FuCo)
Algorithm: Quine-McCluskey

--- INTERMEDIATE SOLUTION ---
frequency cutoff: 2
consistency cutoff: 0.880239
Assumptions:
~SCh (absent)

              raw      unique
              coverage  coverage  consistency
-----
DFH*DFNS*DFBE*DFSS*DFE*DFM*~SCh*InPl  0.162617  0.162617  0.945652
solution coverage: 0.162617
solution consistency: 0.945652

Cases with greater than 0.5 membership in term DFH*DFNS*DFBE*DFSS*DFE*DFM*~SCh*InPl: OCCB (1,0.8),
UCL (0.67,1), AU (0.67,0.8), ASU (0.67,0.8),
UGth (0.67,0.8)
```

In summary, what these results tell us is that the main path followed by RPOs with a higher level of institutional integration of Citizen Science include the development of citizen science projects from different disciplines including but not limited to the Humanities, Natural Sciences, Biology/Ecology, Social Sciences and Multidisciplinary projects. In addition, having multiple citizen science champions seemed essential, this could be related to the fact that students and staff can provide the bottom-up pressure to push for institutional transformations; in addition, senior management citizen science champions can also influence the decision-making processes from top-down which would have a direct impact in modifying the structures in the organisations. Finally, the availability of an institutional plan that includes or considers CS and public engagement was a shared condition by those RPOs with higher institutional Integration. Having a Funded Coordinator appeared not to have a strong weight in supporting institutional integration and didn't appear as part of the formula minimisation.

The next section will go back to the initial 3 sets of recommendations for successful Institutional Change in support of citizen science in RPOs looking to identify their temporal order within the Institutional Integration of Citizen Science in the organisation, from which a series of lessons learnt will be extracted.

## 4. Towards a knowledge-based framework in support of Citizen Science

TIME4CS has defined Institutional Change as a type of change triggered in an organisation with four main dimensions:



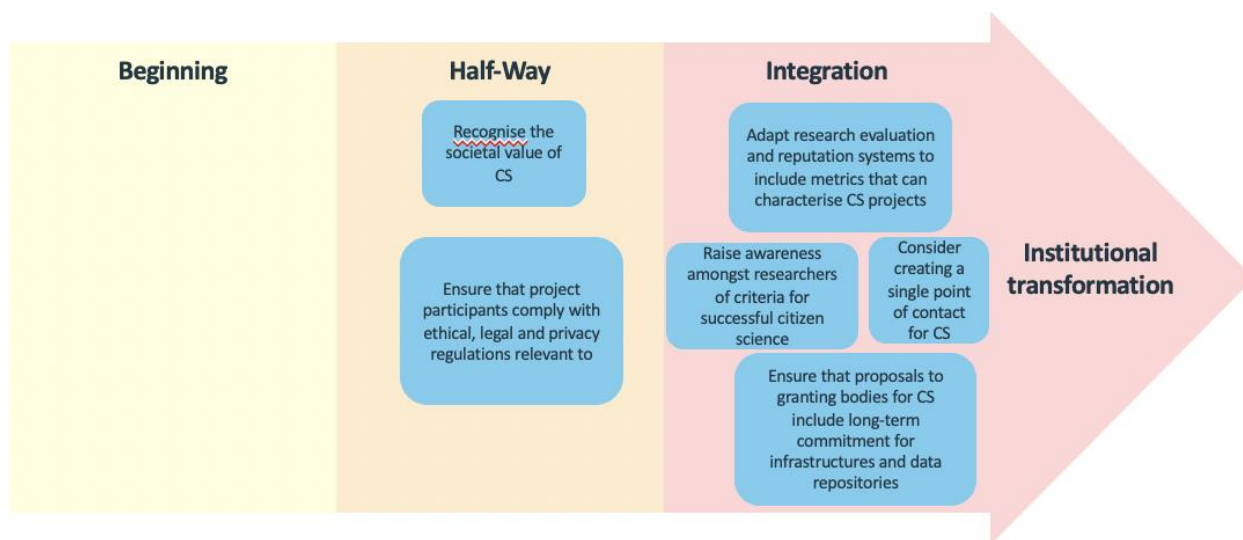


- First, **the change is irreversible**, so it is visibly rooted in the practices and procedures of the organisation and last in time;
- Second, **the change is comprehensive**, so it exceeds changes only on rules and procedures and include other areas like organisational culture, the way it communicates internally and externally, invest resources, etc.;
- Third, **the change is inclusive**, which means that it involves all stakeholders in the organisation and beyond it;
- Fourth, **the change is contextualised**, since change must take into account the background of the organisation and tailor specific measures that are relevant to the organisation specifically.

Based on these four dimensions on this section we will try to understand change as a process that can be divided in at least three stages: a beginning of the change/ transformations; half-way through such change; and the Integration of changes as a constant. Based on these three phases we have incorporated the different recommendations from LERU(2016), from D1.2 and from D1.1 aiming to contribute to the discussion about the elements required to succeed on this task.

If we apply these dimensions rigorously to LERU(2016) recommendations, it seems they are applicable until after some transformations are taking place half-way (Diagram 3). LERU (2016) recommendations were also planned as a top-down strategy of the institutions. This strategy could result problematic when not including *specific measures relevant to the organisation (and the researchers of that organisation) specifically*.

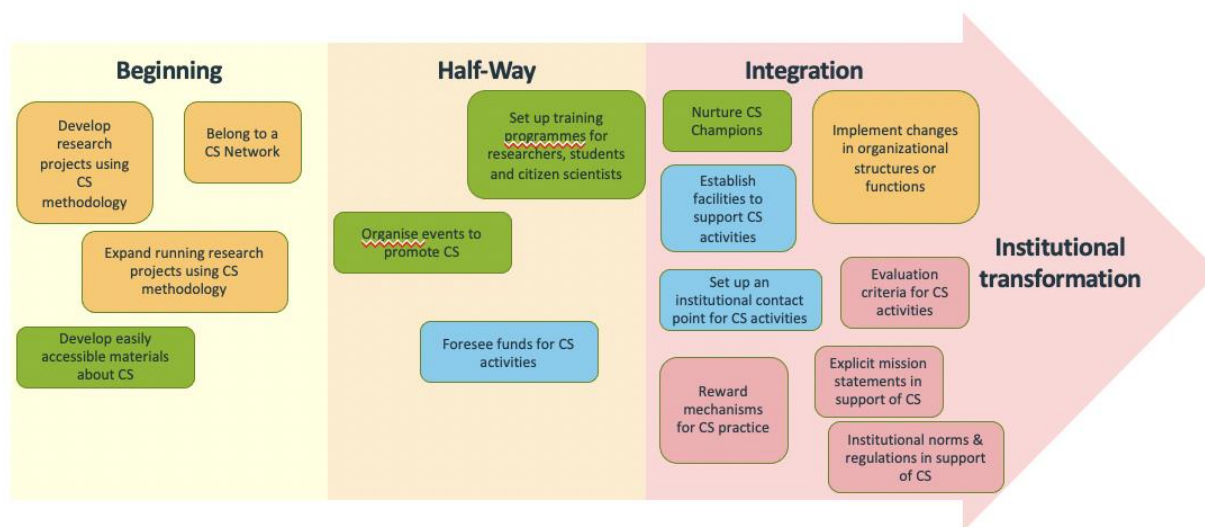
Diagram 3. Institutional transformation based on LERU recommendations



D1.2 presented a clearer series of steps that included steps for the beginning of the change, such as developing projects applying a Citizen Science Methodology, belonging to a Citizen Science network, expanding projects and developing accessible material about Citizen Science; as a half-way stage we could

identify setting up training programmes, organising events to promote Citizen Science and foresee funds for Citizen Science activities; with the highest number of components taking place in the integration stage it could be set up in a similar sequence as the suggested GAs can just take place after some changes have started occurring (Diagram 4).

Diagram 4. Institutional transformation based on D1.2



Finally, based on our fsQCA and D1.1 we concluded that developing Citizen Science projects in a wide variety of disciplines, having Citizen Science champions at different levels, and having a strategic plan in support of CS activities proved to be necessary conditions but on their own were not sufficient to guarantee the success of institutional transition in support of Citizen Science.

After running the fsQCA, the preliminary results were contrasted with the information of the case studies and discussed with collaborators and consortium partners in an online workshop ran on Tue 08/03/2022 (Image 1)

Image SEQ Image \\* ARABIC 1. fsQCA online workshop



Participants were asked to provide feedback and comment on these preliminary results where three universities with high-level of integration provided feedback on their general pathway: University College London(UCL), Aarhus University(AU) and the University of Natural Resources and Life Sciences (BOKU) (see Appendix B for an extended view of their responses), and it resulted evident that while some of the aforementioned conditions were shared by RPOs undergoing institutional integration of citizen science, they didn't necessarily reflect full causality but in some cases, they were present as a result of institutional integration (Diagram 3).

As a beginning shared by all cases examined in the fsQCA, no matter the level of institutional integration in which they were, there were citizen science or participatory research projects demonstrating the interest of the researchers to employ such a methodology. For the case of the collaborators, who provided an extensive follow-up response to their current situation AU self-reported: *“CS projects have been or are running in all faculties at AU, but it is a bottom-up process, led by individual researchers. Peer support and knowledge exchange through internal AU networking was emphasised as important for cross-faculty exchanges and*



*collaborations to happen, as well as increase institutional support”, so while networks of collaboration didn’t prove to be a necessary condition for integration its importance might be more directed to help RPOs and researchers get started developing CS projects. For the case of UCL it is important to add that having developing diverse citizen science projects in different disciplines had also to do with “the work of committed researchers, and champions pushing for more engaged research but also of an RPO that has favoured and strongly supported public engagement in research through different incentives such as training, budget and flexibility to pursue this kind of projects. The general commitment of the institute to Open Science opened up an opportunity to integrate citizen science as part of it”. It is important to mention that having Citizen Science projects in a broad range of disciplines is more important when the RPO has a diverse offer of disciplines as part of its research portfolio, and RPOs dedicated to investigating more specific areas shouldn’t feel discouraged as what is important under this condition is that researchers become aware of the benefits of applying a Citizen Science methodology. BOKU is a good example of that pathway, as “BOKU is a specialised university for life sciences, so research areas such as humanities don’t exist, therefore there are no BOKU citizen science projects from research areas not present at BOKU. Nevertheless, CS projects have been and are still present in areas outside biodiversity and/or ecology at BOKU.”*

After developing Citizen Science projects for a while there might emerge figures in the RPOs recognised as *citizen science champions*, however, this is something that tends to take time and that is why it has been included as a halfway step through institutional integration. From UCL “A key element for achieving a large number of citizen science champions has to do with the high support that UCL has placed in promoting and funding public engagement in research, providing the arena for citizen science champions to grow and multiply their efforts with the students and citizen scientists.” That has been a similar pathway in AU where “Peer support, as well as institutional support, have been critical to keeping champions motivated.” In BOKU the term CS Champion is not in use but there are several researchers who have fostered citizen science, receiving some top-down support to occupy important leadership positions either directing the citizen science working group or the platform Österreich forscht at BOKU on a senior scientist-level. In this sense “BOKU has not only been supporting and funding citizen science within the university, but on a national level by financing the coordinating positions for the CSNA and Österreich forscht.”

As it has been previously mentioned, for the analysis of sufficiency it was decided to drop out the condition *access to national and international* as it is not directly influenced by the RPO, however, based on the experience of the aforementioned institutions there are ways in which they can facilitate researchers' access to such funding. For the case of UCL, there is “the Research and Innovation Services (RIS) established to integrate research, innovation and enterprise support at UCL. This is the office in charge of providing



*information about how to apply for national and international funding, managing funding and research contracts*". However, most of the relevant funding for citizen science projects is still found by researchers, so ideally RPOs should be able to make such information accessible. That has already been the case at AU where *"The Research Support Unit was established at AU to provide support to researchers in all aspects of attracting external funding. They are now also helpful in relation to CS, as they, by request, specifically look for calls aimed at CS."* Of the three RPOs that were reported, BOKU seems to be the one that provides more tailored support regarding external Citizen Science funding for researchers. As such *"BOKU's research support (Forschungsservice) has dedicated persons responsible for citizen science funding on a national and international level and is assisting researchers in coordinating project proposals. Project auditing also gives support to administrative tasks in EU projects (e.g. accounting) regardless if the project is citizen science or not. Dedicated cs-trainings are conducted within the BOKU staff training programme. Furthermore, the legal department of BOKU has built an expertise in legal questions for citizen science project coordinators (e.g. GDPR, copyright law) and is also organising legal training for citizen science and open science projects."*

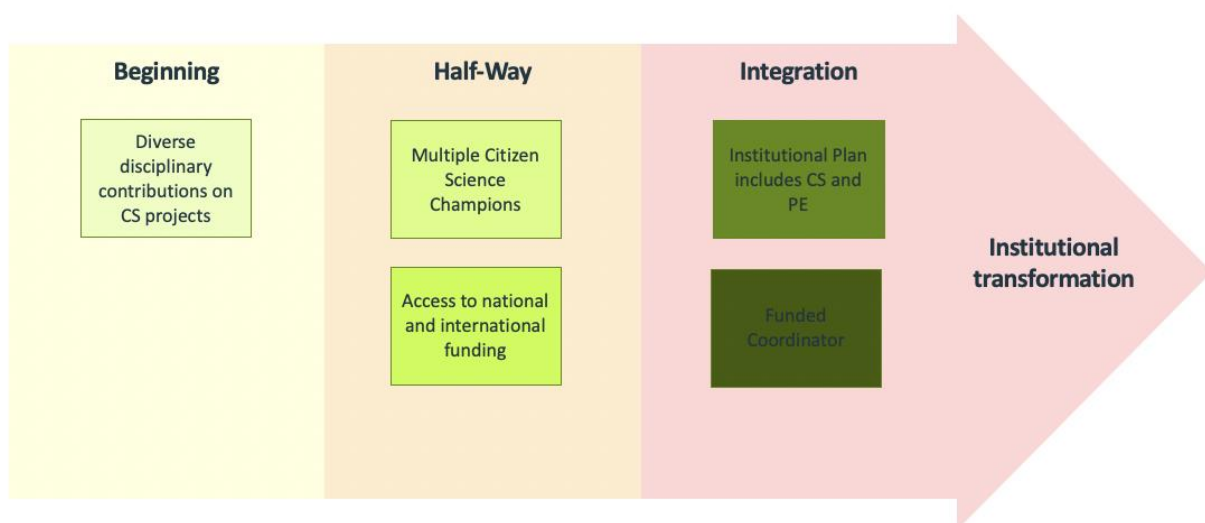
While having a *paid Citizen Science coordinator* appeared as a reported condition on RPOs with a high level of institutional integration this seems to be more the result of such integration rather than a condition for it. This can be observed with the reported data from BOKU that has *"two full-time tenured senior scientists employed for coordinating citizen science activities and on a national level in Austria, and also supports a student coworker assisting in these activities. Furthermore, BOKU also finances the Austrian citizen science platform Österreich forscht ([www.citizen-science.at](http://www.citizen-science.at)) and its maintenance."* However, these coordinators have a previous strong trajectory on Citizen Science pushing bottom-up *"towards institutional recognition of Citizen Science within BOKU"*, so in a sense, having paid coordinators was the result of top-down transformation in the sense that institutional change was already happening; but also bottom-up as the paid coordinators have a strong trajectory pushing for the institutional recognition of Citizen Science in the organisation. While those bottom-up efforts are shared by UCL and AU, where Citizen Science Champions part-take unpaid responsibilities to support Citizen Science activities, none of them have an explicitly paid coordinator. In the case of UCL actions are taking place and there is a *"member of staff with responsibility to the Office of Open Science and Scholarship, with who also pays attention to Citizen Science"* but it is not fully dedicated to it.

Finally, for the case of having Citizen Science as part of the *institutional plan* is a condition that cannot be expected in an RPO at the beginning of its pathway towards institutional transformation but should be seen as part of the final steps to reach a full sustainable integration. However, a good starting point that can



provide some encouragement for those supporters of the use of Citizen Science initiatives is the inclusion of Citizen Science in Open Access or Public Engagement initiatives. The fulfilment of the condition, again, relies on the bottom-up efforts of the Citizen Science Champions who push for the inclusion of this methodology in the plan of their RPOs and from the top-down there is the interest of senior management staff to fulfil national and international requirements of RRI. That has been the case for UCL where Citizen Science *“is part of the 8 Pillars of Open Science on which the Office for Open Science and Scholarship stands and new institutional norms, regulations and policies are currently in the making. Otherwise, the Public Engagement Unit is the entity that provides some strategies that include Citizen Science.”* A similar situation stands for AU where *“CS is not yet explicitly part of the strategy, though AU’s strategic plan [2025] for research excellence and collaboration with external partners and communities implicitly includes CS. The new Natural Sciences Faculty Strategy includes the aim to “Disseminate the concept of ‘Open Science’ to more subject areas”, thus also including CS. It is a work in progress to get it into more strategic plans at AU”.* At BOKU the inclusion of Citizen Science as part of the Institutional Plan seem to have been the result *“Citizen Science is part of the Development Plan (Entwicklungsplan) 2027, which was published in 2021. CS is part of the wider field of societal engagement of BOKU and is recognized as an important component of sustainable, transparent, and inclusive science, that can respond to the challenges of tomorrow. (...)Furthermore, citizen science is also one of the topics in the performance agreements (Leistungsvereinbarungen) between the university and the Ministry for Science and Research.”*

Diagram 5. Chronology of institutional transformation based on the fsQCA conditions



## 5. Conclusions

This document has provided an overview on different pathways and guidelines for successful institutional change in support of citizen science, based on the experiences from existing citizen science projects (LERU, 2016), the routes taken by Front Runners (D1.2) and the multiple experiences of RPOs around the world (D1.1) which together can provide actionable resources for researchers and organisations wanting to support the use of citizen science. However, it must be remembered that citizen science is in constant development, and therefore best practices should be re-examined periodically in light of societal, technological and scientific changes (LERU, 2016) and contextualised according to the country or region where they take place.

Further analysis on institutional change in support of Citizen Science should emphasise on identifying empirically and methodologically if there is a temporal order for conditions to occur.



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# Appendix A. Data Matrix

Case	IbDA	# of CS Projects			Disciplines				Networks			Training			Champions			Plan InPl	Coord		Internal Funding			External Funding					
		NCS	FCS	LCS	DFH	DFNS	DFBE	DFSS	DFE	DFM	NLg	Nna	Nin	Tcl	TST	TStf	StCh		StCh	SMCh	Sch	PuCo	Coor	ShF	Mef	LoF	ExFN	ExFl	ExCh
UCL	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1	0	0	1	1	1	1	
CS-CZ	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1	0	
ICL	0.6	0	0	1	1	1	1	0	1	1	0	1	1	1	1	1	1	1	0	0.67	1	1	1	0	1	1	1	0	
AU	0.8	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0.67	1	1	1	0	1	1	1	0	
UCC	0.6	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	0	0	1	1	0	0	
LU	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	0	0	1	1	0	1	
CU	0.8	0	0	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	0	1	0	
OCCB	0.8	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	1	0	1	1	
ASU	0.8	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0.67	0	1	1	0	1	0	1	1	
TU	0.4	0	1	0	0	1	1	1	1	0	0	1	0	1	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0
DU	0.6	0	1	0	0	1	1	0	0	1	1	1	0	1	0	0	1	1	0	0	0	0	0	1	1	1	0	0	0
GFZP	0.4	0	1	0	0	1	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0	0	1	1	1	0	0	0
IRBL	0.2	0	1	0	0	1	1	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0
CHL	0.4	0	1	0	0	1	1	0	0	1	1	0	0	1	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0
UM	0.2	0	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
UNAM	0.4	0	1	0	1	1	1	0	1	1	1	0	1	0	0	0	1	1	0	0.67	0	1	1	0	1	0	0	0	0
AMU	0.4	0	1	0	0	1	1	0	0	0	0	1	0	1	0	0	0	0	0	0.67	0	0	0	0	1	0	0	0	0
DU-T	0.6	0	0	1	0	1	1	0	1	0	0	1	0	1	0	0	1	1	0	0.67	1	1	0	0	1	0	0	0	0
BOKU	1	0	0	1	0	1	1	0	0	1	1	1	1	1	1	1	1	1	0	1	1	0	0	1	0	0	1	0	0
USX	0.8	0	0	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	0	0.67	0	1	1	0	0	1	0	0	0
IIT	0.4	0	1	0	1	1	1	0	1	1	0	1	1	1	1	1	1	1	0	0.67	0	0	1	0	1	0	0	0	0
UHa	0.4	0	1	0	0	1	1	0	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0
UT	0.6	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0.67	0	0	0	0	1	1	1	1	0
BFA	0.6	0	1	0	0	1	1	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0
TJL	0.4	0	1	0	0	1	1	0	0	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	1	0	0	0	0
UGrb	0.8	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0.67	0	0	0	0	1	1	0	1	0
UAC	0.2	0	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
CUMID	0.2	0	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0
OU	0.6	0	1	0	0	1	1	0	1	1	1	0	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0	0
SRU	0.2	0	1	0	0	1	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
ULSD	1	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	0	1	1	0	1	1	0
UL	0.2	0	1	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	1	0.33	0	0	0	1	0	1	1	0	0
CGR	0.2	0	1	0	0	1	1	0	0	1	0	1	0	1	0	1	1	1	0.33	1	0	0	0	0	0	0	1	1	0
KUT	0.6	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0.67	0	0	0	0	0	1	1	0	1	0
TNI	0.6	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0.33	0	0	0	0	0	0	0	0	0	0
MIU	0.6	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0.67	0	0	0	0	1	1	0	0	0
CSCCB	0.8	0	1	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	0.33	0	1	1	0	0	1	1	1	1	0
US	0.2	0	1	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0



# Appendix B. Knowledge-exchange factors of institutional change

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Conditions for Successful Integration of Citizen Science in Research Performing Organisations

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## Conditions for Successful Integration of Citizen Science in Research Performing Organisations

After discussing some of the bottom-up and top-down conditions encountered through the QCA to be shared within those organisations that have achieved successful institutional integration of Citizen Science, we want to hear from you and know what your RPO is doing to fulfil those conditions. We also want to hear how you think your RPO and even TIME4CS could support covering those conditions.

ABRILCHAVEZ1 MAR 09, 2022 09:45AM

### Disciplinary contributions

#### Explanation

Based on the fsQCA, developing Citizen Science projects on different disciplines results necessary for the successful integration in the RPO, by allowing Citizen Science to "gain its full potential from broadening across research arenas" (Hecker et al, 2018). If CS activities are clustered within your RPO what do you think is needed to broaden its reach to other areas? What has worked in doing so?

#### UCL

More than 15 Citizen Science projects from different disciplines in the humanities, social sciences, natural sciences, biology, ecology, engineering and multidisciplinary have been developed in the last 5 years. The list (which is not exhaustive) include Transcribe Bentham, Colouring London, Histories of Whitechapel, A Memory Map of the Jewish East End, CITIZAN, the Coastal and Intertidal Zone Archaeological Network, Heritage Combs, London Prosperity Board, the Relief Centre, Sapelli, Geokey, SISCODE, SCALINGS, ECSAnVIS, Doing it Together, EveryAware, and so on. These projects are the result of the work of committed researchers, and champions pushing for more engaged research but also of a RPO that has favoured and strongly supported public engagement in research through different incentives such as training, budget and flexibility to pursue these kind of projects.

#### AU

CS projects have been or are running in all faculties at AU, but it is a bottom-up process, led by individual researchers. Peer support and knowledge exchange through internal AU networking was emphasized as important for cross-faculty exchanges and collaborations to happen, as well as increase institutional support

#### BOKU

Around 20 citizen science projects coming from a wide variety BOKU research fields such as zoology, soil ecology, engineering, chemistry, biodiversity, conservation, wildlife biology, forestry, law, organic agriculture or social ecology have been developed in the last 10 years at BOKU. These projects are both research projects using the method citizen science to answer their research questions in collaboration with citizen scientists, and projects on the method citizen science itself to foster quality in citizen science or to explore how citizen science projects can be developed under certain circumstances. Some of these projects are Project Roadkill, FireDatabase, Heavy Metal City-Zen, HomeGrown, Golden Jackal, Beeradar, Wasser schafft, Lehm- und Leinwand im Weinviertel or SamoMAB. These projects are/were conducted by professors, post-docs and PhD students from many different institutes at BOKU and involve(d) a wide variety of target groups e.g. school classes, farmers, garden owners, firemen or hunters. However, BOKU is a specialized university for life sciences, so research areas such as humanities are not existing, therefore there are no BOKU citizen science projects from research areas not present at BOKU. Nevertheless, CS projects have been and are still presents in areas outside biodiversity and/or ecology at BOKU.

### Multiple Citizen Science Champions

#### Explanation

The fsQCA showed us that people organised bottom-up within the RPO can play a central role in supporting Citizen Science initiatives to become sustainable. These Champions that can be Students, Staff and Senior Managers can push for successful integration of Citizen Science in the RPO. What has worked to support and maintain Citizen Science Champions in your RPO? or what is needed to nurture them?

#### UCL

UCL has a longstanding history of CS Champions at the student level, many of them have collaborated in Extreme Citizen Science (ExCiteS) with Muki Haklay or at the

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Institute for Global Prosperity with Henrieta Moore (both unofficial CS Champions). UCL also has several other unofficial CS champions in different departments, such as Anna Cox a strong supporter of CS and Paul Ayriss (Pro-Vice-Provost [UCL Library Services]) at the senior manager level, who is in charge of the Office for Open Science, which following the LERU Roadmap for Open Science strongly supports Citizen Science as one of its eight pillars. A key element for achieving a large number of Citizen Science Champions has to do with the high support that UCL has placed in promoting and funding public engagement in research, providing the arena for Citizen Science Champions to grow and multiply their efforts with the students and citizen scientists.

#### AU

AU has a number of informal CS Champions across all five faculties and in the Science Museums as well as the AU Library, who champions Citizen Science and Open Science among students and researchers through supporting them in their projects. Peer support, as well as institutional support, is critical to keeping champions motivated.

#### BOKU

Although the term CS Champion is not used at BOKU, there are several persons at BOKU that have fostered citizen science and conducted their own projects in various positions and from various BOKU institutes. On professor-level Christian Vogel, Harald Vacik or Johann Zaller have been (or are currently conducting) several citizen science projects and/or have supported post-docs and PhD students to design their own projects. Since the foundation of the citizen science working group and the establishment of the coordinating positions for the Citizen Science Network Austria (CSNA) and its associated platform Österreich forscht at BOKU on a senior scientist-level with Florian Heigl and Daniel Dörler, several master theses have been created with citizen science. Both Florian Heigl and Daniel Dörler are also giving trainings and personal coachings for citizen science for BOKU researchers, they are part of the research support team with a focus on citizen science funding and are also conducting several university courses where students can learn about citizen science. On PhD-student-level Julia Lanner and Jennifer Hatauf have been leading very successful citizen science projects in the last years. BOKU is therefore not only supporting and funding citizen science within the university, but on a national level by financing the coordinating positions for the CSNA and Österreich forscht.

### Institutional Plan that includes Citizen Science

#### Explanation

Through the fsQCA was possible to identify having an Institutional Plan that includes Citizen Science and/or public engagement as an explanatory condition for institutional integration. Having a strategic plan that facilitates CS activities and to network learning and expertise (Blaney et al. 2016), seem to be a top-down step that advances citizen science. How did your organisation include Citizen Science in the institutional Plan or what would be needed for doing this?

#### UCL

CS is part of the 8 Pillars of Open Science on which the Office for Open Science and Scholarship stands and new institutional norms, regulations and policies are currently in the making. However, meanwhile, the Public Engagement Unit is the entity that offers most of the support for coordinating collaboration agreements between, students, researchers and partners in the development of socially engaged research.

#### AU

CS is not yet explicitly part of the AU strategy though AU's strategic plan [2025] for research excellence and collaboration with external partners and communities

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Conditions for Successful Integration of Citizen Science in Research Performing Organisations

implicitly includes CS. The new Natural Sciences Faculty Strategy includes the aim to "Disseminate the concept of 'Open Science' to more subject areas", thus also including CS. It is a work in progress to get it into more strategic plans at AU.

its maintenance. Both coordinators have been active in citizen science before their tenure, and they have worked a lot toward institutional recognition with BOKU. From this perspective (which is probably not comparable to other RPOs) the institutional transformation needed to happen before there were paid coordinators.

**BOKU**

Citizen science is part of the BOKU Development Plan (Entwicklungsplan) 2027, which was published in 2021. CS is part of the wider field of societal engagement of BOKU and is recognized as an important component of sustainable, transparent and inclusive science, that can respond to the challenges of tomorrow. Furthermore, citizen science will also be strengthened further in student education by implementing new citizen science courses. CS is also part of the annual "Wissensbilanz", a report that is tacking stock of important research developments at BOKU and is published by the university rectorate and the university council. Furthermore, citizen science is also one of the topics in the performance agreements (Leistungsvereinbarungen) between the university and the Ministry for Science and Research.

**Paid Citizen Science Coordinator**

**Explanation**

In our fsQCA model we identified the condition that a paid coordinator is needed to lead to organisational transformation. It might be that the causality is actually the other way around (so only after institutional transformation you get a paid coordinator). What will be your view?

**UCL**

UCL has a member of staff with responsibility to the Office of Open Science and Scholarship, with responsibility also to pay attention to Citizen Science. However, at the moment, UCL has no explicit coordinator of Citizen Science.

**AU**

AU does not have a dedicated paid CS coordinator, thus this aspect is sought covered by the CS champions in the various faculties and related institutions. The question is a bit chicken-and-egg it seems - with more CS, you may attract more external funding to also pay for a coordinator; but without the coordinator, you may not get the funding for the CS projects and research...

**BOKU**

BOKU has two full-time tenured senior scientists employed for coordinating citizen science activities within BOKU and on a national level in Austria, and also supports a student coworker assisting in these activities. Furthermore, BOKU also finances the Austrian citizen science platform Österreich forscht ([www.citizen-science.at](http://www.citizen-science.at)) and

**National & International funding available for Citizen Science projects**

**Explanation**

The fsQCA showed that having access to national and international funding for Citizen Science projects resulted was one of the explanatory conditions that in combination (with the previously mentioned conditions) could facilitate institutional integration. RPOs can play an important role in supporting this condition by providing research support for scientists in applying and managing national and international funding (such as providing information on grant applications and post-award management). What information your RPO provides you with to apply for national and international Citizen Science funding? or what information could result you useful if your RPO doesn't provide any support on this condition?

**UCL**

The Research and Innovation Services (RIS) has been established to integrate research, innovation and enterprise support at UCL. This is the office in charge of providing information about how to apply for national and international funding, managing funding and research contracts, and supports researchers to find relevant funding opportunities (including Citizen Science projects).

**AU**

The Research Support Unit was established at AU to provide support to researchers in all aspects of attracting external funding. They are now also helpful in relation to CS, as they, by request, specifically look for calls aimed at CS.

**BOKU**

BOKU's research support (Forschungsservice) has dedicated persons responsible for citizen science funding on a national and international level and is assisting researchers in coordinating project proposals. Project auditing also gives support in administrative tasks in EU-projects (e.g. accounting) regardless if the project is citizen science or not. Dedicated cs-trainings are conducted within the BOKU staff training programme. Furthermore, the legal department of BOKU has built an expertise in legal questions for citizen science project coordinators (e.g. GDPR, copyright law) and is also organizing legal trainings for citizen science and open science projects.

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