POLITECNICO
DI TORINO

Master Thesis
Architecture for Sustainable Design

How we can Assess the Level of Interdisciplinarity and Transdisciplinarity of Academic Institutions?

This document discusses the impacts of
Inter/Trans-Disciplinary on organizational research centers

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Thanks everyone!
Mahmood Ramezanzade

The Assessment of Interdisciplinary and Transdisciplinary of Research Centers within Academic Institutions

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***Abstract*—"Interdisciplinarity" and "Transdisciplinarity" in research are applied to tackle issues whose solutions are out of the boundary of a discipline. These research activities assemble a wide range of subjects and pieces of knowledge not only from different scientific disciplines but also from other bodies of specialized or expert knowledge in order to simultaneously produce knowledge that consequence to adequate solutions and goals. This thesis seeks the rationale for Interdisciplinary and Transdisciplinary Research Centers (ITRCs), how transposes from other research centers, and the challenges associated with measuring its quality. The crucial research question is to investigate empirically the policies established between the first 10 ranked universities that actively supporting ITRCs? In this context, the ITRC is defined as any physical and non-physical research center that merges and unifies different disciplines with their presumptions and studies concentrated on problems that cross the borders of two or even more disciplines.**

Based on a review of the literatures on inter/trans-disciplinary to improve the better understanding; data scripting of quantitative and qualitative analysis to identify the indicators of success/failure as well as strength of the infrastructures; study of papers/reports/articles about the relative surveys by researchers of academic and non-academic experts who are currently participating in ITRCs to examine the quality of research centers. Consequences of the findings demonstrate a correlation between universities ranking and the ITRCs, 'as the number of centers rises, the ranking is rising'. My results also bring the USA with over 90 ITRCs as a striking position on the world; program, master, and 'non-educating' as the most popular educational plan respectively and science, engineering, and energy as more approached disciplines within the ITRCs. Missions, vision, year of foundation, publications, affiliations, facilitating researchers, certain subject popularity from funders perspective plus the value of topics are positively related to impacts of the success/failure within the ITRCs. On this basis, it is recommended that inter/transdisciplinary research centers attempt to inject nonmutual cooperations to tackle complex problems. Further research is required to distinguish additional factors that could improve the feasibility of these centers.

***Keywords*—Interdisciplinary, Transdisciplinary, Research Centers, Success/Failure, Indicators, Measure**

I. Introduction

WHY why transdisciplinary and interdisciplinary are so important to resolving complex problems, the following sentence is explained in one word. "Universities have departments, the real world has problems" (Bozeman & Crow, 1990, p.29). "There is a need for Trans-Disciplinary Research (TDR) when knowledge about a societal relevant problem field is uncertain when the concrete nature of problems is disputed, and when there is a great deal at stake for those concerned by problems and involved in dealing with them" (Pohl & Hadorn, 2007, p.20). Inter-Disciplinary Research (IDR) is based on three types of disciplinary institutions: 1. Organizational (research institutions, universities, funding agencies), 2. Research group (research peers and project team members) and 3. individual works (Castán

Broto, Gislason, & Ehlers, 2009). Institutions encouraged and fostered interactions, which defined performance criteria (Boix Mansilla, Lamont, & Sato, 2016). The co-production of knowledge is required for the implementation of academic institutions in a soluble composition. Leading institutions claim that many of the complex problems society is currently facing demand of innovative solutions that combine knowledge from different scientific disciplines (*Facilitating Interdisciplinary Research*, 2004). In addition, Interdisciplinary/Transdisciplinary Research Center (ITRCs) are used to address problems whose solutions are out the boundary of discipline or area of research practice.

II. Objective

A simple research topic is taken up by (van Rijnsoever, Hessels, & Vandeberg, 2008), which stated Higher academic rank often leads to more collaboration. The thesis explores the rationale for ID and TD research centers, how differs from other research centers and the challenges associated with measuring its quality. The progress of interdisciplinary research (IDR) and transdisciplinary research (TDR) are fundamentally entwined with the process of social research and the societal context of doing science (MacMynowski, 2007) and one way to address this gap is creating inter/trans-disciplinary research centers in educational systems corresponds to a 21st Century vision of the problem.

III. Research Questions

This thesis concentrates on an critical issue which is accompanied by four sub-questions to get the outcomes.

- To investigate empirically "Which" policies are currently in progress between the first 10 ranked universities actively supporting Interdisciplinary/Transdisciplinary Research Center (ITRCs)?
  - What are clear definitions of Inter/Trans-disciplinary (ITD)?
  - Who are the world's leading success centers for Inter-Disciplinary (ID) and Trans-Disciplinary (TD) research?
  - What kind of activities do an Inter-Disciplinary (ID) and Trans-Disciplinary (TD) center carry out to understand indicators of success/failure?
  - How the indicators of an Interdisciplinary/Transdisciplinary Research Center (ITRCs) could be measured?

IV. Methods

A methodology with different methods is used to bring about a unification of the objectives of experts from different disciplines and all social areas in response to the research question and sub-questions.

- Quantitative Research
  - Data scripting to figure out the numbers of physical indicators that have to affect on ITD research qualification.
  - Survey with famous academic and non-academic persons who played an important roll in investigation inter-discipline.
- Qualitative Research
  - Content analysis proves each ITD platform, which places allocated to enhance the research quality.
- Literature review of quantitative and qualitative inter/trans-disciplinary data to understand indicators of success/failure of an ID/TD research center, activities, and structure ability.

V. Literature Review

This section is arranged accordingly: deals with different understandings of IDR and TDR then, a summary of the history of Interdisciplinarity is compiled. Then a summary of the history of Interdisciplinarity is compiled. Next, an overview of the subject and an overview of the indicator or failure in section are examined by an analysis of quantitative and qualitative literature. Eventually, several existing scholars in ID and TD are addressed in order to have clearly defined how this matter is currently going.

VI. Results and Discussion

The result chapter reports the findings around my observation and investigation according to the research questions and gives a precise answer to them. This section supported by a different kind of demonstrations such as pie charts, graphs, word-clouds, map, and tables of the final findings. Besides, it is presented the data related to different kinds, total amount, world map infographic, type of partnership, current activities, and two types of word-cloud related to focus area and education of 140 ITRCs within the top ten universities in the world. It is also supplemented by a flowchart list of ITRCs, and then each flowchart of the top ten universities is supported by a great detail of each center's indicators. At the end of this chapter, the results are discussed and followed by the interpreted the obtained data, implications, identified both limitations and recommendations of study for further investigations.

VII. Conclusion

The research presented in this thesis was motivated by claims 'TrUST - Transdisciplinarity for Urban Sustainability Transition' (Sonetti, n.d.) that aims better understand of current approaches of the interdisciplinary and transdisciplinary research centers (ITRCs). The first objective of this paper was to investigate empirically the policies were established between the first 10 ranked universities actively supporting inter/transdisciplinary research centers. The results determined a correlation, linking the ranking of the universities plus the 140 ITRCs, 'as the number of centers rises, the ranking is rising'. My second aim was to find out a clear definition of interdisciplinary and transdisciplinary research within these centers. I found the means of inter/trans-discipline in research and mission/vision of each center are positively related to each other.

The findings of this study concerning who are the world ID/TD leading centers indicate that the USA with over 90 ITRCs has a striking position in the world and then following that, UK and Switzerland are the succeeding pioneer nations respectively.

My study provides the framework to understand indicators of success/failure of centers and how it could be measured. Depending on the context, factors can behave either positively or negatively. Mission, vision, year of foundation, publications, affiliation, the importance of a topic, rate of popularity for a topic for funders, and facilitating researchers are positively related to impacts of the success of ITRCs. A strong negative effect comes from a comparison between "Non-educating" word frequency and "Ratios of education" that many ITRCs approached to having educational plan meanwhile demanded to be more specific in which kind of educational system they desire to step forward.

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Glossary

A | **E** | **I** | **L** | **N** | **P** | **R** | **T** | **U** | **V**

A

A little room inside a building is a small zone that is allocated to ITR. 62, 77

Alliance Institution is an institution that aims to implement its program with the other association of interdisciplinary programs. 62, 77

E

Education The mechanism by which ITR instructions are obtained or given. 68, 144

I

Independent/Free-standing Not connected to any other system, or sponsored. 67

Inter-institutional/Consortium Existing or occurring between institutions, not only within a university, but also from other university institutions. 67

Interdepartmental/Associated with University/Institute-wide/Cross-school It is not non-academic, it is a secondary or subordinate branch of the main university. 67, 144

L

Laboratorie may be a room or a building that intertwines schools and disciplines physically and intellectually. 62, 77, 85

N

Non-educating demonstrates that ITRCs approached to having educational plan but needed to be more precise in which kind of educational system they want to step forward for training their students or researchers and does not mean that the centers have not attended to it. 73

not-applicable Information following indicators related to quantitative/qualitative analysis approved that the center is not applicable for the purpose of having/performing specific facts, therefore no value has been assigned to the attribute. 49

P

Program if interdisciplinary research is a program it means that something is arranged to continue improving a particular topic. 62, 77, 92, 99, 119, 132

Programs Variety assumptions such as certain propose run for a particular goal "chen distinguished visitor programs (see 4.24); academic programs; discipline education program, etc. 73

Public-private partnership the core foundation is centered around or is peer-based and built upon collaborations that conduct research for their own country. 67, 144

R

Research Concentrated investigation and study of ITR and sources to establish facts and arrive at new conclusions. 68, 144

Research and Education Providing both approaches of ID/TD and education. 68

Research Center is a center usually resides in a university and reports to the dean and has complicated strength to tackle interdisciplinary and transdisciplinary issues. 62, 77, 85, 106, 112, 119

Research Institution the institute refers to the Provost or Vice President for Research and Innovation and may have one or several centers affiliated with it. 62, 77, 85, 99, 106, 126, 134

T

Team of Researchers/Hub is the effective center, region or network of activity between researchers. 62, 77, 106, 119

U

Unassigned Not assigned or set aside for a specific purpose. 49, 67, 68

V

Virtual Platform focuses on mutual collaboration between researchers from all regions of the world and usually does not exist in a specific location. 62, 77, 92, 106, 112, 119

Acronyms

B | C | E | F | G | H | I | J | M | N | O | P | S | T | U | W

B

BBE Division of Biology and Biological Engineering. 17, 99

C

C2SM Center for Climate Systems Modeling. 18, 124

CASBS Center for Advanced Study in the Behavioral Sciences. 16, 86

CBA Center for Bits and Atoms. 16, 81

CC-CS Citizen Science Center Zurich. 18, 123

CCE Division of Chemistry and Chemical Engineering. 17, 100

CID Cambridge Infectious Diseases. 17, 116

CMRAE Center for Materials Research in Archaeology and Ethnology. 16, 82

CRASSH Centre for Research in the Arts, Social Sciences, and Humanities. 17, 113

CRC Cultural Research Centre. 18, 132

CSLI Center for the Study of Language and Information. 16, 89

E

ETH Zurich ETH Zurich Swiss Federal Institute of Technology. 15, 60, 63, 118, 119, 136

F

FSI Freeman Spogli Institute. 16, 88

G

GPI Global Priorities Institute. 17, 106

GPS Division of Geological and Planetary Sciences. 17, 101

H

HEI Higher Education Institution. 27

HEPL Hansen Experimental Physics Laboratory. 16, 85, 87

I

ICCS Interdisciplinary Center for Conservation Science. 17, 107

ID Inter-Disciplinary. 19, 29, 31–33, 35, 43, 44, 47–52, 55, 56, 59, 70, 106, 119, 132, 136–140, 143–146

IDR Inter-Disciplinary Research. 23, 27, 31, 33, 36, 46, 50

IIIS Institute for Interdisciplinary Information Sciences. 18, 134

ITD Inter/Trans-disciplinary. 14, 29, 31, 32, 41, 43, 45, 59, 143–147

ITDR Inter/Trans-disciplinary Research. 41

ITR Interdisciplinary and Transdisciplinary Research. 19, 119, 146

ITRC Interdisciplinary/Transdisciplinary Research Center. 14–16, 19, 24, 27, 31, 32, 37, 43, 44, 50, 58–60, 62, 64, 65, 67–73, 75, 76, 84, 85, 91, 98, 99, 105, 106, 118, 119, 125, 131–134, 136–140, 142–146

J

J-PAL Abdul Latif Jameel Poverty Action Lab. 16, 79

M

MIT Massachusetts Institute of Technology. 48, 60, 62, 63, 70, 77, 78, 136–138

MITEI MIT Energy Initiative. 16, 80

N

NoC Network of Interdisciplinary Internet and Society Research Centers. 17, 94

NUS National University of Singapore. 15, 62, 63, 131, 132

O

ODID Oxford Department of International Development. 17, 108

OeRC Oxford e-Research Centre. 17, 109

P

PSC Zurich-Basel Plant Science Center. 17, 120

PZ Project Zero. 16, 93

S

SMART Singapore–MIT Alliance for Research and Technology. 16, 78

T

TD Trans-Disciplinary. 19, 29, 31–33, 43, 44, 47–52, 55, 56, 59, 70, 106, 119, 132, 136–140, 143–146

TDR Trans-Disciplinary Research. 23, 27, 31, 33, 46, 50

TMCD Technology and Management Centre for Development. 17, 110

TREC Harvard Transdisciplinary Research in Energetics and Cancer Center. 17, 97

U

UCCRI University of Cambridge Conservation Research Institute. 17, 114

W

WFSC World Food System Center. 17, 121

WGH Interdisciplinary Concentration Women, Gender, and Health. 17, 95

"Conceptions should not be defined, they should be explained. Conceptual nature of terms creates a higher polymorphism in the science language. The more profound and advanced a conception is, the higher its polymorphism."

~V.V. Nalimov
(Polymorphism – a Greek term: poly – many and morphe – a form)

1 Introduction

"Universities have departments, the real world has problems" (Bozeman & Crow, 1990, p.29). In a word, this sentence explains why interdisciplinarity/transdisciplinarity are so vital in solving complicated problems that are socially relevant. "There is a need for Trans-Disciplinary Research (TDR) when knowledge about a societal relevant problem field is uncertain when the concrete nature of problems is disputed, and when there is a great deal at stake for those concerned by problems and involved in dealing with them" (Pohl & Hadorn, 2007, p.20). Inter-Disciplinary Research (IDR) is based on three types of disciplinary institutions: 1. Organizational (research institutions, universities, funding agencies), 2. Research group (research peers and project team members) and 3. individual works (Castán Broto, Gislason, & Ehlers, 2009). "Universities establish multiple disciplinary departments

and teaching programs" (Choi & Pak, 2006, p.352). Institutions encouraged and fostered interactions, which defined performance criteria (Boix Mansilla, Lamont, & Sato, 2016). In many universities information is generated and evaluated largely for disciplinary frameworks and priorities. The co-production of knowledge is required for the implementation of academic institutions in a soluble composition. Leading institutions claim that many of the complex problems society is currently facing demand of innovative solutions that combine knowledge from different scientific disciplines (*Facilitating Interdisciplinary Research*, 2004). Interdisciplinary and transdisciplinary research performance and evaluation are both generative processes of harvesting, capitalizing, and leveraging multiple expertise. Individual standards must be calibrated, and tensions among different disciplinary, professional, and interdisciplinary approaches carefully managed in balancing acts that require negotiation and compromise (Julie T Klein, 2008). In addition, Interdisciplinary/Transdisciplinary Research Center (ITRCs) are used to address problems whose solutions are out the boundary of discipline or area of research practice.

1.1 Thesis object

A simple research topic is taken up by (van Rijnsoever, Hessels, & Vandeberg, 2008), which stated Higher academic rank often leads to more collaboration. In this thesis, a wide variety of inter-disciplinary research centers in the ten leading universities is assessed in line with a vision of problems in the 21st century to obtain success/failure indicators. Before embarking on the thesis, certain terms need to be defined.

1.1.1 Intra/Multi/Cross/Inter/Trans-disciplinarity

The meanings for some of the recurring terms are mentioned in this section to explain how the terms are used in the framework of thesis.

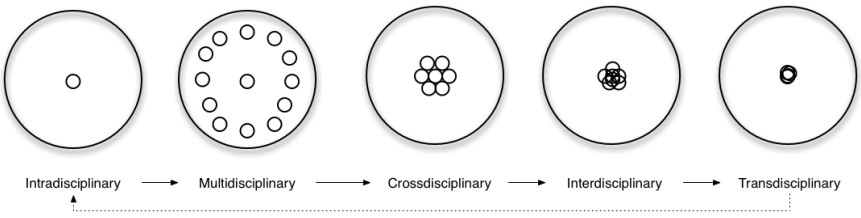


Figure 1.1: Transdisciplinary development snapshot by (Alexander Refsum Jensenius, 2012)

The image is summarizes the transdisciplinary development in a snapshot by (Alexander Refsum Jensenius, 2012). Incorporate concepts from (Zaman, Academy, & Goschin, 2010), (Tress, Tress, & Fry, 2005), (Choi & Pak, 2006), (Alexander Refsum Jensenius, 2012) make it simple in a research project.

Intradisciplinary - Within etymology = intra- + disciplinary. "Intradisciplinary" Within a single academic discipline. Collaboration depends heavily on the scope of the discipline and the specificity of the research concern. For instance, This is a conceptual approach of Geography. Inter-disciplinary approach indicates the relationship between Geography and other disciplines while intra-disciplinary approach shows relationship among the sub-branches within the discipline of Geography (Ram Pravesh Yadav, 2018).

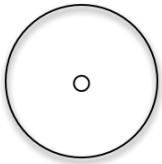


Figure 1.2: Intradisciplinary - Within (Alexander Refsum Jensenius, 2012)

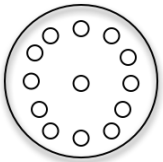


Figure 1.3: Multidisciplinary - Add/Multiply (Alexander Refsum Jensenius, 2012)

Multidisciplinary - Add/Multiply etymology multi- + disciplinary. "Multi-disciplinarity" outcomes as a straightforward combination of various disciplines that maintain their unique perspectives unchanged. They share a connection that is not collaborative, but collective, and can work together to create a more complicated picture of reality. The topic of

analysis will best expose its different characteristics by exploring different perspectives, using the techniques and observations provided by a variety of developed disciplines.

Crossdisciplinary — Intersect, Transfer etymology cross- + disciplinary. "Cross-disciplinary" applies to several types of cross-border interactions, looking at one discipline from an other's viewpoint. Researchers are working together to move knowledge from one discipline to the other.For example, views from political science are being used in fictional literature to understand political dispute. As part of the current university, cross-disciplinarity has a long background, particularly among disciplines that share borders or those with a shared focus. Physics and astronomy disciplines demonstrate this background. Physic studies a law that determines the universe; these laws extend to non-Earthly contexts (to the best of modern knowledge). Physics and astronomy programs are therefore usually located in the same academic department, providing for cross-disciplinary interaction.

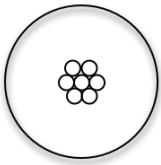


Figure 1.4: Crossdisciplinary — Intersect, Transfer
(Alexander Refsum Jensenius, 2012)

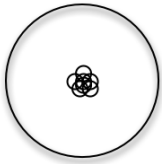


Figure 1.5: Interdisciplinary - Integrate, Synthesise
(Alexander Refsum Jensenius, 2012)

Interdisciplinary - Integrate, Synthesise etymology inter- + disciplinary. "Interdisciplinary" comes from the process of merging and integrating different disciplines together with their methodologies and presumptions. It includes crossing the formal borders between sciences and combining their methods in favor of a common purpose. "Methodologies and assumptions belonging to different disciplines are connected and modified in order to adapt to the needs of the research, creating new tools which allow for the investigation of difficult subjects that surpass the possibilities of a single discipline." (Zaman et al., 2010). In the field of architecture, for instance, complex topics such as SDGs, urban transitional, sustainability, and design imply various approaches that combine chemistry, drafting for de-

sign, engineering design, fundamentals of physics, architectural illumination and electrical systems.

Transdisciplinary - Transcend, Whole etymology trans- + disciplinary. "Transdisciplinary" For one of the first times was stated (Roland W. Scholz, Lang, Wiek, Walter, & Stauffacher, 2006), in a 1973 OECD report on environmental education. Transdisciplinarity describes a study that focuses on issues that cross the borders of two or even more disciplines "when a common set of axioms prevail, related to but lying beyond and complementing traditional disciplines" (Emmelin, 1975). With the other word, principles or techniques originally developed by one discipline but now commonly used by others.

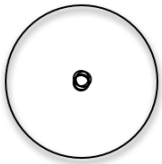


Figure 1.6: Transdisciplinary - Transcend, Whole
(Alexander Refsum Jensenius, 2012)

1.2 Pros and Cons of Inter/Trans-Disciplinary Research Centers

These research actions collect a wide range of subjects and pieces of knowledge not only from different scientific disciplines but also from extra-academic and other bodies of specialized or expert knowledge. For this reason, Higher Education Institutions (HEIs) are putting effort in creating ITRCs. Some of the significant factors that support Inter-Disciplinary Research (IDR) and Trans-Disciplinary Research (TDR) centers are, for instance:

- Interdisciplinary research brings discipline-wide researchers together at interfaces, borders and even across borders to create new disciplines (*Facilitating Interdisciplinary Research*, 2004).

- A Wider Audience as the Result of Interdisciplinary Research (Glod, 2016). It does mean that, every field of study has its own universe

scope and its own observation toolkit and the wider audience can also benefit from being open to observations.

- Transdisciplinarity is a specific form of interdisciplinarity that, while recognizing the invaluable contribution from different scientific fields, also emphasizes the need for cooperation and communication among the various parts of society with these academic disciplines in order to meet the complex challenges we face today (J Thompson Klein et al., 2001).

- "Research infrastructures are not simply the basis for research, but can also open up new vistas in cross-domain research" (Duşa, Nelle, Stock, & Wagner, 2014, p.129) and achievement between all disciplines or enhancing communication skills (Strebten, 2011).

- Better work of prediction and explanation. Methodology usually does not help to appreciate the human world's institutional and psychological complexity. It certainly does not help to explain the world more accurately (Glod, 2016).

- Understanding the preoccupations of each member of a team when developing concrete solutions (Broto, Allen, & Rapoport, 2012).

- Understanding the methodological tools available within each discipline, which helped researchers building realistic expectations about what a particular discipline has the capacity to address (Broto et al., 2012).

- Understanding the conversations each discipline is having about the subject being studied (Broto et al., 2012).

- Understanding the professional costs and benefits for team members of doing interdisciplinary research and using this information to develop

deliverable and/or publications that facilitate the career development of all team members (Broto et al., 2012).

- Mastering multiple approaches and methodologies (Lau & Pasquini, 2004).

- "Career path" Interdisciplinarity takes many forms and this can influence the types of career paths that academic researchers experience (Lyall, 2019).

- Resistance to changes in researchers practices, particularly those that bear most directly on relations with industry, public and of course on the design and development of novel artefacts (Balmer, 2013).

Factors can act negatively or positively, depending on their context. Factors are Context-dependent, but can also be translated from problems to the research study. Following this, overcoming a mono-disciplinary view of data or technique is important to have a wider evaluation of the pros and cons of a problem. Nevertheless, Inter/Trans-disciplinary (ITD) research still encounters difficulties in its implementation and hinder transdisciplinary collaboration, because:

- The existing body of knowledge on ID and TD is disjointed and dispersed across a wide array of journals and other publications, which renders it less accessible to newcomers and means that, as a research community, we do not have an easily comprehensible "canon" that would enable us to accumulate shared learning about interdisciplinary careers (Lyall, 2019).

- Lack of consensus in the literature is perceived by many authors (von Wehrden et al., 2019) as a deficit that currently impedes efforts towards incentives interdisciplinary and transdisciplinary approaches (Adams, Loach, & Szomszor, 2016).

- There is also a lack of common understanding and a particular interpretation as a reason for interdisciplinary and transdisciplinary failure, and cooperation takes a longer time.

- Following Snow, we submit that the lack of interdisciplinary interaction involving scientists and humanists is less about hostility and more about mutual ignorance. As Snow put it, “They have a curious distorted image of each other” (MJF, TE, & KC, 2014, p.4).

- Integration confusion and time-consuming curriculum preparation (Strebten, 2011).

- Uniformity of points of view and rejection of ID (Robinson et al., 2016).

- Discussion on the legality of specific disciplines and Interdisciplinary Research.

- Negotiating positions within and across rigid research groups to seek employment and secure research (Lau & Pasquini, 2004).

- More critical positions, such as that of (Rafols & Meyer, 2009), propose that “interdisciplinary” is not the right term to explain cognitive dynamics at the boundaries of disciplines.

- ”Communicative” Different disciplines use different ‘languages’ and the same word may mean different things in different disciplines, resulting in a great deal of frustration until this is clarified (Bruce, Lyall, Tait, & Williams, 2004).

- The capacity building challenge (Lowe, Phillipson, & Wilkinson, 2013) and lack of space to consolidate knowledge.

1.3 Focus and Scope

The thesis explores the rationale for Inter-Disciplinary (ID) and Trans-Disciplinary (TD) research centers, how differs from other research centers and the challenges associated with measuring its quality. The progress of Inter-Disciplinary Research and Trans-Disciplinary Research are fundamentally entwined with the process of social research and the societal context of doing science (MacMynowski, 2007) and one way to address this gap is creating ITRCs in educational systems corresponds to the 21st-century vision of the problem. Many of the considerations addressed in this thesis are aligned with related key questions. What interdisciplinary research projects are undertaken, which disciplines are involved, how conflicts are resolved, and the acceptance of the research by the rest of the scientific community (MacMynowski, 2007).

1.4 Methods

The thesis is, in fact, based on data scripting techniques for quantitative and qualitative analysis to determine the number of physical indicators affecting the qualification of IDR/TDR research. A study of scholar surveys with academic and non-academic experts currently involved in ITRCs, as well as the review of relative surveys on the quality of selected ITD interviews, to improve the understanding of the quality of ITRCs.

Content analysis of selected ITD interviews helps to carry out the qualitative analysis. Literature review into the IDR/TDR research center quantitative analysis to understand the success/failure indicators of these centers, including their infrastructure strengths. Reviewing subsequent recent literature on regional approaches are summarized to standards for assessing the effectiveness of ITRCs.

By the above, these literature-based analyses are joined together with realistic observations to propose an updated set of criteria for the analysis of

the findings of ITD research centers.

1.5 Research Questions

This thesis concentrates on an critical issue which is accompanied by four sub-questions to get the outcomes.

- To investigate empirically "Which" policies are currently in progress between the first 10 ranked universities actively supporting Interdisciplinary/Transdisciplinary Research Center (ITRCs)?
  - What are clear definitions of Inter/Trans-disciplinary?
  - Who are the world's leading success centers for ID and TD research?
  - What kind of activities do an ID and TD center carry out to understand indicators of success/failure?
  - How the indicators of an ITRC could be measured?

1.6 Thesis Structure

Chapter 2 includes a summary of the relevant literature, interpretation of the interdisciplinary and transdisciplinary, accompanied by analytical methods and current researchers in the field of ID and TD. Methods used throughout the thesis with its process as well as qualitative analysis of academic literature and then described in Chapter 3, after which the results are shown and then discussed, followed by interpreted the data, identified both limitations and recommendations of the study for the further investigations are indicated in Chapter 4. finally, the key conclusions are outlined in Chapter 5.

2

Literature Review

This review, which assesses interdisciplinary and transdisciplinary research, provides instruction from emerging national literature about the subject that is reviewed in recent years. This section is arranged accordingly: (section 2.1) deals with different understandings of IDR and TDR. Then a summary of the history of Interdisciplinarity (subsection 2.1.1) is compiled. Next, an overview of the subject and an overview of the indicator or failure in section are examined by an analysis of quantitative and qualitative literature (subsection 2.2. Eventually, several existing scholars in ID and TD are addressed (section 2.3) in order to have clearly defined how this matter is currently going.

2.1 Definitions of Interdisciplinarity and Transdisciplinarity

In the past 30 years, scholars have discussed concepts of interdisciplinarity across many disciplines, yet they are still confused with other kinds of cooperation. The word "interdisciplinary," used frequently is still vague across the works of literature. For example, a multidisciplinary or transdisciplinary perspective was collectively referred to as (Tress et al., 2005; Repko, Newell, & Szostak, 2011; Julie Thompson Klein, 2010; Lyall, 2019). These concepts may not have been the main focus of these studies, so there has been limited attention in defining them. Although the reliability or validity of their studies may not fundamentally be compromised, the caution in presenting definitions that affect consistency in current and future research.

Nevertheless, a structure develops from the search for meanings, which can provide sufficient information to reach a consensus on what is inter/transdisciplinarity. Following (Mallon & Bunton, 2005),the patterns can also provide adequate information. Interdisciplinary collaboration is characterized by the fact that members from different areas work together on one project. The analysis, synthesis, and harmonization of connections into a coordinated and coherent whole.

Although transdisciplinarity is quite alike to interdisciplinarity, transdisciplinary practitioners do "generally interested in generating knowledge that has both academic and practical implications" and it is somewhat separate from interdisciplinarity because "interdisciplinarians often do the same [generating knowledge in both academic and practical implications], but do not insist on this to the same degree" (Szostak, 2015).

Interdisciplinary	Teams work jointly but still from a discipline-specific base to address a common problem
Transdisciplinary	Teams work using a shared conceptual framework, drawing together discipline-specific theories, concepts, and approaches to address a common problem. Focus on both practical and academic implications.

Table 2.1: The aspects of ID and TD theories are shortened in the table by (Rosenfield, 1992).

The synonymous references made to inter/transdisciplinarity, other confusions exist in the interdisciplinarity framework, such as the interpretation of interdisciplinarity by the (Apostel et al., 1972), which gives an overview into the degree to which interdisciplinarity matters: "An adjective describing the interaction among two or more different disciplines. This interaction may range from simple communication of ideas to the mutual integration of organizing concepts, methodology, procedures, epistemology, terminology, data, and organization of research and education in a fairly large field. An interdisciplinary group consists of persons trained in different fields of knowledge or disciplines with different concepts, methods, and data in terms organized into a common effort on a common problem with continuous intercommunication among the participants from the different disciplines" (Apostel et al., 1972, p.25-26).

Although this interpretation is versatile, it is also contrary to the term itself. For instance, the term ID has been used liberally in the literature (Barković, 2010; Amey & Brown, 2004; Aboelela et al., 2007), and without a comprehension of the concept it applies can be difficult to criticize. Nevertheless, the interdisciplinarity concepts vary between the researchers; in the interpretation of interdisciplinarity, many features are important. For instance, (Lattuca, 2002, p.25) declares that interdisciplinarity scales "from simple communication of ideas to mutual integration of organizing concepts, methodology, procedures, epistemology, terminology, data and organization of research and education in fairly large field".

Nevertheless, (Amey & Brown, 2004) suggests that 'easy concepts' should not be treated because 'interdisciplinary' as the convergence component of an cross-disciplinary interactive method fails. In addition, one could argue that 'simple communication of ideas' also conveys the absence of intellectual exchanges that are critical in the search for solidarity among disciplines and in the transforming of disciplinary perspectives into new knowledge. Moreover, this definition does not stress on the existence of different disciplines, making it possible for people to argue that based on this definition, the collaboration among people with distinct individual personalities is considered as 'interdisciplinary'. Additionally, this concept does not highlight the

presence of different disciplines, leading people to argue that based on that description, cooperation between individuals with distinct personalities is known as 'interdisciplinary'.

With the broad use of interdisciplinarity, (Salter & Hearn, 1997) have differentiated into two subjects within the definition of interdisciplinarity: 'conceptual' and 'instrumental'. Such subjects help scientists to define their research paradigms. Instrumental interdisciplinary research, which is also identified as applied research, refers to studies which integrate the disciplinary frames into "temporary synthesis based on a specific problem" (Salter & Hearn, 1997, p.29). This research does not typically have any formal house, epistemology or process, although from this form of interaction it may create new information. It is also recognized as Inter-Disciplinary Research (IDR) based on concerns that discuss societal problems and needs (J Thompson Klein et al., 2001). One of the most renowned and important pieces of interdisciplinary instrumentation is the Apollo Space project in which experts from different fields exploited their expertise and collaborated to resolve issues in this space project. The collaboration did not involve a particular approach or techniques as the main aim was to find the best solutions in the face of project difficulties.

Conceptual interdisciplinarity, on the other hand, reflects on interdisciplinary epistemological issues. The conceptual interdisciplinary method, according to (Salter & Hearn, 1997), attempts to integrate expertise from different disciplines and draw on a permanent new field of information. Eventually, an interdisciplinary practical and analytical endeavor to achieve information convergence.

Besides these two interdisciplinary themes, (Brewer, 1999, p.328) stressed that the definition of interdisciplinarity is also characterized as "problems designate theory and methods, not the reverse, in sharp contrast to discipline-based and curiosity-driven inquiry". Furthermore, the word interdisciplinarity is defined by (Julie Thompson Klein, 1990, p. 56) as "a juxtaposition of disciplines that are integrative, interactive and cumulative", which is "neither a subject matter nor a body of content. It is a process for achieving

an integrative 21 synthesis, a process that usually begins with a problem, question, topic, or issue" (p.188).

The essence of their collaborative work often characterizes the concepts of interdisciplinarity. (Aboelela et al., 2007), for example, defines interdisciplinary collaborations as: "Any study or group of studies undertaken by scholars from two or more distinct scientific disciplines. The research is based upon a conceptual model that links or integrates theoretical frameworks from those disciplines, uses study design and methodology that is not limited to any one field, and requires the use of perspectives and skills of the involved disciplines throughout multiple phases of the research process" (p.341).

There is proof that transdisciplinarity arises across specific types of problems, e.g. actual, dynamic, socially relevant problems that involve the convergence of science and society information (Burger, Kamber, Schindler, & Henry, 2003; Roland W Scholz, Mieg, & Oswald, 2000; J Thompson Klein et al., 2001). Transdisciplinarity has been generally understood today as a system or as an operation that produces, incorporates and preserves information in the fields of technology, science and culture (J Thompson Klein et al., 2001; Julie Thompson Klein, 2004). As indicated in the prefix "trans," transdisciplinary concerns extend beyond the disciplines. One of the key components of ITRC's approach is: organizing collaborative learning networks between science and society, so that people from outside the universities can be involved in trans-discipline processes (Roland W Scholz & Marks, 2001).

2.1.1 Brief Interdisciplinary Background

The emphasis on the current concept of interdisciplinarity is important but it also involves an understanding of the history of interdisciplinarity and of the fundamental concepts that shape interdisciplinarity until now and continue to influence it. Through her seminal book, (Julie Thompson Klein, 1990) has widely written about the past of divisions and interdisciplinary

plays, "Interdisciplinarity: history theory, and practice." Since the majority of discussions about the literature's history of interdisciplinarity go back to Klein, this review is based mainly on Klein's work.

While there are several claimed that the idea of interdisciplinarity was a new phenomenon at the beginning of the twentieth century (Turner & Rojek, 2001; Hearn, 2003; Aram, 2004), Plato, Aristotle, and Kant, to mention only a few prior thinkers (Julie Thompson Klein, 1990), have addressed the basic principle of interdisciplinarity. Plato believed in philosophical ideas of a single scientific field, in which one could combine and synthesize wisdom, since philosophy is eternal and unaware of other forms of knowledge (Julie Thompson Klein, 1990).

In Roman times, though, there were questions about a proper type of advanced education in one discipline (Hearn, 2003; Julie Thompson Klein, 1990). In the Modern University, the 'Trivium' divisions (graphics, philosophy, and rhetoric) and 'Quadrivium' (music, math, algebra, and astronomy) became a standard, where students shouldn't study anything, just practice advanced studies through the incorporation of the general studies-known as 'small towns' (Julie Thompson Klein, 1990).

The word disciplines were used during the Middle Ages in Rome, Bologna and Solerna in reaction to the demands of church and economic needs (Julie Thompson Klein, 1990; Hearn, 2003). External factors have emerged as the main focus of information acquisition compared to previous ones. As such, the Philosophers Bacon, Descartes, Kant, and Hegel shared their worry over the breakdown of wisdom in the Renaissance era, believing that there was considerable diminution of the idea of the rational thought (Julie Thompson Klein, 1990).

In the 1940s, systemic thinking and unification revisited the educational landscape during the war and the post-war era, even with topics such as structural issues, field policy and the discussion on how these fields could be combined or unified (Chettiparamb, 2007). In the course of that time there had been no discussions on the definitions of this type of cooperation, as the

aim was not to delay in theoretical arguments but to quickly reconstruct damaged cities (Julie Thompson Klein, 1990).

However, interdisciplinary thinking in higher education establishments was strong in 70s, known as the 'Watershed Era', where research and interdisciplinary partnerships were supported and funded extensively (Julie Thompson Klein, 1990). The UK Association for Research and Innovation in Higher Education has made a clear distinction at this point-with symbols-between "integration" and "correlation" (Julie Thompson Klein, 1990; Chettiparamb, 2007). That category was alluded to as ' integration ' to the construction of bridges where all the schools were complete.This is now referred to as multidisciplinary. 'Correlation' applies, on the other side, to a group merger or interdisciplinary sections of the sciences. They acknowledged the third kind of partnership that was the convergence of methodological and transcendental ideas (Julie Thompson Klein, 1990).

2.2 Quantitative/Qualitative Methods of Analysis for Interdisciplinary Research

Many scholars used these various quantitative methods for both empirical and grey literary databases to evaluate their quantitative through modeling topics and by using network analysis, idea extraction and common statistical approaches.

The qualitative review of academic literature is focused on the corpus chosen from a comprehensive survey that gathers and interprets empirical evidence to meet a specific research problem and pre-specifies eligibility criteria. Scholars use explicit, systematic approaches selected to minimize biases, provide the characteristics and findings of the included studies, and provide a systematic presentation and memorization (Jahan, Naveed, Zeshan, & Tahir, 2016).

For analyzing the main method was based theory (Corbin & Strauss, 2014),

which was complemented by the categorized approach (Freeman, 2017). "Grounded Theory can be defined as the interplay between researchers and data. It provides rigorous yet flexible guidelines that begin with openly exploring and analysing inductive data and leads to developing a theory grounded in data. Induction starts with the study of a range of individual cases and extrapolates patterns from them to form a conceptual category" (Charmaz, 2006, p.188). Fundamental Theory is not restricted to a specific data collection process, but incorporates data collection approaches that best match the current investigation problem and on-going data analysis (Flick, 2014). This research is motivated by categorical reasoning as well (Freeman, 2017). The grouping method for interpretation (Polkinghorne, 1995) supports categorical reasoning. Categorial Thinking develops standards from which data units can be described and structured. This defines when there is something that gives meaning in comparison to the mental system. This mutually constitutive, human-positioned relationship constitutes a categorization in social science research of a rich way of thinking (Freeman, 2017).

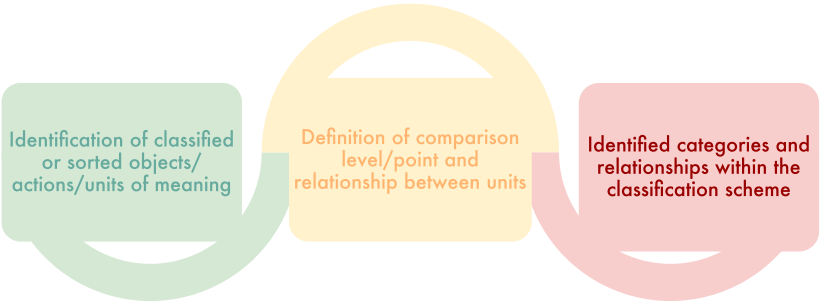


Figure 2.1: Actions under (Freeman, 2017) Categorial Thinking.

2.3 Current Researchers on Interdisciplinary and Transdisciplinary Research

Although scientists are still exploring how Inter/Trans-disciplinary (ITD) skills can be learned and instilled, some scholars have been attempting to identify them. Besides, a growing call for ITD, aims to learn more about scholars who engage in this research.

Experiments on personality traits is explored by (Guimarães, Pohl, Bina, & Varanda, 2019) which believes in "Our results bring the Inter/Trans-disciplinary Research (ITDR) personality a step further in taking a form"(p.1), and also investigated that a special combination of motivations, attitudes, skills and behaviours can characterize ITDR personalities. However, They trust in the academic environment and career paths do not seem primed and optimized for such ITDR estimates.

As (Hadorn et al., 2008, p.27) Hirsch Hadorn et al. (2008, 27) explain: The present structure of the academy is based on disciplines (Connell, 2019): " Disciplines shape scientific research by forming the primary institutional and cognitive units in academia, on which the internal differentiation of science into specialized curricula, professions, and research is done. Members of a discipline communicate within their community, share basic assumptions and examples about meaningful problems, and set standards for reliable and valid methods, as well as establish what is considered a good solution to a problem. What modern science gains and preserves is based to a large extent on disciplinary structures".

Disciplines were often found to be important but not enough to meet the challenges of the 21st century, particularly in creating a sustainable future (ICSU & ISSC, 2015). As (Gilbert, 2016, p.192) mentions, "everything is now … deeply entangled, inter-connected, unpredictable and open …. 'Reality' is incomprehensible via the traditional disciplines, which rely on reducing the system to a selection of discrete units, inevitably leaving out key aspects." This means that continuing to build universities according

to disciplinary divides may be unwise or—following Sardar's definition of "post-normal times" even unhelpful in dealing with the multiple "ignorance" of our time that "unlike ordinary ignorance, which is a void to be filled by research and knowledge, requires radically new ways of thinking" (2010, 440). This implies that it can still be unwise or-according to Sardar's definition of 'post-normal times' even counterproductive to continue to build universities according to disciplinary disciplines in the face of the varied 'ignorance' of our times that "unlike ordinary ignorance, which is a void to be filled by research and knowledge, requires radically new ways of thinking" (2010, 440).

3

Methodology

This chapter presents the method that is used during this process and was motivated by techniques from data scripting of quantitative and qualitative analysis to determine the number of physical indicators influencing qualification of ID/TD researches. A study of scholars surveys with academic and non-academic experts who are currently involved in ITRCs as well as a review of relative surveys on the quality of selected ITD interviews, improved the better understanding to examine the quality of ITRCs. An investigation on the quantitative analysis of the ID/TD research centers to understand the success/failure indicators of these centers including the strength of their infrastructures. Next, regional approaches to standards for assessing the efficiency of the ITD research centers are synthesized in the literature review.

3.1 Data Collection

Many authors suggest that qualitative research encompasses various types of information, including documents, field notes, interviews and other sources (Creswell & Creswell, 2017; Miles, Huberman, Huberman, & Huberman, 1994; Stake, 2006; Yin, 2009). I selected the top ten universities from a valid source "QS World Ranking Universities" for data collection. The idea behind was that the top universities indeed pay very close attention to being a leader in research growth, putting much more effort into it plus allocating more funds to build a new structured ID/TD research center. It therefore boosted the method and helped to obtain more reliable data through ITRCs.

I also managed digital tools to collect the data. The first purposes were to involve collecting data for all ID/TD research partners of universities; and further, to produce high-level statistics of comprehensive data-sets that provide insight to the qualitative results obtained from smaller samples. To achieve this, I investigated websites related to each university to finding out the availability of any ID/TD center by searching in Google and Bing search engines and then Wikipedia which was one the most powerful search tools to gather the data. However, I could not rely on Wikipedia information in some cases because data has not been updated up to the time I was looking for research centers or a lack of information about a specific center. During the Wikipedia investigation, I found some clues on the website only by citing a center on Wikipedia's website but unluckily not further knowledge. Websites of parent academies also had so beneficial for exploring the physical location of the centers which was the purpose of quantitative research. Universities designated an elegant campus map web to specify the location of each building and even which type of programs located inside the building. Accordingly, the identification of structures and geographic locations are stripped of the data collected by the campus map of universities.

- Parent University
- Acronym of ITD center
- Country
- Visualisation type of ITD center
- Type of ITD center
- Activities
- Educational Activities
- Number of Students
- Areas of Focus in Research OR Research Theme
- Vision OR Outreach OR Agenda
- Mission OR Assignment
- Year founded
- Type of Fund
- SDGs
- Affiliation
- url of project
- Name of Building
- Physical location OR conviviality places
- Logo

Quantitative and Qualitative analysis

Research Centers

Programs

Team of Researchers / Hub

Laboratories

Alliance Institutions

Research Institutions

Small room inside a building

Virtual Platforms

Massachusetts Institute of Technology

Insert the top 10 universities in Nvivo

2019 QS World Ranking University

3.1.1 Methods of Data Collection and Processing

Procedures for data collection complied with the conceptual framework comprising of the following dimensions:

- Comprehensions in interdisciplinarity and transdisciplinarity
- Area of focus in research/research theme and the most repeated collaboration among certain discipline
- Mission or assignment of IDR/TDR
- Vision/outreach or agenda related to to IDR/TDR
- Type of educational activities of IDR/TDR
- Structural components or committees of IDR/TDR

The aim was to collect the data appropriate with the analytical units such as researchers, funders, organizations. I present an axonometric methodology figure for a more comprehensive perception in this section (see 3.1).

At the beginning of the process, a full list of universities ranking in 2019 from "QS Intelligence Unit | 2020 QS World University Rankings Supplement", n.d. derived and the top 10 first universities were selected to go on a deep journey. In the next round, all these ten universities inserted into the software which is called Nvivo (see 3.1.1.1). The program typically does an analysis of the survey but in my case, I have decided to adapt the software interface for my own purpose. Accordingly, each university specified as a case node and quantitative/qualitative analysis as a case classification.

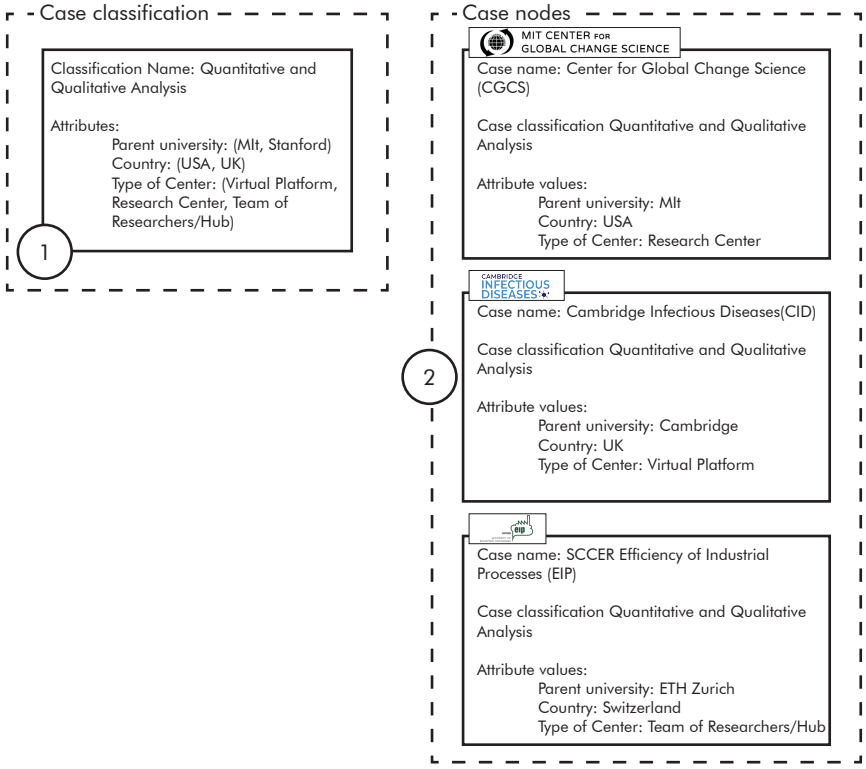


Figure 3.2: Case Classification and Case Nodes of centers with Nvivo (see 3.1.1.1)

This is a flowchart of Nvivo's compilation (see 3.1.1.1) storage of my findings. I appended the name of the university for each case and then earmarked each center as a subcase and what sort of interdisciplinary or transdisciplinary center is not important at this stage. I took my manual case classification after creating a single subcase, which I called "Quantitative and Qualitative analysis" to respond to each attribute[1]. Clear definition of the flowchart is(see 3.2), On the left, I outlined the description of my chosen case classification with its attributes and I called some attributes including Parent University, Country and Type of research center. The full list of all

[1]Attributes are a subcategory of case classification and considered as indicators of ID/TD centers.

case classification attributes is at the axonometric methodology (see 3.1). There are case nodes on the right that are connected to each ID/TD research center and represented with a center emblem, case classification and attribute values, respectively. The case name is the name of the center followed by its acronym if it existed and case classification is a list of indicators for assessing each center and this section took considerable time in my thesis cycle during the center investigations. The next one is attribute values which refer to factors of each center and is a subcategory of case classification. For some of the attributes, there were constant values that a center could not go beyond its values such as type of centers that show each ID and TD research center must be filed within one value like research center, research institute, a team of researchers and virtual platforms, etc.

The following progress in axonometric methodological data collection (see 3.1), I decided the MIT as one of the universities to gather data through its ID/TD research centers, and then included into Nvivo software. Most of the data during the study were kept inside the Nvivo as proof of documentation or as an easy-to-access checklist for the future if I had to recheck anything. Better to point out strongly that there was almost no research area concentrated on compiling a list of research centers for interdisciplinary and transdisciplinary 'Studies' research (see 4.11.3) or ID/TD research centers. In the chapter of discussion, I demonstrated the reason why the word studies are highlighted here. It was indeed difficult to retrieve data from indirect sources about centers when we are talking about quantitative analysis. The assessment of these data concerning qualitative analysis was meanwhile very profound.

After gathering the data in axonometric methodology (see 3.1) process, I realized which universities had ID/TD centers and I showed these centers with a black arrow, but two lock circles between the arrows are present in the photograph that demonstrated the university did not have a small room inside a building/research institution as a type of ID/TD research center.

Then, I committed these pieces of information to their related attribute values in Nvivo, which did not require questions and were precise to me.

Nevertheless, some information was not sufficiently accurate and I had to ask an expert or communicate with those in charge of the center and approve of my mines.

At the last step in axonometric methodology (see 3.1) of collecting the accurate states of information about ID/TD centers, I filled all the distinguished achievements inside the Nvivo. if I found a lack of data on the value of an attribute, that was deemed "Unassigned" and if they did not have the value of the attribute, it was considered "not-applicable". For instance, the name of the building of the Interdisciplinary Concentration Obesity Program of Harvard University is assigned as not-applicable, because they do not have a particular location. Although, having no physical zone does not mean that it could not be a ID/TD center. Regarding the same center, there is Unassigned for a type of fund which means that I was not able to find relevant information or from the center's side there was a lack of information.

3.1.1.1 Nvivo

The program enables users to identify, sort and organize information; examine data relationships and combine analyzes with liaison, formatting, searching, and modeling. NVivo is applied to help people to organize and analyze non-numerical or unstructured data.

The researcher or analyst can use their search and query engine to test theories, identify trends and cross analyze data in several ways. In my case, I try to adapt to the software interface for my purpose. The software normally does the interpretation of the sample. NVivo accommodates a wide range of research methods, including network and organizational analysis, action or evidence-based research, discourse analysis, grounded theory, conversation analysis, ethnography, literature reviews, phenomenology, mixed methods research and the Framework methodology ("NVivo - Wikipedia", n.d.).

NVivo supports audio, video, digital photos, Word, PDF, tablets, rich email, text, web or social media content, etc. Users are able, through Tran-

scribeMe, to exchange data with apps such as Excel, Microsoft Word, IBM SPSS Statistics, EndNote, One Note, Surveymonkey and Evernote, or to order transcripts from NVivo ("NVivo - Wikipedia", n.d.).

3.1.2 Literature Reviews

In the course of the systematic literature review, I queried PubMed, Scopus and JSTOR databases for records on IDR and TDR. I generated detailed search strings for PubMed (see 3.1.2.2) that represent the literature review's main research questions; namely: various understandings of IDR/TDR and factors and measures of the success or failure of them, adoption in research, and research organizations.

JSTOR database provides less sophisticated data-analytical tools, but I included items with ID or TD in the description, to counteract the documented bias towards ITRCs in Scopus and WoS (Kulczycki et al., 2018).

The subsequent data set consists of 86 items i.e. metadata from scholarly publications (authors, abstracts, keywords, tags names). For qualitative analysis, a collection of the literature was chosen based on a systematic review (see 3.1.3).

3.1.2.1 Query Framework

I identified six sets of keywords, which fit my main research issues.

Two measures were used to classify these keyword sets. First, an initial listing of keywords was established on the framework of the ID and TD scoping analysis of "Interdisciplinary/Transdisciplinary Research Center (ITRC)". Secondly, in order to get to the final list of keywords, I loaded many more keywords according to what I had found as an ID/TD research center's indicators.

Set A	Set B	Set C	Set D	Set E	Set F
interdisciplinarity	success	academic	rank	quantitative	fund
interdisciplinary	successful	institution	grade	qualitative	govern
transdisciplinarity	prosperity	center	level	quantity	
transdisciplinary	failure	reseach	classification	quality	
ID	unsuccessful	virtual	position		
TD	setback	network	status		
interdisciplinary research	lack	team	rate		
transdisciplinary research	fail	researcher	rating		
	failed	researchers	degree		

Table 3.1: Keyword sets for the evaluation of academic literature

3.1.2.2 Querystring in PubMed and Scopus

Since PubMed and Scopus provide the same search and filtering features, both databases were queried using the same method. The process consisted of four phases, which consisted of identifying the literature base and inserting limits that forced resources to be filtered down to obtain an optimal set of data.

First Step: For this, I grouped keyword package A with B, C, and D into doubles by using similarity index in both databases and then I searched within the keywords, abstracts, and titles of results. This approach helped me to scan the databases in a more structured manner, using keywords comprising of two related words or "doubles," rather than keywords that may occur without a particular connection, for example, "transdisciplinary research" (i.e. when I use Boolean AND, I get results even if terms "interdisciplinary" appear and "researcher" appear in the same description, title, and keywords at a random location instead of the nearest operator)

Second Step: Then I looked (again in the keywords, descriptions, and overviews) within range of objects that either address ID and TD purposes (keyset C), or add to the success/failure variables or measures (sets B).

Third Step: Besides, I restricted the dataset to Set A keyword elements (ID and TD in different forms) in the title and this was a strong sign of relation with the topic. Stage 1-3 in both PubMed and Scopus turn into

the following strings:

(((((((((Interdisciplinarity) OR interdisciplinary) OR transdisciplinarity) OR transdisciplinary) OR ID) OR TD)) OR Interdisciplinary research) OR transdisciplinary research))) AND (((((((((success) OR successful) OR prosperity) OR failure) OR unsuccessful) OR setback) OR lack) OR fail) OR failed)))) AND Search ((((((((((((academic) OR institution) OR center) OR research) OR virtual) OR network) OR team) OR researcher) OR researchers)) AND ((((((((((((rank) OR grade) OR level) OR classification) OR position) OR status) OR rate) OR rating)) OR degree)) AND (((((quantitative) OR qualitative)) OR quantity) OR quality))) AND ((fund) OR govern)

Fourth Step: Eventually, I released my group analysis boundary:

- Sort of paper: Journals, Chapters in books, Reports, Books, and Article; Paper language: English.

3.1.2.3 Use Analytical Datasets

The dataset established the basis for quantitative and qualitative research. I used a complete dataset of 86 records for quantitative qualitative analysis, ID/TD definitions (see 1.1), and chapter literature review (see 2).

3.1.3 Qualitative Analysis of Academic literature

The qualitative review of academic literature is focused on the body chosen from a comprehensive survey that gathers and interprets empirical evidence to meet a specific research problem and pre-specified eligibility criteria. Scholars use explicit, systematic approaches selected to minimize biases, provide the characteristics and findings of the included studies, and provide a systematic presentation and memorization (Jahan et al., 2016). In the subsequent analysis, the main characteristics of a systematic review were:

- A clearly defined collection of goals with pre-defined research eligibility criteria;
- A clear technique which can be reproduced;
- A systemic search to identify all studies that fulfill the requirements of eligibility;
- An evaluation of the validity of the results of the studies included, such as the risk assessment of bias (Higgins et al., 2019).

An analysis process for qualitative evidence-synthesis developed by sociologists (Noblit & Hare, 1988), which is a seven-step, theory- and theoretically hypothesis-generating system. In this process, concept data from primary qualitative studies are systematically composed to identify and develop new concepts, theories, and models. They were designed to maintain the original meanings and contexts of concepts for study (Emma F France et al., 2014; Emma F. France et al., 2019). According to these characteristics and potential applications, meta-ethnography is an appropriate tool for achieving the objectives for the scholarly evaluation and study of quality content.

A distinctive technical systemization method of translation and replication of translations has been developed by the originators of meta-ethnography (Noblit & Hare, 1988), underlined by social comparison theory, which includes the review of conceptual evidence, for example, ideas, themes established by primary study authors (Emma F France et al., 2014; Emma F. France et al., 2019). Although some methods to qualitative synthesis are aggregated in nature, meta-ethnography is an interpretative method that not only aims at summarizing data on a subject of interest but at arriving at new interpretations of the subject (Uny, France, & Noblit, 2017). This synthesis is the result of translating the studies, which promotes the student to understand and transmit ideas, concepts, and metaphors across various studies (Britten et al., 2002). Meta-ethnography aims to create a new configuration/interpretation, a new model, a logical structure, or a hypothesis, although this may not be feasible, for example, if there have been no empirical developments since the first, conceptual main research account (Uny

et al., 2017).

The 7 stages characterized in (Noblit & Hare, 1988) are briefly discussed (see 3.1.3) and related to the steps that followed in the thesis: (3.1.3.1) the starting point; (3.1.3.2) determining the applicability of the first interest; (3.1.3.3) the reading of the studies; (3.1.3.4) the association of the studies; (3.1.3.5) the translations into each other; (3.1.3.6) the synthesizing of the translations; and (3.1.3.7) the synthesization of studies;

3.1.3.1 Starting Point

The method "to define intellectual interests that quality research can inform" is identified by (Noblit & Hare, 1988, p.26). The current synthesis focuses on the three agreed thesis objectives. In this step, the central investigative problem that follows meta-ethnography has not been updated.

3.1.3.2 Determining the applicability of the interest

Analysis should be carried out "driven by some substantive reason for a substantive interest derived from a comparison of any set of studies" (Noblit & Hare, 1988, p.28). This includes the identification and selection of synthesizing study accounts. In my case, the present phase has taken two successive steps: first, constructing the main body or dataset and the second selection of literature. 83 publications come in this sub-set of primary research. These have been labeled and tested for a variety of keywords. According to research concerns, this collection was coordinated and operational. A first selection based on titles and abstracts was made after the removal of duplicates. Three reviewers also made similar separate analyses in the second circuit of these 86 documents of the names and abstracts. Differences were explored and addressed in the reviewers ' findings.

I developed a system of a grouping of articles by the type of evidence they applied to the study issue based on the inclusion criterion. Three main

understanding categories and types I construct: 1.ID/TD research; 2.interdisciplinary research; 3. Analysis in case. I create a categorization focused on this initial definition, that classifies each title in one or more categories: what, how, where, where, why. The research segment includes and descriptions of these groups because they have significant effects on my thesis.

3.1.3.3 Reading of the studies

This phase involves reading research and capturing examples regularly with close attention to detail in experiments and what they mean in the field of interest (Emma F France et al., 2014). To order to systematically explain the significance of qualitative data obtained from previous processes, we have established a qualitative content analysis (Mayring, 2000; Schreier, 2014). (Schreier, 2014; Mayring, 2000). The successive sections of the content are allocated to the divisions of the coding structure. The structure is at the heart of the system which contains all those elements that are part of the content analysis and understanding. The approach is distinguished by three features: the examination of quality content reduces results, is systemic, and is scalable.

Codification includes the labeling of pieces of data with a mark that categorizes, lists and records of the piece of data at the same time (Charmaz, 2006). Nodes or divisions of coding are largely based on the above-mentioned seven stages of meta-ethnography with specific nodes for other relevant data.

In NVivo 3.1.1.1 the data from the selected links are encoded with a coding framework that was relied on the keyword set in the previous stage. The method used to analyze this analysis was the theory (Corbin & Strauss, 2014), supplemented by a categorized approach (Freeman, 2017). Triangulation between methods permitted for quality evaluation and a continuous progress assessment of the coding phase (Flick, 2014).

Coding is a useful tactic in order to recognize and coordinate data units for a confidential analysis of behavior. The dynamic interpretation changes

between the group definition and the transfer of data into category systems profit from the inductive method used in this analysis (Freeman, 2017).

The reviewers' suggestion (Noblit & Hare, 1988) "a list of key metaphors, phrases, ideas and concepts (and their relations) used in each account, and to juxtapose them" to believe the relationship between the studies initially. I also suggest that researchers recall the application of experiments to the thesis before deciding: They are treated as "reciprocal translations" if accounts are directly identical. The data is considered "reputational," if it is fairly new. In conclusion, the various "but related research" represents an "argument," which is also described as the discovery process of a "full" among several works (Noblit & Hare, 1988, p.63).

At the same time, a shared and refutational translation (Noblit & Hare, 1988) was introduced as the basis for the synthesis. Most of the sources discuss the Inter-Disciplinary and Trans-Disciplinary perspectives, as well as the inconsistencies and misconceptions regarding their beliefs and conceptualization.

These are the three main stages: (1) collection or other documentation, and how it covers each other, of knowledge (concept, topic, metaphor, conclusions),(2) review of data between the study and (3) use of these facts in deciding the relationship of the studies (Emma F. France et al., 2019).

3.1.3.4 Association of the studies

In and across accounts, the metaphors and concepts in every account and its interactions are compared or translated to try and retain the structure of relationships between accounts. In combination the translations are a meta-ethnographic synthesis (Emma F France et al., 2014; Noblit & Hare, 1988).

3.1.3.5 Translation into each other

In and across accounts, the metaphors and concepts in every account and its interactions are compared or translated to try and retain the structure of relationships between accounts. In combination the translations are a meta-ethnographic synthesis (Emma F France et al., 2014; Noblit & Hare, 1988).

3.1.3.6 Synthesizing the translations

Through this phase, the interpretations accomplished through step 5 are bridged. Such versions are contrasted to each other to see whether there are common types or whether other translations or definitions can include those of other research. The second level of synthesis is possible; it involves analyzing and translating types of competing interpretations (Noblit & Hare, 1988) in order to develop new concepts/interpretations.

3.1.3.7 Synthesizing of the studies

The aim in this stage is to adapt the communication of synthesis to the intended audience (Noblit & Hare, 1988). To make it intelligible and meaningful. As already stated, data were coded in this process, read repeatedly by a revisor and contrasted with the research problem and keywords systemically.

4

Results and Discussion

This section supported by different kinds of demonstrations such as pie charts, graphs, word-clouds, maps, and tables of the final findings. Besides, it is presented the data related to different kinds, total amount, world map infographic, type of partnership, current activities, and two types of word-cloud related to focus area and education of 140 ITRCs within the top ten universities in the world. It is also supplemented by a flowchart list of ITRCs, and then each flowchart of the top ten universities is supported by a great detail of each center's indicators. It is noteworthy to say that, I only comprise five ITRCs of each university in the paper version of my thesis, in order to respect sustainability. Nevertheless, a complete list of ITRCs is presented in the electronic version of the thesis.

At the end of this chapter, the results are discussed and followed by the interpreted the obtained data, implications, identified both limitations and recommendations of study for further investigations.

4.1 Review of Research Questions

This thesis concentrates on an important topic, and four sub-questions accompany it to achieve the final results. The main research question is o investigate empirically "Which" policies are currently in progress between the first 10 ranked universities actively supporting Interdisciplinary/Transdisciplinary Research Center (ITRCs)? And four sub-questions are What are clear definitions of Inter/Trans-disciplinary? Who are the world's leading success centers for ID and TD research? What kind of activities do an ID and TD center carry out to understand indicators of success/failure? How the indicators of an ITRC could be measured?

4.2 Total amount of the ITRCs within the top 10 first universities

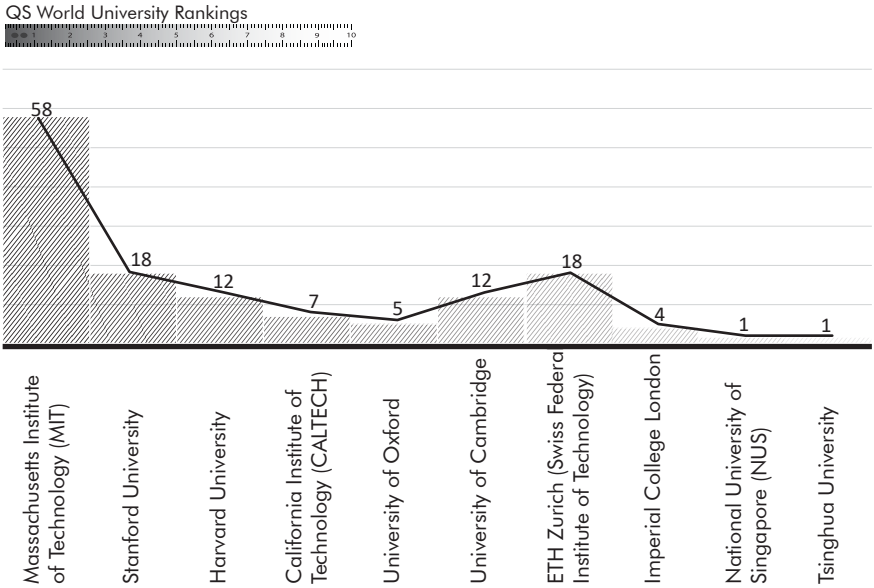


Figure 4.1: The total number of ITRCs inside the top 10 first academic institutions around the globe.

The number of Interdisciplinary/Transdisciplinary Research Center (ITRC) that are established by the first ten top QS world ranking universities on the globe is represented with various shades of gray color in the giver bar chart.

While the Massachusetts Institute of Technology includes the biggest number of the foregoing research centers accounting for 58, Tsinghua University has established just one center, so, if this university intends to compete with the MIT, it should invest more budget in not only attracting more researchers but also providing more facilities. The Stanford University and ETH Zurich Institute of Technology both have 18 research centers that

occupy the second rank in common. Furthermore, 12 research centers are active in Harvard University, which has the same number of research centers like the University of Cambridge does.

In spite of the above-mentioned universities, except the first two including just one center and have been placed at the end, the other universities comprising Imperial College London, University of Oxford and eventually California Institute of Technology stands at lower ranks with setting up 4, 5 and 7 respectively.

In general, the number of research centers has a close relationship with the development of the examined universities because the more the number of research centers is, the bigger the number of researchers should be. Moreover, if the low ranking universities intend to compete with the high ranking ones, they are required to allocate more budgets for employing more researchers.

4.3 The different kinds of ITRCs within the top ten Universities

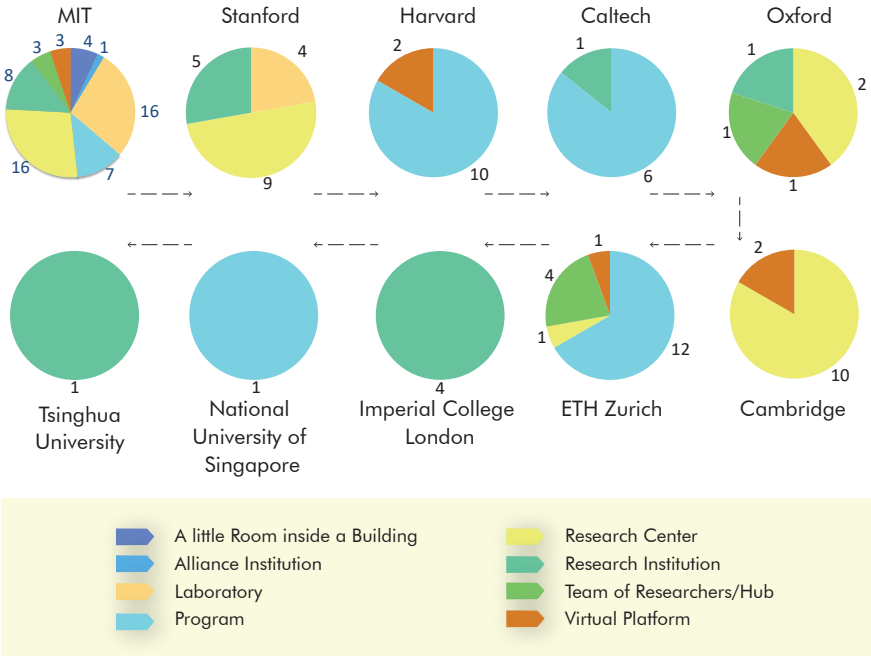


Figure 4.2: The different kinds of ITRCs one per color within the top 10 universities. The number against the color indicates the different quantity per each research center.

Interpretation of the legend words: A little room inside a building; Alliance Institution; Laboratorie; Program; Research Center; Research Institution; Team of Researchers/Hub; Virtual Platform.

The given pie charts illustrate ten high ranking universities in the world concerning the number of their interdisciplinary and transdisciplinary research centers. A cursory glance at the studied universities shows that Massachusetts Institute of Technology (MIT) includes the biggest number of research centers accounting for 58 centers while the National University of

Singapore (NUS) and Tsinghua University have launched just one research center.

As is self-evident, MIT has the biggest number of laboratories and research centers, each of which includes 16 cases and Stanford has 4 laboratories, whereas the other universities including Harvard, Caltech, Oxford, Cambridge, and ETH Zurich Swiss Federal Institute of Technology (ETH Zurich) are not provided with laboratories. Research centers are available in just five universities among which MIT with 16 cases occupies the first rank and Zurich stands at the lowest level with just one case. In terms of program research centers, Zurich, Harvard, MIT, Caltech and the National University of Singapore include 12, 10, 7, 6 and 1 cases respectively.

Moreover, ETH Zurich is the second university in which 4 kinds of research centers can be accessible the same as Oxford University. Most of these universities (6 out of 10) are equipped with Research Institutes, among which MIT with 8 cases, Stanford with 5 and Imperial College London with 4 cases can be placed from first to the third rank. The only university providing a team of researchers, virtual platforms, and alliance institution is MIT.

Overall, apart from MIT, Oxford, and ETH Zurich, the other universities do not offer more than three types of research centers to their researchers and students; consequently, they have to devote more budget to establishing new research centers.

Different kind of ITRCs	Name of parent university	N. of matching cases
A little Room inside a Building	MIT	4
Alliance Institution	MIT	1
Laboratory	MIT	16
Program	MIT	7
Research Center	MIT	16
Research Institution	MIT	8
Team of Researchers/Hub	MIT	3
Virtual Platform	MIT	3
Laboratory	Stanford University	4
Research Center	Stanford University	9
Research Institution	Stanford University	5
Program	Harvard University	10
Virtual Platform	Harvard University	2
Program	Caltech	6
Research Institution	Caltech	1
Research Center	University of Oxford	2
Research Institution	University of Oxford	1
Team of Researchers/Hub	University of Oxford	1
Virtual Platform	University of Oxford	1
Research Center	University of Cambridge	10
Virtual Platform	University of Cambridge	2
Program	ETH Zurich	12
Research Center	ETH Zurich	1
Team of Researchers/Hub	ETH Zurich	4
Virtual Platform	ETH Zurich	1
Research Institution	Imperial College London	4
Program	National University of Singapore (NUS)	1
Research Institution	Tsinghua University	1

Table 4.1: A table of matching cases of different kinds of ITRCs within the top 10 universities.

4.4 World map infographic of the 140 ITRCs

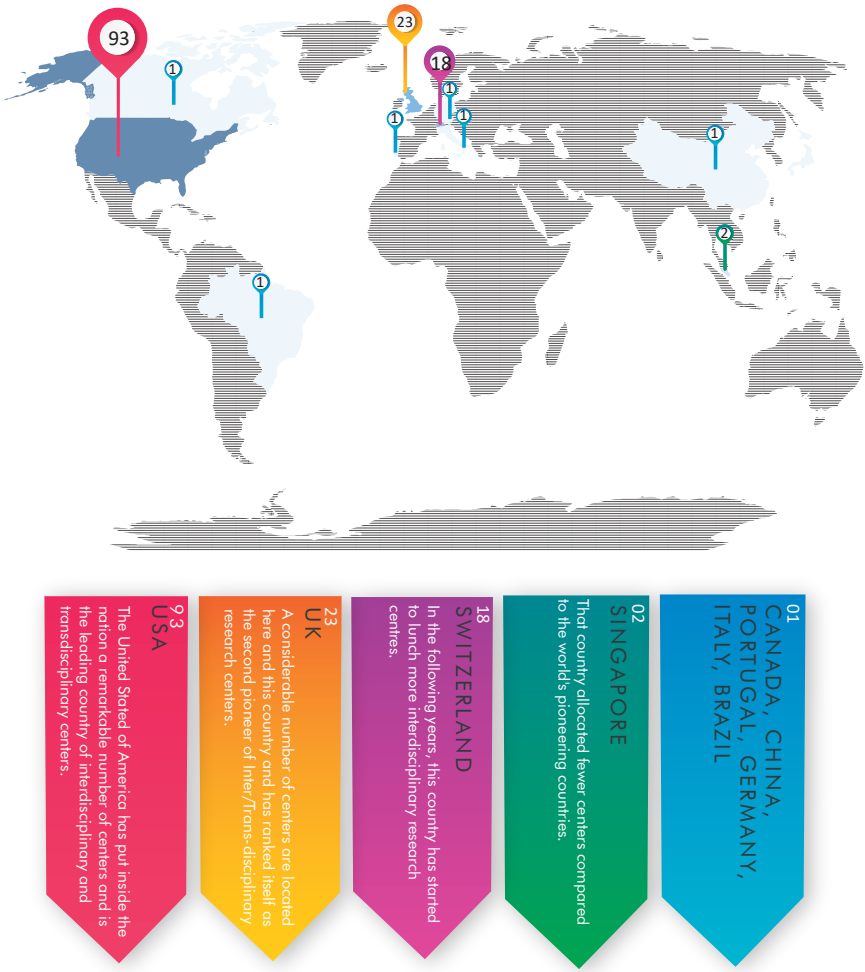


Figure 4.3: World map infographic of 140 ITRCs in all over the world within the top ten universities

This map compares the countries which are pioneers in touching ITRCs. As is shown on the map, the United States of America includes the biggest num-

ber of the foregoing research centers and some countries comprising China, Canada, Portugal, Germany, Italy, and Brazil as a group has established one research center and stand at the lowest rank.

Singapore has set up two research centers and stands higher than in the first group countries. Switzerland with 18 interdisciplinary centers enabling it to occupy the third rank according to the provided map, and it has devoted more budget to such research centers. The UK has allocated a more significant amount of money to establishing inter/trans-disciplinary research centers and enjoys having 23 centers, so it has occupied the second rank.

Finally, the USA, by launching 93 interdisciplinary and transdisciplinary research centers which demands a huge amount of investment and is definitely the main leading country in the world.

4.5 Type of Partnerships between the 140 ITRCs

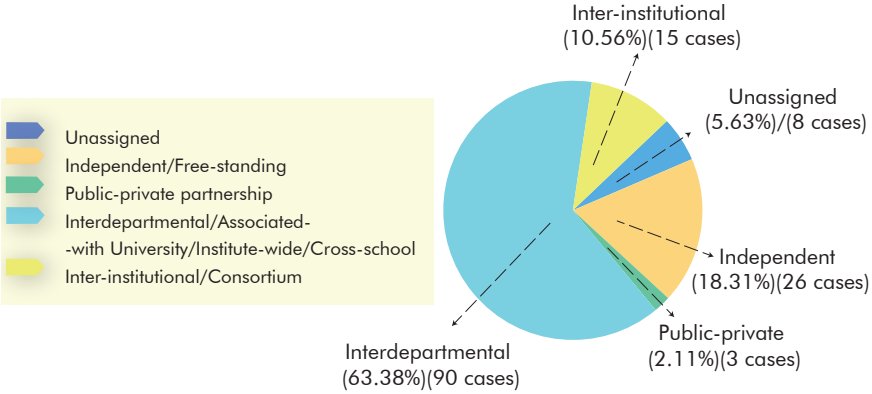


Figure 4.4: Type of partnerships between 140 ITRCs

Interpretation of the legend words: Unassigned; Independent/Free-standing; Public-private partnership; Interdepartmental/Associated with University/Institute-wide/Cross-school; Inter-institutional/Consortium.

The pie chart reveals the rate of partnerships that take place between ITRCs. These relations are analyzed based on five types. What stands out in the pie chart is the high percentage of interdepartmental connections and public-private connections have formed the smallest percentage.

A brief contrast shows that 63.38%(90 cases) of communications happen between interdepartmental centers, while inter-institutional interactions just account for 10.56%(15 cases), which is almost 1/6 of the former one. Furthermore, independent connections occurring between interdisciplinary and transdisciplinary centers constitute 18.31(26 cases) percent.

On the other hand, the minimal ratios of interactions go to the unassigned ones and public-private connections which constitute 5.63%(8cases) and 2.11%(3 cases) respectively.

In general, it is an undeniable fact that, in most interdisciplinary and transdisciplinary centers, different kinds of departments need to have collaborated with one another, consequently, this type of communication comprises the biggest ratio.

4.6 Current activities at the 140 ITRCs

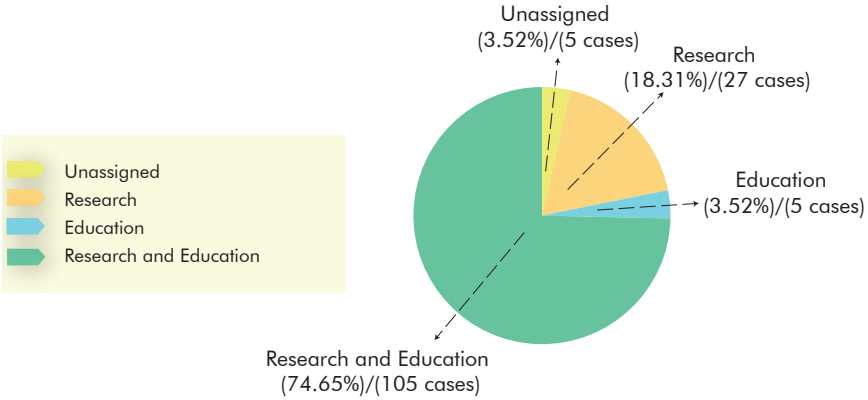


Figure 4.5: Current activities at the 140 ITRCs

Interpretation of the legend words: Unassigned; Research; Education; Research and Education.

The ratios of activities that are performed within the ITRCs are illustrated in the percentile through the pie chart. These activities are mainly studied under four main types.

The biggest part of these activities is relevant to research and education when those pertaining to just education and unassigned ones comprise the minimal ratios amounting to 3.52%(5 cases) for each.

Having analyzed the data provided through the pie chart, one can easily perceive that 74.65%(105 cases) percent of such center's activities are al-

located to research and education. Research stands at the second rank by assuming 18.31%(27 cases) of such academic to itself. On the other hand, the studied centers have not taken important measures with regard to education. Although this field is more significant, just 3.52%(5 cases) of such centers' activities belong to it. Moreover, unassigned activities have the same share as education.

All in all, it can be easily inferred that the proportion of research and education activities is approximately 23 times as great as that of education, and four times as big as the proportion of research.

4.7 Foundation year of the 140 ITRCs within the top ten universities

	Unassigned	1920-1930	30-40	40-50	50-60	60-70	70-80	80-90	1990-2000	2000-2010	2010-2020
MIT	**14**	-	-	**4**	**2**	**3**	**8**	**6**	**4**	**13**	**3**
Stanford	**8**	-	-	-	**2**	**1**	-	**2**	**2**	**1**	**2**
Harvard	**9**	-	-	-	-	**1**	-	-	**1**	-	**1**
Caltech	**1**	**2**	-	-	**1**	**2**	-	-	-	-	**1**
Oxford	-	-	-	-	**1**	-	-	-	-	**1**	**2**
Cambridge	-	-	-	-	-	-	-	-	-	**4**	**6**
ETH Zurich	**10**	-	-	-	-	-	-	-	**1**	**3**	**4**
Imperial College London	-	-	-	-	-	-	-	-	-	**2**	**2**
National University of Singapore	-	-	-	-	-	-	-	-	-	-	**1**
Tsinghua University	-	-	-	-	-	-	-	-	-	**1**	-

Table 4.2: Table of the foundation year for the 140 ITRCs within the top 10 universities.

The table demonstrates the establishment period of the 140 ITRCs within the top ten leading universities. A glance reveals that there are rapidly increasing numbers of these centers.

In 2010-2020, the number of ITRCs is much comparable to 1920-1930. Interdisciplinary and transdisciplinary research was not very popular in 1930-1940 since in these years there were no foundations nor have any statistics on it been identified. Although the general trend increases, it fluctuates a little during 1920-1990.

Notably, the MIT university started to establish the ITRCs since 1940-1950, while Tsinghua University and the National University of Singapore started to establish these centers in 2000-2010 and 2010-2020 respectively. The reality that 42 centers are remained undiscovered in the table, should not be overlooked.

Overall, according to the table significance of ID and TD are clear for the most top universities in the world.

4.8 Word-cloud of focus areas of the 140 ITRCs

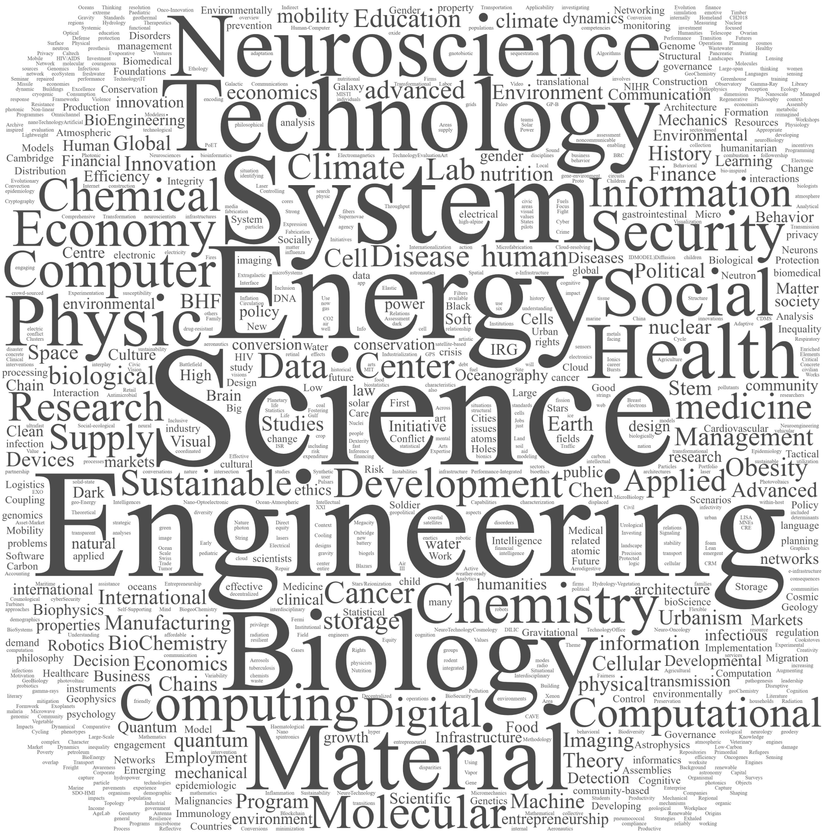


Figure 4.6: Word-cloud of focus areas of the 140 ITRCs

The given diagram, known as a word cloud, compares 140 centers for inter-disciplinary and transdisciplinary studies all over the world and emphasizes the number of words used frequently in the studied centers.

As is self-explanatory the most frequently used words are more highlighted like science and engineering compared to the least frequently applied words.

According to the given data, science and its derivatives stand on the top because this term and its derivations like scientific, sciences, etc. have been used the most frequently in the studied centers. It is followed by engineering, which is repeated 41 times in each of the 140 centers dealing with interdisciplinary and transdisciplinary studies. The next word occupying the third place is systems, which have been applied 36 times in these centers. Its repetition is equal to that of energy. Biology is located after energy and before neuroscience. Its frequency of usage is 26.

The four words of neuroscience, technology, physics, and health are equally emphasized in these centers because they are reported to have 18 times repetitions. Although the terms material and social are under health and physics, their difference in terms of repetition is minimal, which indicates the number of 17. There is a significant difference between science at the top of the list and science the plural form of science since the frequency of science is 14, and it is followed by chemistry having been repeated 12 times.

On the other hand, although the terms computing and computer are referred to by 10 times, the computer is supposed to have the highest frequency because its presence can be seen in all fields.

Word	**Frequency**	**Word**	**Frequency**	**Word**	**Frequency**	**Word**	**Frequency**
Science	61	Social	17	Information	8	human	6
Engineering	41	Chemistry	12	Research	8	Lab	6
Energy	36	Computer	10	Center	7	advanced	5
System	36	Computing	10	Climate	7	biological	5
Biology	26	Economy	10	Data	7	Cell	5
Technology	21	Security	10	medicine	7	Education	5
Material	19	Chemical	9	Supply	7	Management	5
Health	18	Molecular	9	Sustainable	7	Obesity	5
Neuroscience	18	Computational	8	Applied	6	storage	5
Physic	18	Development	8	Cancer	6	Advanced	4
		Digital	8	Disease	6	BHF	4

Table 4.3: Frequency of words of 140 ITRCs within their area of focuses.

4.9 Word-cloud of the most approachable educating systems of the 140 ITRCs

Figure 4.7: Word-cloud of the most approachable educating systems of the 140 ITRCs

Interpretation of several words: Programs; Non-educating.

This word cloud illustrates the diversity of educational activities that ITRCs have offered to their students and researchers. Such centers have provided their students with diverse types of activities which are arranged in descending order from programs, which have the highest frequency, to non-

educating, which is offered just in 8 centers.

Having reviewed the given information concerning the interdisciplinary to transdisciplinary centers, we can obviously realize that 81 centers offer programs, which are followed by master education offered by 48 centers. Moreover, it can be clearly observed that research and student with the same number, which is 33, are located in the following ranks. The centers which offer activities including course, bachelor, Ph.D., school account for 30, 24, 23, and 13 respectively.

Furthermore, the educational centers involved in workshops, seminars, and lectures have the same number which is 13. However, the other highlighted educational activities range between 11 and 8, which show the lowest discrepancies.

Although the other branches of educational activities like online courses, educating teachers, laboratories, are important in interdisciplinary and transdisciplinary research centers, they are located after even non-educating courses.

word	**Frequency**	**word**	**Frequency**	**word**	**Frequency**	**word**	**Frequency**
Programs	81	Workshop	12	Educating Teachers	7	Independent	4
Master	48	Fellowship	11	Opportunity	6	interdisciplinary	4
Non-educating	44	Academi	10	Activity	5	Level	4
Research	33	Classe	10	Education	5	opportunities	4
Student	33	POSTDOC	10	Management	5	projects	4
Course	30	Summer	10	Science	5	Supply	4
Bachelor	24	Training	10	Sciences	5	Technology	4
Ph.D.	23	Innovation	8	Chain	4	Biomedical	3
School	13	non-educating	8	Events	4	Career	3
Lecture	12	Study	8	Executive	4	Chen	3
Seminar	12	Oline courses	7	Experience	4	Degree	3

Table 4.4: Frequency of words of 140 ITRCs within their educating systems.

4.10 List of the 140 Interdisciplinary and Transdisciplinary Research Centers

This section provides the complete flowchart for ITRCs throughout the top 10 universities. The name of centers and the kind of activities they are currently doing are illustrated in comprehensible flowcharts. If an Interdisciplinary or transdisciplinary research center has a specific abbreviation or in the case of the center is famous with a special name, are named inside the parenthesis in front of the name of the center.

Besides, this section covers a full detail of indicators that are relevant to each ITRC, and also a brief interpretation concerning each center. In the case of something interesting from my point of view that had been taken place within a center such as an innovative educating approach or a mysterious name selected for a part of its structure to learn and train new attendees to a center, are mentioned and explained in this section.

The structure for this section is first at the beginning of each subsection a flowchart with a complete list of ITRCs within a university is presented and supplemented by details about each of them. In order to be sustainable, only I point out up to 5 ITRCs for each university. Although, in the electronic file of my thesis I will mention to all of the ITRCs.

MIT - Massachusetts Institute of Technology

Research Centers

- Center for Collective Intelligence (CCI)
- Center for Energy and Environmental Policy Research (CEEPR)
- Center for Environmental Health Sciences (CEHS)
- Center for Global Change Science (CGCS)
- Center for Information Systems Research (CISR)
- Center for International Studies (CIS)
- Center for Real Estate (MIT/CRE)
- Center for Transportation and Logistics (CTL)
- Deshpande Center for Technological Innovation
- Division of Comparative Medicine (DCM)
- Haystack Observatory
- Leventhal Center for Advanced Urbanism (LCAU)
- Martin Trust Center for MIT Entrepreneurship
- MIT Center for Art, Science, and Technology (CAST)
- MIT.nano

Programs

- Initiative on the Digital Economy (IDE)
- Joint Program on the Science and Policy of Global Change
- MIT D-Lab (D-Lab)
- MIT Program in Art, Culture, and Technology (ACT)
- MIT Sea Grant College Program
- MIT-Woods Hole Oceanographic Institution Joint Program in
- Oceanography OR Applied Ocean Science and Engineering (WHOI)
- Women's and Gender Studies Program (WGS)

Laboratories

- Abdul Latif Jameel Poverty Action Lab (J-PAL)
- Abdul Latif Jameel World Water and Food Systems Lab (J-WAFS)
- Computer Science and Artificial Intelligence Laboratory (CSAIL)
- Edgerton Center
- Laboratory for Financial Engineering (LFE)
- Laboratory for Information and Decision Systems (LIDS)
- Laboratory for Manufacturing and Productivity (LMP)
- Laboratory for Nuclear Science (LNS)
- Lincoln Laboratory (LL)
- Materials Research Laboratory (MRL)
- Microsystems Technology Laboratories (MTL)
- MIT Environmental Solutions Initiative (ESI)
- MIT Innovation Initiative
- MIT Media Lab
- Nuclear Reactor Laboratory (NRL)
- Research Laboratory of Electronics (RLE)

Research Institutes

- Institute for Data, Systems, and Society (IDSS)
- Institute for Medical Engineering and Science (IMES)
- Institute for Soldier Nanotechnologies (ISN)
- Institute for Work and Employment Research (IWER)
- Koch Institute for Integrative Cancer Research (NCI)
- McGovern Institute for Brain Research
- MIT Kavli Institute for Astrophysics and Space Research (MKI)
- Picower Institute for Learning and Memory

Virtual Platforms

- Knight Science Journalism Program (KSJ)
- Legatum Center for Development and Entrepreneurship
- MIT Portugal Program (MPP)

Team of Researchers /Hub

- Internet Policy Research Initiative (IPRI)
- MIT Energy Initiative (MITEI)

Little Room Inside a Building

- Center for Archaeological Materials (CMRAE)
- Center for Bits and Atoms (CBA)
- Center for Computational Engineering (CCE)
- Simons Center for the Social Brain (SCSB)

Alliance Institutions

- Singapore–MIT Alliance for Research and Technology (SMART)

4.10.1 Flowchart of ITRCs within MIT

The provided flow chart introduces various parts that Massachusetts Institute of Technology (MIT) has established and the sub-sections of each part. Overall MIT includes eight departments, among which Alliance Institutions has just one sub-section; on the other hand, Laboratories have comprised the biggest number of sub-sections, which is followed by Research Centers that have 15 sub-centers.

In spite of Alliance Institutions which is set up with the association of Singapore University, Laboratories are divided into 16 different kinds of Laboratories, each of which follows special activities such as Poverty Action Lab, Computer Science and Artificial Intelligence Lab, etc. the diversity of these Laboratories shows how significant the role of empirical academic activities is at this university.

The second important role is attributed to research centers which mainly deal with the human environment and health issues. Moreover, Programs and Research Institutions should support the same number of sub-sections, which amount to 8 sub-branches. Nevertheless, the other sections like Virtual Platforms, A little room inside a building and Team of Researchers/Hubs are not devoted to so many sub-sections and include a small number of sub-branches that do not exceed 4.

4.10.1.1 Up to 5 ITRCs of MIT

Singapore–MIT Alliance for Research and Technology	
Parent university	Massachusetts Institute of Technology (MIT)
Acronym of ITRC	SMART
Country	Singapore
Year founded	1/1/2007
Kind of ITRC	Alliance Institution
Type of partnerships	Independet/Free-standing
Current activities	Research and Education
SDGs	Unassigned
Name of building	CREATE Tower NUS
Address of physical place	1 CREATE Way 10-01 CREATE Tower Singapore 138602
url of project	https://smart.mit.edu

Table 4.5: SMART

- Educational activities: "Undergraduate Research Opportunities Programme, Graduate Fellowship Programme, Postdoctoral Research Fellows Programme"
- Areas of focus in research/research theme: "Science and technology: Antimicrobial Resistance, BioSystems and Micromechanics, Disruptive and Sustainable Technologies for Agricultural Precision, Future Urban Mobility, and Low Energy Electronic Systems"
- Vision/outreach/agenda: "Serve as a major anchor point for MIT in Asia; a place for innovation and industrial engagement for MIT in Asia Serve as a magnet to attract excellent people and ideas to MIT and Singapore in a seamless manner Become a globally branded research center with an Singaporean focus - With diversity in sponsorship oriented around a stable core".
- Mission/Assignment: "Support the MIT mission to advance knowledge and education. Identify and carry out research on critical problems of societal significance of interest to Singapore. Develop robust

collaborations with researchers from local Universities and Institutions. Co-advise local doctoral students and post-doctoral researchers. Be a magnet for attracting and anchoring global research talent to Singapore".

- Fund: "Innovation Grant"
- Affiliation: "National Research Foundation of Singapore (NRF)"

Abdul Latif Jameel Poverty Action Lab	
Parent university	Massachusetts Institute of Technology (MIT)
Acronym of ITRC	J-PAL
Country	United States
Year founded	1/1/2003
Kind of ITRC	Laboratory
Type of partnerships	Unassigned
Current activities	Research and Education
SDGs	1. No Poverty
Name of building	Ford Building (E19)
Address of physical place	400 Main Street, E19-201, Cambridge, MA 02142, USA
url of project	https://www.povertyactionlab.org

Table 4.6: J-PAL

- Educational activities: "In-person Open Enrollment Courses, Custom Courses, Online Courses, J-PAL/MITx MicroMasters Program, J-PAL/PUC Diploma in Impact Evaluation, Research Staff Training, Webinar, J-PAL Evaluating Social Programs Custom Course"
- Areas of focus in research/research theme: "Agriculture, Crime, Violence, and Conflict Education, Environment, Energy, and Climate Change, Finance, Firms, Gender, Health, Labor Markets, Political Economy and Governance"
- Vision/outreach/agenda: "To help governments, NGOs, donors, and the private sector apply evidence from randomized evaluations to their

work, and contributes to public discourse around some of the most pressing questions in social policy and international development".

- Mission/Assignment: "is to reduce poverty by ensuring that policy is informed by scientific evidence. We do this through research, policy outreach, and training".

- Fund: "Unassigned"

- Affiliation: "Anchored by a network of 194 affiliated professors at universities around the world, J-PAL conducts randomized impact evaluations to answer critical questions in the fight against poverty"

MIT Energy Initiative	
Parent university	Massachusetts Institute of Technology (MIT)
Acronym of ITRC	MITEI
Country	United States
Year founded	1/1/2006
Kind of ITRC	Team of Researchers/Hub
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	13. Climate Action
Name of building	Ford Building E19
Address of physical place	400 Main Street, Cambridge, MA 02139
url of project	http://energy.mit.edu

Table 4.7: MITEI

MITei
MIT Energy Initiative

- Educational activities: "interdisciplinary Energy Studies Minor for undergraduates, Graduate and Postdoctoral, Online Education, Education Research, seminars, symposia, and conferences"

- Areas of focus in research/research theme: "areas: solar energy; energy storage; advanced nuclear energy systems; materials for energy and extreme environments; mobility systems; carbon capture, utilization, and storage; energy bioscience; and electric power systems"

- Vision/outreach/agenda: "We approach this by conducting research to reduce the impact of producing and using concrete, and to develop tools to support infrastructure decisions: life-cycle environmental, cost, and hazard resistance".
- Mission/Assignment: "is to develop breakthroughs that will achieve sustainable and durable homes, buildings, and infrastructure".
- Fund: "Unassigned"
- Affiliation: "Ready Mixed Concrete (RMC) Research and Education Foundation, Portland Cement Association (PCA)"

Center for Bits and Atoms	
Parent university	Massachusetts Institute of Technology (MIT)
Acronym of ITRC	CBA
Country	United States
Year founded	1/1/2001
Kind of ITRC	A little Room inside a Building
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Wiesner Building, E15
Address of physical place	The MIT Center for Bits and Atoms, Room E15-401, 20 Ames Street, Cambridge, MA 02139
url of project	http://cba.mit.edu

Table 4.8: CBA

- Educational activities: "Startups, workshops, Classes"
- Areas of focus in research/research theme: "computer science, physical science"
- Vision/outreach/agenda: "ion beam probes for nanostructures, laser micromachining and X-ray microtomography for microstructures, and multi-axis machining and 3D printing for macrostructures advisors for popular media".
- Mission/Assignment: "exploring the boundary between computer science and physical science. CBA studies how to turn data into things,

and things into data. It manages facilities, runs research programs, supervises students, works with sponsors, creates startups, and does public outreach."

- Fund: "Unassigned"
- Affiliation: "Unassigned"

Center for Materials Research in Archaeology and Ethnology	
Parent university	Massachusetts Institute of Technology (MIT)
Acronym of ITRC	CMRAE
Country	United States
Year founded	1/1/1977
Kind of ITRC	A little Room inside a Building
Type of partnerships	Inter-institutional/Consortium
Current activities	Research and Education
SDGs	Unassigned
Name of building	Unassigned
Address of physical place	CMRAE HQ, Office of the Director, MIT, 77 Massachusetts Ave, Room 8-138, Cambridge, MA 02139
url of project	http://web.mit.edu/cmrae/

Table 4.9: CMRAE

- Educational activities: "Graduate Courses, Graduate Laboratory, Undergraduate Courses"
- Areas of focus in research/research theme: "biological, chemical, geological, physical, and materials science"
- Vision/outreach/agenda: "to enrich our knowledge of past and present day non-industrial societies by making the natural and engineering sciences part of our investigative tool kit".
- Mission/Assignment: "Scientific study of the materials technologies associated with human activity, when carried out within the framework of the human sciences, provides a more integrated realization of the physical, social, cultural, and ideological world in which we function".
- Fund: "Unassigned"

- Affiliation: "Boston University, Brandeis University, Harvard University, University of Massachusetts at Boston and Amherst, Massachusetts Institute of Technology, Museum of Fine Arts, Boston, Tufts University, Wellesley College".

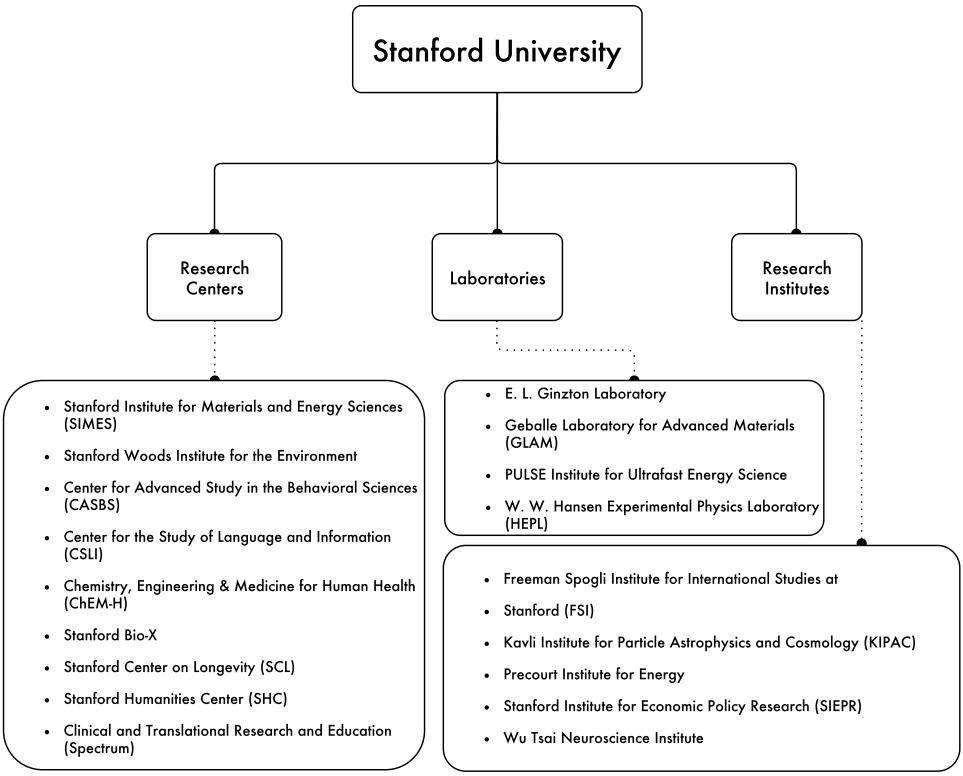


Figure 4.9: List of ITRCs within the Stanford University

4.10.2 Flowchart of ITRCs within Stanford University

The flow chart shows how many ITRCs Stanford university has established and the subsidiaries that each main center includes.

Research Centers of this university is built up of various centers including nine Research Centers whose activities are mainly in the field of energy, environment and human sciences pertaining to behavior, language study, and humanities as well as engineering and medicine.

The second biggest section comprises Research Institutions accounting for six various centers that are active in international studies, working on the particle, astrophysics and cosmology, precourt institute for energy, economic policy and Neuroscience. Finally, Laboratories have four main buildings in which experimental activities are carried out such as EL. laboratory, GIAM laboratory dealing with advanced materials and HEPL (see 4.11) dealing with experimental physics.

4.10.2.1 Up to 5 ITRCs of Stanford University

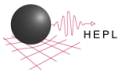
Center for Advanced Study in the Behavioral Sciences	
Parent university	Stanford University
Acronym of ITRC	CASBS
Country	United States
Year founded	1/1/1954
Kind of ITRC	Research Center
Type of partnerships	Independet/Free-standing
Current activities	Research and Education
SDGs	Unassigned
Name of building	Cntr. For Advan. Study In Behav.Sci (12-200)
Address of physical place	75 Alta Rd Stanford
url of project	https://casbs.stanford.edu

Table 4.10: CASBS

- Educational activities: "Unassigned"
- Areas of focus in research/research theme: "Social sciences and related fields in humanities, sciences, medicine, and engineering"
- Vision/outreach/agenda: "connects its scholars and programs with the public and constantly seeks to build relationships and engage broader communities, near and far. Connect with us"!
- Mission/Assignment: "brings together deep thinkers from diverse disciplines and communities to advance understanding of the full range of human beliefs, behaviors, interactions, and institutions. A leading incubator of human-centered knowledge, CASBS facilitates collaborations across academia, policy, industry, civil society, and government to collectively design a better future".
- Fund: "Unassigned"

Hansen Experimental Physics Laboratory	
Parent university	Stanford University
Acronym of ITRC	HEPL
Country	United States
Year founded	1/1/1951
Kind of ITRC	Laboratory
Type of partnerships	Independet/Free-standing
Current activities	Research
SDGs	Unassigned
Name of building	Exptl Physics Lab - South (04-270)
Address of physical place	491 South Service Rd Stanford
url of project	https://web.stanford.edu/group/hepl/

Table 4.11: HEPL



- Affiliation: "Unassigned"

- Educational activities: ""

- Areas of focus in research/research theme: "satellite-based instruments for investigating gravity (GP-B), gamma-rays (Fermi Large Area Telescope) and solar physics (SDO-HMI), the Laser in Space Antenna (LISA), the search for cryogenic dark matter (CDMS), the Enriched Xenon Observatory (EXO), advanced GPS satellites, the overlap regions of atoms, lasers and fast electronics, photovoltaic retinal prosthesis, laser tissue interactions, and the encoding, processing and transmission of visual information"

- Vision/outreach/agenda: "Unassigned".

- Mission/Assignment: "It supports interdisciplinary research programs in fundamental science and engineering. In partnership with other departments and schools (e.g., Engineering and Medicine), HEPL provides unique research and educational opportunities for students".

- Fund: "Unassigned"
- Affiliation: "Unassigned"

Freeman Spogli Institute for International Studies at Stanford	
Parent university	Stanford University
Acronym of ITRC	FSI
Country	United States
Year founded	Unassigned
Kind of ITRC	Research Institution
Type of partnerships	Independet/Free-standing
Current activities	Research and Education
SDGs	Unassigned
Name of building	Encina Hall Center (06-010)
Address of physical place	616 Jane Stanford Way Stanford
url of project	https://fsi.stanford.edu

Table 4.12: FSI

Stanford | Freeman Spogli Institute for International Studies

- Educational activities: "Unassigned"
- Areas of focus in research/research theme: "energy, environment, governance, health and medicine, international development, international relations, security, society"
- Vision/outreach/agenda: "to understanding the problems, policies, and processes that cross international borders and affect lives around the world".
- Mission/Assignment: "Produce world-class, world-wide research,Teach and train tomorrow's leaders,Engage policymakers".
- Fund: "Unassigned"
- Affiliation: "Unassigned"

Center for the Study of Language and Information	
Parent university	Stanford University
Acronym of ITRC	CSLI
Country	United States
Year founded	1/1/1983
Kind of ITRC	Research Center
Type of partnerships	Independet/Free-standing
Current activities	Research
SDGs	Unassigned
Name of building	Cordura Hall (Csli) (14-070)
Address of physical place	210 Panama St, Stanford, CA 94305, United States
url of project	https://www-csli.stanford.edu

Table 4.13: CSLI

- Educational activities: "Unassigned"
- Areas of focus in research/research theme: "logic, language, computation, philosophy, and cognition"
- Vision/outreach/agenda: "The Center's objective is to facilitate collaborations among these researchers and thereby amplify Stanford's already considerable strengths in cognitive sciences".
- Mission/Assignment: "serves Stanford faculty and students who are engaged in research involving computational, logical, and stochastic modeling of cognitive functions and processes".
- Fund: "Unassigned"
- Affiliation: "Unassigned"

Stanford Bio-X	
Parent university	Stanford University
Acronym of ITRC	Unassigned
Country	United States
Year founded	11/1/1998
Kind of ITRC	Research Center
Type of partnerships	Independet/Free-standing
Current activities	Research and Education
SDGs	Unassigned
Name of building	Clark Center (07-340)
Address of physical place	318 Campus Drive, Palo Alto, CA 94305, United States
url of project	https://biox.stanford.edu

Table 4.14: Stanford Bio-X

- Educational activities: "Become a PhD Fellow, Present at a Conference, Take a Class, Attend a Workshop, Summer Research Program"
- Areas of focus in research/research theme: "the intersection of bioscience with engineering, computer science, physics, chemistry, and other fields"
- Vision/outreach/agenda: "We aim to make Stanford the most exciting place in the world for combining a broad range of scientific and engineering disciplines in biosciences research and for training the next generation of leaders".
- Mission/Assignment: "The Mission of Bio-X is to catalyze discovery by crossing the boundaries between disciplines, to bring interdisciplinary solutions and to create new knowledge of biological systems, in benefit of human health.".
- Fund: "The Stanford Bio-X Undergraduate Summer Research Program"
- Affiliation: "Unassigned"

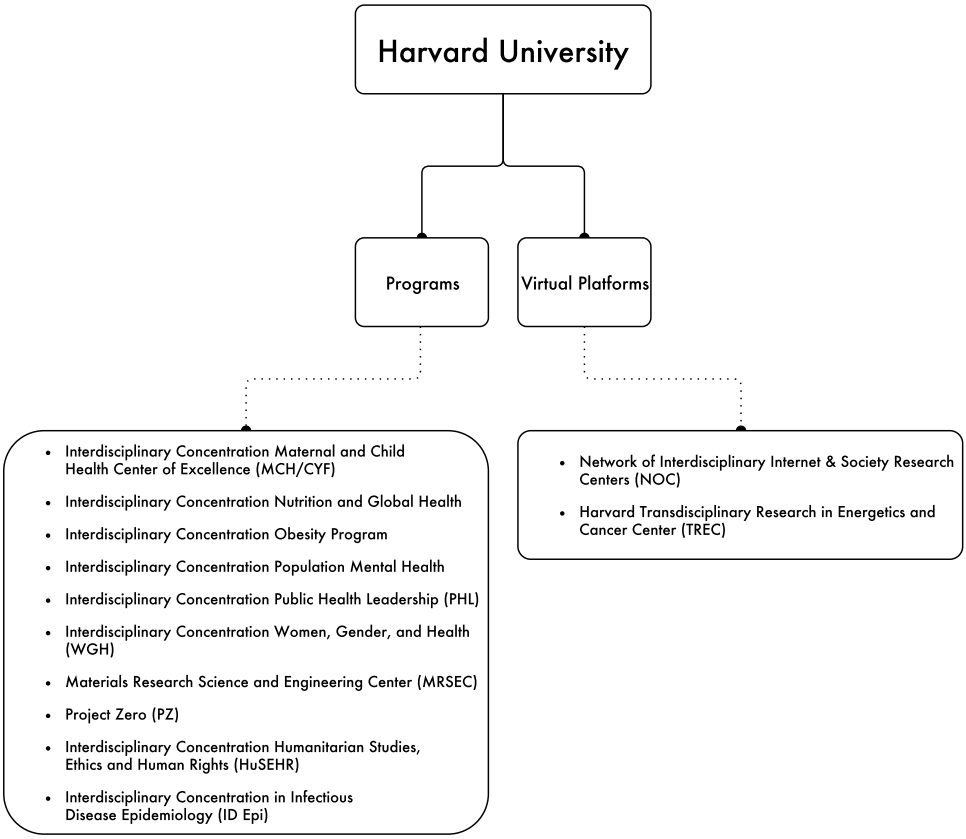


Figure 4.10: List of ITRCs within the Harvard University

4.10.3 Flowchart of ITRCs within Harvard University

The flow chart pertaining to Harvard University indicates that Programs and Virtual Platforms have their ITR departments active in various fields.

Having reviewed the programs, we can clearly realize that Programs which are pursued in such departments include ten sub-divisions, each of which has special activities. Among these centers, six departments work on interdisciplinary concentrations, which are involved in issues relevant to either maternal and child health or public health including nutrition, obesity, maternal health, and gender health. Moreover, two centers carry out some programs in the field of science and engineering, while one interdisciplinary center has concentrated its studies on ethics and human rights and one conducts research on infectious disease epidemiology.

However, Virtual Platforms have two divisions, one of these two centers work in the field of interdisciplinary Internet Networks and society research, and the other one deal with researching energetic and cancer.

4.10.3.1 Up to 5 ITRCs of Harvard University

Project Zero	
Parent university	Harvard University
Acronym of ITRC	PZ
Country	United States
Year founded	1/1/1967
Kind of ITRC	Program
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Not Applicable
Address of physical place	Not Applicable
url of project	http://www.pz.harvard.edu

Table 4.15: PZ

- Educational activities: "Online courses, Events, Two-weeks classroom, Offering scholarship to researchers"
- Areas of focus in research/research theme: "Arts, Assessment re-imagined, Character and ethics, Civic agency, Creativity, Developing understanding, Global competencies, Intelligence, Thinking"
- Vision/outreach/agenda: "Understanding and engaging today's most pressing societal issues: from climate change to mass migration, from global health to the digital revolution, requires that we prepare our young to integrate disciplinary perspectives and to do so with quality".
- Mission/Assignment: "is to understand and enhance learning, thinking and creativity for individuals and groups in the arts and other disciplines.".
- Fund: "Unassigned"
- Affiliation: "Unassigned"

Network of Interdisciplinary Internet and Society Research Centers	
Parent university	Harvard University
Acronym of ITRC	NoC
Country	United States
Year founded	1/1/2012
Kind of ITRC	Virtual Platform
Type of partnerships	Public-private partnerships
Current activities	Research
SDGs	Unassigned
Name of building	Unassigned
Address of physical place	The administrative lead periodically alternates among the participating centers
url of project	http://networkofcenters.net

Table 4.16: NoC

- Educational activities: "Unassigned"

- Areas of focus in research/research theme: "policy, regulation and governance, human behavior and social impact, new markets and business models, intellectual property, privacy, and security, and many other issues"

- Vision/outreach/agenda: "these institutions have sought to analyze and understand the growing impact of digital technologies on society and share those findings in such ways that serve the public interest".

- Mission/Assignment: "It aims to increase interoperability between participating centers in order to collectively confront transnational issues on a global level".

- Fund: "The participating centers of the Network can individually and collectively engage in fundraising efforts on issues relevant to the Network. The activities are governed by the respective rules applicable to each participating center (e.g. University's fundraising and conflict of interest policies). The Steering Committee is responsible that any funding directed towards the activities of the Network will respect and bolster the values of the Network"

- Affiliation: "Nexa Center for Internet & Society at Politecnico di Torino"

Interdisciplinary Concentration Women, Gender, and Health	
Parent university	Harvard University
Acronym of ITRC	WGH
Country	United States
Year founded	1/1/1996
Kind of ITRC	Program
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Not Applicable
Address of physical place	Not Applicable
url of project	https://www.hsph.harvard.edu/women-gender-and-health/

Table 4.17: WGH

- Educational activities: "non-degree programs Courses"
- Areas of focus in research/research theme: "women, gender and health, gender and gender inequality"
- Vision/outreach/agenda: "Unassigned".
- Mission/Assignment: "Addressing issues of women, gender, and health requires the study of the health of women and girls – and men and boys – throughout the life course, with gender, gender equality, and biology understood as important and interacting determinants of well-being and disease".
- Fund: "Unassigned"
- Affiliation: "faculty members, post-doctoral fellows, and students who meet monthly to discuss"

- Educational activities: "non-degree programs Courses"

Interdisciplinary Concentration Obesity Program	
Parent university	Harvard University
Acronym of ITRC	Unassigned
Country	United States
Year founded	Unassigned
Kind of ITRC	Program
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Not Applicable
Address of physical place	Not Applicable
url of project	https://www.hsph.harvard.edu/obesity-program/

Table 4.18: Interdisciplinary Concentration Obesity Program

- Areas of focus in research/research theme: ”obesity in individuals and populations; biological and social determinants of obesity; epidemiologic and prevention study designs; health and social consequences of obesity; worksite-, community-, and school-based interventions; gene-environment interactions; and global obesity epidemiology and prevention”
- Vision/outreach/agenda: ”Unassigned”.
- Mission/Assignment: ”two-fold: (a) provide training on the theoretical, methodological, and applied knowledge and skills necessary to prepare students to conduct obesity related epidemiologic and prevention research; and (b) train international students and scholars who can apply knowledge and skills at HSPH to obesity research in international settings.”.
- Fund: ”Unassigned”
- Affiliation: ”Department of Nutrition, Department of Epidemiology, Department of Social and Behavioral Sciences, Department of Global Health and Population, Department of Environmental Health, Department of Health Policy and Management”

Harvard Transdisciplinary Research in Energetics and Cancer Center	
Parent university	Harvard University
Acronym of ITRC	TREC
Country	United States
Year founded	Unassigned
Kind of ITRC	Virtual Platform
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Not-applicable
Address of physical place	Not-applicable
url of project	https://www.hsph.harvard.edu/trec/

Table 4.19: TREC

- Educational activities: "Monthly seminars, mini-symposia, and travel assistance for junior investigators"
- Areas of focus in research/research theme: "obesity, energy expenditure, or cancer"
- Vision/outreach/agenda: "to translate these findings into actionable behavioral interventions, to train the next generation of investigators in energetics (the study of energy balance) and cancer, and to disseminate this knowledge and develop public health strategies to reduce risk of obesity and cancer".
- Mission/Assignment: "is designed to increase the understanding of the determinants of obesity from the molecular to societal level and across the lifespan, to clarify the biological links of obesity with cancer risk and survivor ship".
- Fund: "annual funding for pilot and feasibility studies"
- Affiliation: "Harvard School of Public Health, Harvard Medical School, Harvard-affiliated Brigham and Women's Hospital, Children's Hospital Boston, DanaFarber/Harvard Cancer Center, Harvard Pilgrim Health Care Institute, Harvard Center for Population and Development"

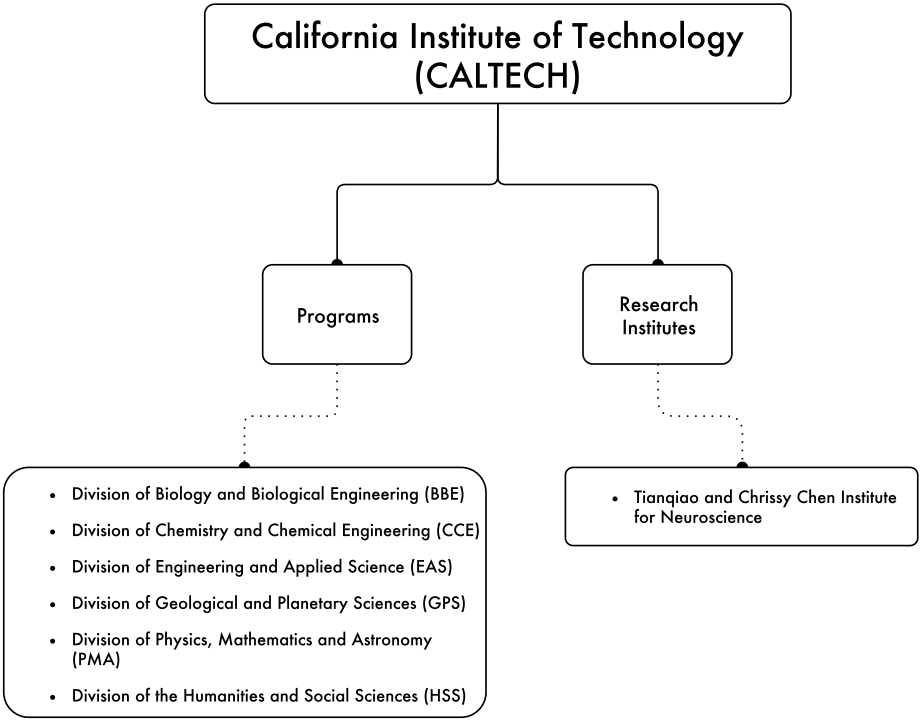


Figure 4.11: List of ITRCs within the California Institute of Technology (Caltech)

4.10.4 Flowchart of ITRCs within California Institute of Technology

This flow chart illustrates two main ITRC parts of the California Institute of Technology. These include Programs and Research Institution.

Programs Department has more divisions accounting for 6 active departments, among them, five departments are involved in basic sciences such as the division of Biology and Biological Engineering, Chemistry and Chemical Engineering, applied science, Geological and Planetary Science and the division of Mathematics, Physics and Astronomy.

In spite of the former part, Research Institution has just one institute for Neuroscience, therefore, it can be inferred that the California Institute of Technology has mainly focused on basic sciences.

4.10.4.1 ITRCs of California Institute of Technology

Division of Biology and Biological Engineering	
Parent university	California Institute of Technology (CALTECH)
Acronym of ITRC	BBE
Country	United States
Year founded	1/1/1970
Kind of ITRC	Program
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Not Applicable
Address of physical place	Not Applicable
url of project	http://www.bbe.caltech.edu

Table 4.20: BBE

Caltech The Division of Biology and Biological Engineering

- Educational activities: "Undergraduate Studies, Graduate Studies, Postdoctoral Programs, Courses"

- Areas of focus in research/research theme: "Biochemistry, Structural, and Molecular Cell Biology, Biological Engineering,Developmental Biology and Genetics, Microbiology and Immunology, Neuroscience, Molecules to Neurons, Neuroengineering Neurons to Behavior, Neuroscience of Brain Disorders, System Biology, Evolutionary and Organismal Biology"
- Vision/outreach/agenda: "Unassigned".
- Mission/Assignment: "advancing investigations of and expanding knowledge about the nature of life—from a single molecule to an entire organism".
- Fund: "Unassigned"
- Affiliation: "50 faculty research laboratories"

Division of Chemistry and Chemical Engineering	
Parent university	California Institute of Technology (CALTECH)
Acronym of ITRC	CCE
Country	United States
Year founded	1/1/1955
Kind of ITRC	Program
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Division of Chemistry and Chemical Engineering
Address of physical place	1200 East California Boulevard, Pasadena CA 91125
url of project	http://www.cce.caltech.edu

Table 4.21: CCE

Caltech Division of Chemistry and Chemical Engineering

- Educational activities: "undergraduate and graduate students with a world-class education, coursework"
- Areas of focus in research/research theme: "chemistry, Chemical Engineering, Biochemistry and Molecular Biophysics, Biochemistry and Molecular Biophysics"

- Vision/outreach/agenda: "".
- Mission/Assignment: "Together they apply their most innovative ideas to our fundamental knowledge of chemical processes, thereby tackling some of chemistry's most complex problems".
- Fund: "Unassigned"
- Affiliation: "Unassigned"

Division of Geological and Planetary Sciences	
Parent university	California Institute of Technology (CALTECH)
Acronym of ITRC	GPS
Country	United States
Year founded	1/1/1926
Kind of ITRC	Program
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Arms Laboratory (building 25 on the campus map, near the corner of California Boulevard and Wilson Avenue).
Address of physical place	1200 E. California Blvd., Pasadena, CA 91125
url of project	http://www.gps.caltech.edu

Table 4.22: GPS

- Educational activities: "Graduate and Undergraduate academic programs"
- Areas of focus in research/research theme: "Geology, Geobiology, Geochemistry, Geophysics, Planetary Sciences, Environmental Science and Engineering"
- Vision/outreach/agenda: "approach to these problems relies heavily on fundamental science and on interdisciplinary collaborations with colleagues from across Caltech, as well as at the U.S. Geological Survey and the Jet Propulsion Laboratory".

- Mission/Assignment: "integration of both earth and planetary sciences within one division gives it a unique perspective on our world and our universe, providing its researchers with the opportunity to apply lessons learned from the earth's geological past to the study of other".
- Fund: "Unassigned"
- Affiliation: "The Bruce Murray Laboratory for Planetary Visualization, The Center for Geomechanics and Mitigation of Geohazards (GMG), The Ronald and Maxine Linde Center for Global Environmental Science, Seismological Laboratory, Terrestrial Hazard Observation (THOR)"

Division of the Humanities and Social Sciences	
Parent university	California Institute of Technology (CALTECH)
Acronym of ITRC	HSS
Country	United States
Year founded	1/1/1962
Kind of ITRC	Program
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Most of the HSS division is housed in two buildings on campus: Baxter Hall (building 77 on the campus map) and Dabney Hall (building 40)
Address of physical place	division's administrative offices are on the second floor of Baxter Hall
url of project	https://www.hss.caltech.edu

Table 4.23: Division of the Humanities and Social Sciences

- Educational activities: "Undergraduate Studies, Graduate Studies, Postdoctoral Programs, HSS Courses"
- Areas of focus in research/research theme: "Humanities Research: Intellectual History, Literature and History, Origins and Foundations of Science, Scientific Philosophy, Social Science History, Visual Culture;Research Areas in the Social Sciences: Applied Microeconomics,

Business, Economics, and Management, Economics and Computer Science, Economic History, Economic Theory Experimental Social Science, Political Economy, Political Science, Social and Decision Neuroscience, Statistical Methodology ”

- Vision/outreach/agenda: ”Unassigned”.
- Mission/Assignment: ”HSS researchers apply cutting-edge methodologies to deepen our knowledge and understanding of our world”.
- Fund: ”Unassigned”
- Affiliation: ”The Einstein Papers Project, The Francis Bacon Award in the History and Philosophy of Science and Technology, Collaborations with The Huntington, Caltech-Huntington Humanities Collaborations (CHHC)The Eleanor Searle Visiting Professorship in History”

Tianqiao and Chrissy Chen Institute for Neuroscience	
Parent university	California Institute of Technology (CALTECH)
Acronym of ITRC	Unassigned
Country	United States
Year founded	1/1/2016
Kind of ITRC	Research Institution
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Unassigned
Address of physical place	1200 East California Blvd., Pasadena CA91125
url of project	https://neuroscience.caltech.edu

Table 4.24: Tianqiao and Chrissy Chen Institute for Neuroscience

Caltech Tianqiao and Chrissy Chen Institute for Neuroscience

- Educational activities: ”Neuroscience PhD Options, Chen Institute Workshops, Networking Opportunities [1], Annual Retreat, Chen Graduate Fellows, Chen Distinguished Visitor Program [2], Symposium”

[1]The Chen Institute sponsors monthly Social Hours that bring together graduate students, postdoctoral scholars, scientific staff and faculty to share ideas, build community and encourage cross-disciplinary collaborations.

[2]The intention here is to invite visitors with a broad perspective on the brain and computation who can come talk to all of us.

- Areas of focus in research/research theme: "neuroscientists and biologists to economists, chemists, physicists, computer scientists, social scientists, and engineers. Works of researchers will be focused through six interdisciplinary research center: the TandC Chen Brain-Machine Interface Center, The TandC Chen Center for Social and Decision Neuroscience, the TandC Chen Center for Systems Neuroscience, the Center for Molecular and Cellular Neuroscience, the Caltech Brain Imaging Center, the Chen Center for Neuroscience Education"
- Vision/outreach/agenda: "The Chen Institute at Caltech will ultimately be housed in a new state-of-the-art building that will be named in honor of the donors and function as the nexus for neuroscience research at Caltech".
- Mission/Assignment: "It is a key component of a neuroscience initiative that is geared toward deepening our understanding of the brain's structure and how the brain works at its most basic level, as well as why and how it fails as a result of disease or through the aging proce".
- Fund: "Awards base of Professors fund, Travel Grants, Graduate innovator grant awards"
- Affiliation: "Affiliated Faculty"

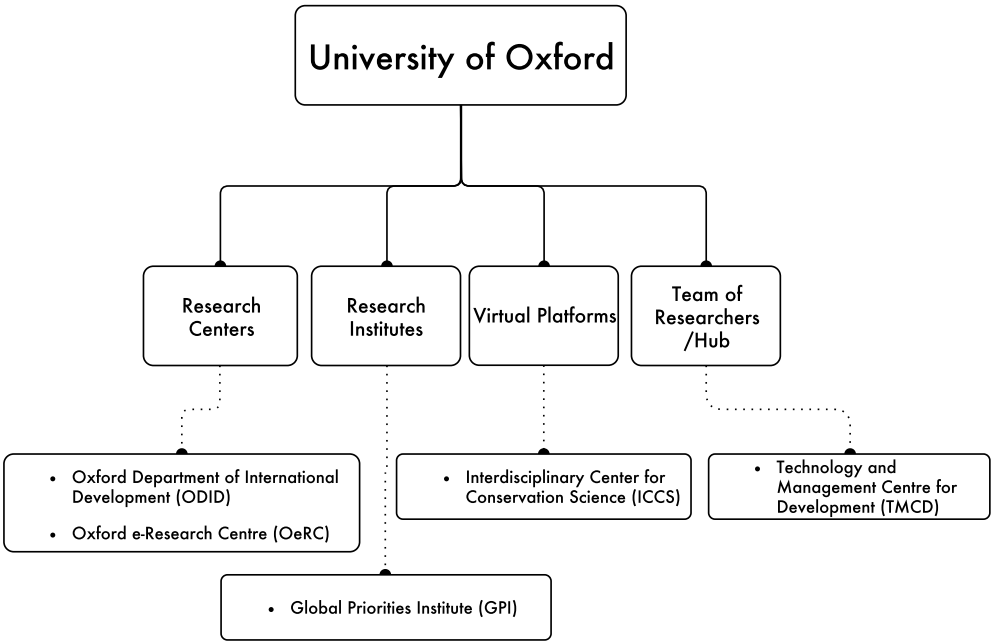


Figure 4.12: List of ITRCs within the University of Oxford

4.10.5 Flowchart of ITRCs within University of Oxford

The flow chart drawn up for the university of Oxford illustrates the main ID and TD research departments. As can be noticed, apart from Research Centers, which includes two sub-divisions, Research Institution, Virtual Platform and Team of Researchers/Hub.

As the chart reveals, Research Centers comprise two divisions, one of which works on international development. The second subsidiary carries studies on the e-research center. The second main Research Institution department conduct studies on global priority institute. The field of an interdisciplinary center for conservation science is assigned to Virtual Platform.

Finally, the department of the Team of Researchers/Hub works on technology and management.

Although this university has set up four main ITRCs, their realm of studies is not so vast, therefore, they require more development.

4.10.5.1 ITRCs of University of Oxford

Global Priorities Institute	
Parent university	University of Oxford
Acronym of ITRC	GPI
Country	United Kingdom
Year founded	1/1/2018
Kind of ITRC	Research Institution
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research
SDGs	Unassigned
Name of building	Global Priorities Institute
Address of physical place	Manor Road Building, Manor Rd, Oxford OX1 3UQ
url of project	https://globalprioritiesinstitute.org

Table 4.25: GPI

- Educational activities: "Not-applicable"

- Areas of focus in research/research theme: "philosophy and economics"
- Vision/outreach/agenda: "A world in which global priorities are set by using evidence and reason to determine what will do the most good".
- Mission/Assignment: "To conduct and promote world-class, foundational academic research on how most effectively to do good".
- Fund: "The Atkinson Scholarship, The Parfit Scholarship"
- Affiliation: "Unassigned"

Interdisciplinary Center for Conservation Science	
Parent university	University of Oxford
Acronym of ITRC	ICCS
Country	United Kingdom
Year founded	1/1/2016
Kind of ITRC	Virtual Platform
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research
SDGs	Unassigned
Name of building	University of Oxford
Address of physical place	University of Oxford 11a Mansfield Road OX1 3SZ, UK
url of project	https://www.iccs.org.uk

Table 4.26: ICCS

- Educational activities: "Not-applicable"
- Areas of focus in research/research theme: "social and ecological systems; Understanding resource user incentives, Planning for effective and socially just conservation, Accounting for social-ecological system dynamics"
- Vision/outreach/agenda: "to consider the incentives, pressures and challenges faced by individual decision-makers, and to bring together multidisciplinary teams who are best placed to address these issues".

- Mission/Assignment: "addresses the challenges that humanity faces in halting the decline of global biodiversity".
- Fund: "Unassigned"
- Affiliation: "Researchers of all around the glob, University of Oxford"

Oxford Department of International Development	
Parent university	University of Oxford
Acronym of ITRC	ODID
Country	United Kingdom
Year founded	1/1/1954
Kind of ITRC	Research Center
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Oxford Department of International Development
Address of physical place	Queen Elizabeth House, 3 Mansfield Road, Oxford OX1 3TB
url of project	https://www.qeh.ox.ac.uk

Table 4.27: ODID

- Educational activities: "postgraduate students on doctoral and master's programmes, post-doctoral fellows, academic visitors"
- Areas of focus in research/research theme: "Economic Development and International Institutions, Migration and Refugees in a Global Context, Political Change, Conflict and the Environment, Human Development, Poverty and Children"
- Vision/outreach/agenda: "to generate academically rigorous research into the underlying structures and overarching processes of development".
- Mission/Assignment: "developing countries, and engage in extensive policy advisory work for governments, international agencies and civil society organisations".
- Fund: "Unassigned"

- Affiliation: "Oxfrod Department of Economics,International Growth Centre (IGC),International Migration Institute (IMI),Oxford Poverty and Human Development Initiative (OPHI),Refugee Studies Centre (RSC),Technology and Management Centre for Development (TMCD),Young Lives"

Oxford e-Research Centre	
Parent university	University of Oxford
Acronym of ITRC	OeRC
Country	United Kingdom
Year founded	1/1/2006
Kind of ITRC	Research Center
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research
SDGs	Unassigned
Name of building	Oxford e-Research Centre
Address of physical place	7 Keble Road, Oxford OX1 3QG
url of project	https://www.oerc.ox.ac.uk

Table 4.28: OeRC

- Educational activities: "Not-applicable"
- Areas of focus in research/research theme: "Advanced e-Infrastructure and Cloud Computing, Internet, Information and Interaction, Scientific Computing, Software, Repositories and Data Management, Visual Computing engagement; innovation and partnership; advanced e-infrastructure and cloud computing"
- Vision/outreach/agenda: "provide a world-leading environment that enables collaborative research, interfacing innovative technologies across academic and commercial partnerships to address the grand challenges of today and the future".
- Mission/Assignment: "connect disciplines, applications and computation to accelerate research and collaboration.".
- Fund: "Unassigned"

- Affiliation: "Unassigned"

Technology and Management Centre for Development	
Parent university	University of Oxford
Acronym of ITRC	TMCD
Country	United Kingdom
Year founded	1/1/1970
Kind of ITRC	Team of Researchers/Hub
Type of partnerships	Independet/Free-standing
Current activities	Research and Education
SDGs	Unassigned
Name of building	Technology and Management Centre for Development
Address of physical place	Oxford Department of International Development, 3 Mansfield Road, Oxford OX1 3TB
url of project	https://www.oxfordtmcd.org

Table 4.29: TMCD

- Educational activities: "Visiting Fellowships Programme, Workshops, Seminars"
- Areas of focus in research/research theme: "Technology and Industrialisation in Developing Countries, China Innovation and Entrepreneurship, Trade in Environmentally Sound Technologies, The Inclusive Digital Model (IDMODEL)Diffusion of Innovation in Low Income Countries (DILIC), The Internationalisation of Emerging Market MNEs"
- Vision/outreach/agenda: "Unassigned".
- Mission/Assignment: "Helping policy makers and firms improve lives through thriving innovation".
- Fund: "Unassigned"
- Affiliation: "Oxford Department of International Development"

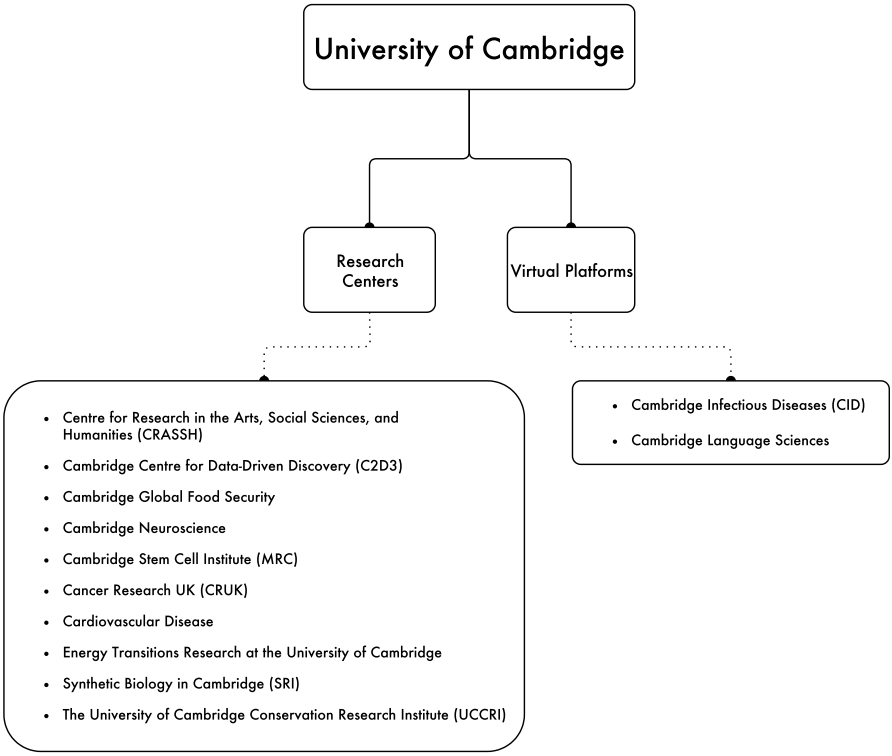


Figure 4.13: List of ITRCs within the University of Cambridge

4.10.6 Flowchart of ITRCs within University of Cambridge

Cambridge University, one of the high ranking universities in the world has provided its students with Research Centers and Virtual Platforms as the relevant flow chart illustrates. Each of these two parts has some subdivisions raised below.

The Research Centers, which are significantly more than Virtual Platforms, include ten centers, each of which deals with various issues. Among them, two centers carry out research about humanities and data-driven discovery and five centers are active in food science and mainly human health issues like stem cells and diseases. Furthermore, one center is active in the field of energy transition and another one paves the way for research in synthetic biology. Finally, the tenth center focuses on conservation research known as UCCRT.

Virtual Platforms consist of two centers. The first center conducts some activities concerning infectious diseases, while the other one studies language sciences.

These departments seem to require more development in the future.

4.10.6.1 Up to 5 ITRCs of University of Cambridge

Centre for Research in the Arts, Social Sciences, and Humanities	
Parent university	University of Cambridge
Acronym of ITRC	CRASSH
Country	United Kingdom
Year founded	1/1/2001
Kind of ITRC	Research Center
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research
SDGs	Unassigned
Name of building	Alison Richard
Address of physical place	7 West Rd, Cambridge CB3 9DP
url of project	http://www.crassh.cam.ac.uk

Table 4.30: CRASSH

- Educational activities: "Not-applicable"
- Areas of focus in research/research theme: "arts, social sciences, humanities"
- Vision/outreach/agenda: "Unassigned".
- Mission/Assignment: "mission is to create new resources for thought, stimulate interdisciplinary research and disciplinary innovation, establish new intellectual networks and affiliations, respond to emerging social and political challenges, engage new publics in humanities research and help to shape public policy".
- Fund: "Opportunities for Cambridge faculty members and graduate students, Funding opportunities for scholars outside Cambridge"
- Affiliation: "University of Cambridge"

University of Cambridge Conservation Research Institute	
Parent university	University of Cambridge
Acronym of ITRC	UCCRI
Country	United Kingdom
Year founded	1/1/2016
Kind of ITRC	Research Center
Type of partnerships	Independet/Free-standing
Current activities	Research and Education
SDGs	Unassigned
Name of building	The David Attenborough Building
Address of physical place	Pembroke Street, Cambridge, CB2 3QZ
url of project	https://www.conservation.cam.ac.uk

Table 4.31: UCCRI

- Educational activities: "Career Researcher Programme"
- Areas of focus in research/research theme: "Knowledge and Expertise in Conservation, Conservation Across Protected and Productive Landscapes, Biodiversity in the Future Earth, The Values of Nature"
- Vision/outreach/agenda: "Create an interdisciplinary environment for research on biodiversity conservation and the social context within which humans engage with nature, To build a diverse and inclusive conservation community, To pursue common agendas from a variety of intellectual starting points, Engage in non-traditional conservation training and support, Develop a nurturing space for, and actively facilitate, cross-disciplinary collaboration and knowledge exchange ".
- Mission/Assignment: "delivers an ambitious programme of research, bringing the natural sciences and technology into intellectual dialogue with the arts, humanities and social sciences".
- Fund: "Research grants, New investigator grants, Public engagement call, External Sites"

- Affiliation: "Schools within the University: Arts and Humanities, Social Sciences and Humanities, Biological Sciences, Physical Sciences, Clinical Medicine and Technology."

Cambridge Global Food Security	
Parent university	University of Cambridge
Acronym of ITRC	Unassigned
Country	United Kingdom
Year founded	1/1/2017
Kind of ITRC	Research Center
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research
SDGs	Unassigned
Name of building	Department of Plant Sciences
Address of physical place	Downing Street, Cambridge, CB23EA
url of project	https://www.globalfood.cam.ac.uk

Table 4.32: Cambridge Global Food Security

- Educational activities: "Not-applicable"
- Areas of focus in research/research theme: "crop Science, policy, economics and public health"
- Vision/outreach/agenda: "Vision is to address the challenges of ensuring that all people at all times have access to sufficient, safe and nutritious food that meets their dietary needs and preferences for an active and healthy life; and to work with stakeholders across business policy and civil society to put innovative solutions into practice".
- Mission/Assignment: "Integrating scientific and technological innovation in food quality, yield and sustainability with interdisciplinary approaches to understanding the behavioural, social and political conditions of food security".
- Fund: "EPSRC IAA Postdoctoral Placements, External Fundings"
- Affiliation: "A Network of Expertise"

Cambridge Infectious Diseases	
Parent university	University of Cambridge
Acronym of ITRC	CID
Country	United Kingdom
Year founded	1/1/2006
Kind of ITRC	Virtual Platform
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research
SDGs	3. Good Health and Well-Being
Name of building	Unassigned
Address of physical place	Unassigned
url of project	https://www.infectiousdisease.cam.ac.uk

Table 4.33: CID

CAMBRIDGE INFECTIOUS DISEASES

- Educational activities: "Not-applicable"
- Areas of focus in research/research theme: "biological sciences, medicine, physical sciences, social sciences, humanities, computer science, engineering and technology"
- Vision/outreach/agenda: "vision is to build a world-leading interdisciplinary centre with capacity to develop innovative solutions for intractable infectious disease problems and support evidence for infectious disease policy".
- Mission/Assignment: "is working to capitalise on and extend this expertise by creating novel research through bridging disciplines working on infectious diseases".
- Fund: "Search by Funding Type, University Funding, CID Research Incubator Fund, CID Research Networks Fund, Research Professional"
- Affiliation: "Researchers of all around the glob"

- Educational activities: "Cambridge Language Sciences"
- Areas of focus in research/research theme: "language science"

Cambridge Language Sciences	
Parent university	University of Cambridge
Acronym of ITRC	Unassigned
Country	United Kingdom
Year founded	Not Applicable
Kind of ITRC	Virtual Platform
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	The Faculty of English
Address of physical place	9 West Road, Cambridge CB3 9DP
url of project	https://www.languagesciences.cam.ac.uk

Table 4.34: Cambridge Language Sciences

- Vision/outreach/agenda: "strengthen research collaborations and knowledge transfer across disciplines in order to address large-scale multidisciplinary research challenges relating to language research".
- Mission/Assignment: "mission is to promote dialogue between language scientists of all disciplines, to stimulate innovative thinking and to catalyse the formation of new interdisciplinary partnerships for novel research and creative teaching.".
- Fund: "Horizon 2020, Cambridge Language Sciences Incubator Fund, Research Professional"
- Affiliation: "Cambridge Assessment and Cambridge University Press, world-leading partners in the field of language sciences,"

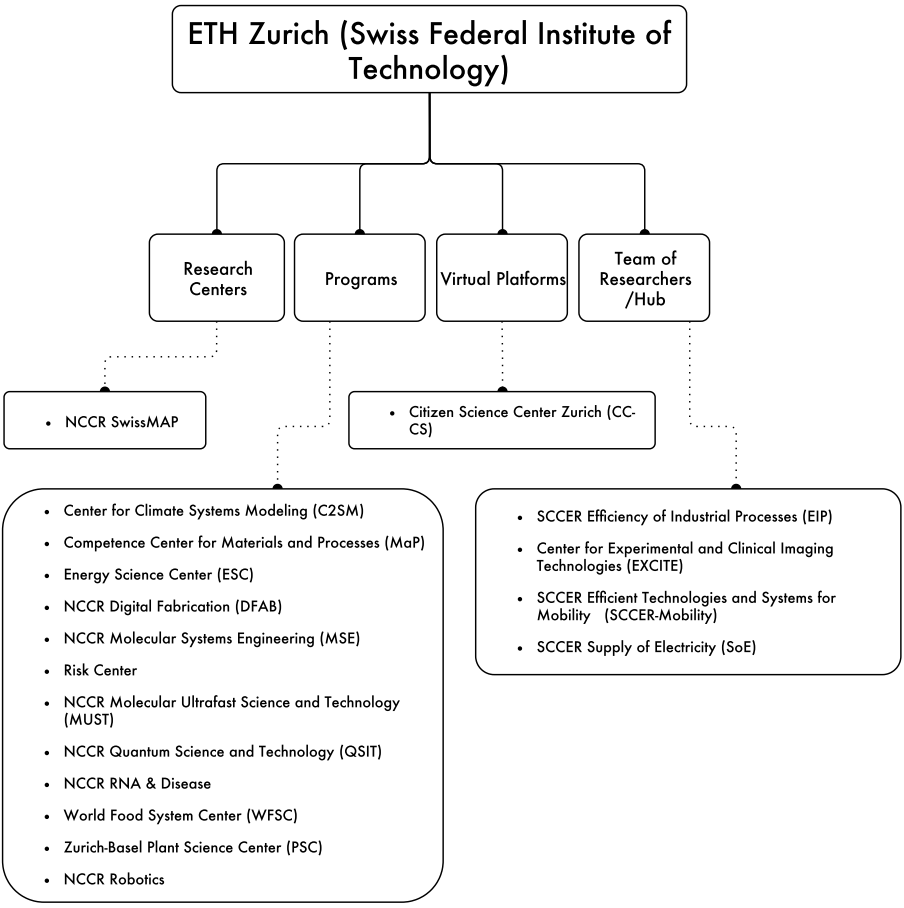


Figure 4.14: List of ITRCs within the ETH Zurich

4.10.7 Flowchart of ITRCs within ETH Zurich

The flow chart provided for ETH Zurich presents some information about four ID/TD research departments active in the foregoing institute of Technology.

Based on the given data, the most approachable kind of ITR is that of Programs, which includes 12 different centers. These programs involve climate system modeling, competence center for materials and processes energy science center and digital fabrication. Two centers work on molecular sciences known as MSE and MUST. The other six centers have programs in the field of Quantum, RNA, and diseases, food systems of the world, Basel plant science and Robotics.

It is followed by a Team of Researchers/Hubs working on four kinds of sciences including efficiency of industrial prosses, Experimental and clinical imaging Technology, Efficient Technologies and systems for mobility and supply of electricity.

However, the two other departments called Research Center and Virtual Platform run just one ITRC known as NCCR Swiss Map and Citizen science center Zurich respectively.

4.10.7.1 Up to 5 ITRCs of ETH Zurich

Zurich-Basel Plant Science Center	
Parent university	ETH Zurich (Swiss Federal Institute of Technology)
Acronym of ITRC	PSC
Country	Switzerland
Year founded	1/1/1998
Kind of ITRC	Program
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Zurich-Basel Plant Science Center
Address of physical place	Rämistrasse 101, 8092 Zürich
url of project	https://www.plantsciences.uzh.ch/en.html

Table 4.35: PSC

- Educational activities: "PhD Program in Plant Sciences, PhD Program in Science and Policy, PSC Summer School, Master's Coursework, Registration to PhD Program, Procedures and Important Documents, Terms and Conditions"
- Areas of focus in research/research theme: "biological and environmental issues now facing society"
- Vision/outreach/agenda: "wish to promote knowledge that contributes to sustainable solutions in agriculture and resource use. The list below provides a brief (and non-comprehensive) overview of research topics being explored by members of the PSC".
- Mission/Assignment: "Facilitate cooperation and enhance research synergies, Promote fundamental research in plant sciences, Initiate and support inter- and transdisciplinary research, Apply the results of research in plant sciences and create added value to ecosystem managemen. Guarantee future competence in the field of plant sciences, Advance the curricula in plant science education with innovative learning concepts, Intensify co-operation with business, politics, and government, Encourage dialogue with the public".

- Fund: "Research Funding and Fellowships"
- Affiliation: "University of Zurich, ETH Zurich, University of Basel"

World Food System Center	
Parent university	ETH Zurich (Swiss Federal Institute of Technology)
Acronym of ITRC	WFSC
Country	Switzerland
Year founded	Unassigned
Kind of ITRC	Program
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Building STE
Address of physical place	Stampfenbachstrasse 52/56, 8092 Zürich
url of project	https://worldfoodsystem.ethz.ch

Table 4.36: WFSC

- Educational activities: "Summer Schools, Courses, Alumni Support and areer Development, Student Theses Opportunities"
- Areas of focus in research/research theme: "Effective Food Value Chains, Appropriate Nutrition for Health, and Sustainable Food Production"
- Vision/outreach/agenda: "increase the impact of research by supporting the dissemination and implementation of resarch findings; increase public awareness of the challenges of the world food system and the solution approaches; act as an initial reference location for food relevant issues at the ETH; and increase the visibility of the work, impact, potential, and expertise of the ETH in food systems".
- Mission/Assignment: "mission is to be a leader in scientific research, education and outreach across the food system that contributes to the key challenges of food and nutrition security, environmental health, and social well-being. We do this by working across temporal and spatial scales and in collaborative partnerships with key stakeholders".

- Fund: "Unassigned"
- Affiliation: "Unassigned"

NCCR SwissMAP	
Parent university	ETH Zurich (Swiss Federal Institute of Technology)
Acronym of ITRC	Unassigned
Country	Switzerland
Year founded	Unassigned
Kind of ITRC	Research Center
Type of partnerships	Inter-institutional/Consortium
Current activities	Research and Education
SDGs	Unassigned
Name of building	Section de mathématiques
Address of physical place	2-4 rue du Lièvre, Case postale 64, 1211 Genève 4, Suisse
url of project	http://www.nccr-swissmap.ch

Table 4.37: NCCR SwissMAP

- Educational activities: "High School Outreach program (aimed at students and teachers);Master Classes (Master and early graduate level);Graduate program;Postdoctoral opportunities"
- Areas of focus in research/research theme: "Geometry, Topology, and Physics, Field Theory; Quantum Systems; Statistical Mechanics; String Theory"
- Vision/outreach/agenda: "goal is to bring our understanding of this field to a new level, which will have two-fold benefits: on one hand, it will help to make the description of nature mathematically more precise, and on the other it will lead to a deeper understanding of the mathematics in terms of which these physical ideas are described. ".
- Mission/Assignment: "Our mission is to bring these subjects and their interaction to a new level".
- Fund: "Unassigned"

- Affiliation: "ETH Zurich, University of Geneva, University of Zurich, EPFL, University of Bern, University of Fribourg and CERN"

Citizen Science Center Zurich	
Parent university	ETH Zurich (Swiss Federal Institute of Technology)
Acronym of ITRC	CC-CS
Country	Switzerland
Year founded	Unassigned
Kind of ITRC	Virtual Platform
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research
SDGs	Contributing to the global effort toward sustainable development
Name of building	Not-applicable
Address of physical place	Not-applicable
url of project	https://citizenscience.ch/en/

Table 4.38: CC-CS

- Educational activities: "Not-applicable"
- Areas of focus in research/research theme: "including community based research, crowd-sourced data collection, community-based monitoring, civic science"
- Vision/outreach/agenda: "Unassigned".
- Mission/Assignment: "Engaging academic scientists and the public in next-generation citizen science projects, Providing the resources, expertise and technical know-how to develop, set up, and run citizen science projects, Maintaining the highest standards of excellence Contributing to the global effort toward sustainable development, by creating actionable knowledge and data that can help tackle the UN SDGs at the local, regional and global level".
- Fund: "Unassigned"
- Affiliation: "University of Zurich, ETH Zurich"

Center for Climate Systems Modeling	
Parent university	ETH Zurich (Swiss Federal Institute of Technology)
Acronym of ITRC	C2SM
Country	Switzerland
Year founded	Unassigned
Kind of ITRC	Program
Type of partnerships	Inter-institutional/Consortium
Current activities	Research and Education
SDGs	13. Climate Action
Name of building	Building CHN
Address of physical place	Universitätstrasse 16, 8092 Zürich
url of project	https://c2sm.ethz.ch

Table 4.39: C2SM

- Educational activities: "Summer School, Master Program, Technical Training"
- Areas of focus in research/research theme: "Swiss Climate Scenarios CH2018, Cloud-resolving climate modeling, High performance computing, Paleo Fires from high-alpine ice cores"
- Vision/outreach/agenda: "seeks to foster interdisciplinary research and interactions across the partner institutions and research groups".
- Mission/Assignment: "is to provide a technical and scientific platform and a network for its partners institutions".
- Fund: "Unassigned"
- Affiliation: "ETH Zurich, MeteoSwiss, Empa, WSL, and Agroscope."

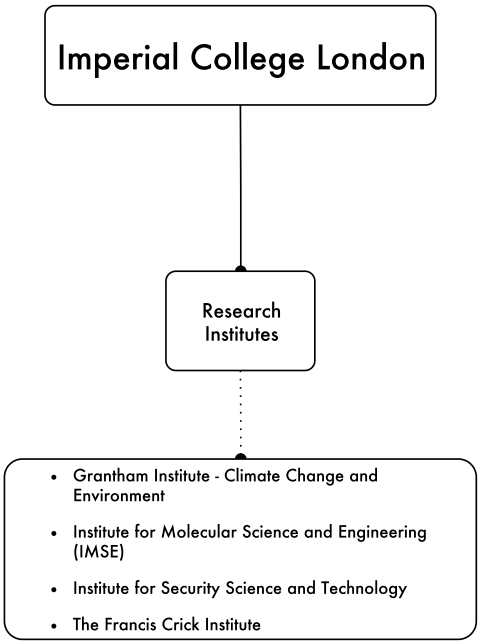


Figure 4.15: List of ITRCs within the Imperial College London

4.10.8 Flowchart of ITRCs within Imperial College London

Based on the flow chart, Imperial College London has important Research Institutions, which includes four divisions as follows.

The first institute, known as Grantham Institute, deals with climate change and the environment. The second institute works on molecular science and engineering. The next one is active in the field of security science and technology and, finally, there is the Francis Crick Institute.

This collage needs to invest more in various fields of science and humanities if its authorities intend to complete with other advanced colleges in the world.

4.10.8.1 ITRCs of Imperial College London

The Francis Crick Institute	
Parent university	Imperial College London
Acronym of ITRC	Unassigned
Country	United Kingdom
Year founded	1/1/2016
Kind of ITRC	Research Institution
Type of partnerships	Independet/Free-standing
Current activities	Research and Education
SDGs	Unassigned
Name of building	The Francis Crick Institute
Address of physical place	1 Midland Road, London NW1 1AT
url of project	https://www.crick.ac.uk

Table 4.40: The Francis Crick Institute

- Educational activities: ”PhD programme, PhD studentships, summer

student programme, 12-month sandwich(*), master's and undergraduate thesis"

- Areas of focus in research/research theme: "Biochemistry and Proteomics, Cell Biology, Cell Cycle and Chromosomes, Chemical Biology and High Throughput, Computational and Systems Biology, Developmental Biology, Ecology, Evolution and Ethology, Gene Expression, Genetics and Genomics, Genome Integrity and Repair, Human Biology and Physiology, Imaging, Immunology, Infectious disease, Metabolism, Microfabrication and Bioengineering, Model organisms, Neurosciences, Signalling and Oncogenes, Stem Cells, Structural Biology and Biophysics, Synthetic Biology, Tumour Biology"
- Vision/outreach/agenda: "ambition is to discover the biology underlying human health, improving the treatment, diagnosis and prevention of human disease, and generating economic opportunities for the UK".
- Mission/Assignment: "helping to understand why disease develops and to translate discoveries into new ways to prevent, diagnose and treat illnesses such as cancer, heart disease, stroke, infections and neurodegenerative diseases".
- Fund: "Partnership Networking Fund, Government confirms UKCMRI funding"
- Affiliation: "Medical Research Council (MRC), Cancer Research UK, Wellcome, UCL, Imperial College London and King's College London"

- Educational activities: "PhD Science and Solutions for a Changing Planet, Msc Climate Change, Management and Finance, Online Learning: Clean Power Programme, Research Experience Placements, Research Making a Difference"
- Areas of focus in research/research theme: "Climate Science, Earth and Life Sciences, Energy and Low-Carbon Futures, Economics and Finance, Resources and Pollution, Health"

Grantham Institute - Climate Change and Environment	
Parent university	Imperial College London
Acronym of ITRC	Unassigned
Country	United Kingdom
Year founded	1/1/2007
Kind of ITRC	Research Institution
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Grantham Institute Imperial College London
Address of physical place	Exhibition Road, South Kensington, London SW7 2AZ
url of project	https://www.imperial.ac.uk/grantham/

Table 4.41: Grantham Institute - Climate Change and Environment

- Vision/outreach/agenda: "A sustainable, resilient, zero-carbon future".
- Mission/Assignment: "To contribute to, and lead on, world-class research, training and innovation towards effective action on climate change and the environment".
- Fund: "Unassigned"
- Affiliation: "Imperial staff associated with the Institute who are driving forward research in climate change and the environment"

Grantham Institute - Climate Change and Environment	
Parent university	Imperial College London
Acronym of ITRC	Unassigned
Country	United Kingdom
Year founded	1/1/2007
Kind of ITRC	Research Institution
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Grantham Institute Imperial College London
Address of physical place	Exhibition Road, South Kensington, London SW7 2AZ
url of project	https://www.imperial.ac.uk/grantham/

Table 4.42: Grantham Institute - Climate Change and Environment

- Educational activities: "Masters in Research"

- Areas of focus in research/research theme: "Molecular Science and Engineering, Clean water, Fight infection, Clean green energy"
- Vision/outreach/agenda: "To achieve enduring excellence in research and education at the interface of molecular science and engineering, for the benefit of society".
- Mission/Assignment: "Accelerating innovation by transcending disciplinary boundaries in engineering, science, medicine and business to transform research and education".
- Fund: "Unassigned"
- Affiliation: "Unassigned"

Institute for Security Science and Technology	
Parent university	Imperial College London
Acronym of ITRC	Unassigned
Country	United Kingdom
Year founded	1/1/2008
Kind of ITRC	Research Institution
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Level 2 Admin Office, Central Library
Address of physical place	South Kensington Campus, London SW7 2AZ
url of project	https://www.imperial.ac.uk/security-institute/

Table 4.43: Institute for Security Science and Technology

- Educational activities: "MSc Security and Resilience: Science and Technology, PhD opportunities"
- Areas of focus in research/research theme: "Financial Systems, Healthcare and Medical Devices, Climate and Environmental Security, Biosecurity, Critical Infrastructure"
- Vision/outreach/agenda: "Geo-political uncertainties, climate change and changing cyber and physical attack methods give rise to a constantly evolving security landscape. We envisage, design and coordinate the application of science and technology to answer the grand security challenges raised".

- Mission/Assignment: ”We coordinate interdisciplinary and trans-disciplinary research in security across Imperial College London. We further act as a security science, technology and innovation interface for academia, government and industry”.
- Fund: ”Unassigned”
- Affiliation: ”backbone of the Institute”

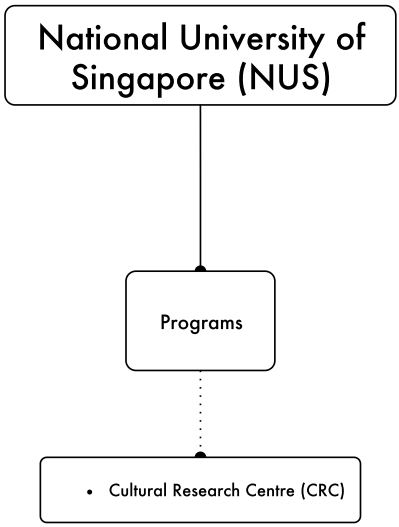


Figure 4.16: List of ITRCs within the National University of Singapore (NUS)

4.10.9 Flowchart of ITRCs within National University of Singapore (NUS)

The provided flowchart demonstrates that only one interdisciplinary Program center CRC has been holding within the National University of Singapore (NUS). Nevertheless, it is clear that this university is a new ITRC founder and needs to pay greater attention to running more ID/TD research centers.

4.10.9.1 ITRCs of National University of Singapore (NUS)

Cultural Research Centre	
Parent university	National University of Singapore (NUS)
Acronym of ITRC	CRC
Country	Singapore
Year founded	1/1/2019
Kind of ITRC	Program
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	Department of Communications and New Media
Address of physical place	Faculty of Arts and Social Sciences, National University of Singapore, Blk AS6, 03-41, 11 Computing Drive, Singapore 117416
url of project	https://blog.nus.edu.sg/cnmcrc/

Table 4.44: CRC

- Educational activities: "collaborative lab workshops, public seminars"
- Areas of focus in research/research theme: "industry, government, cultural sectors and community groups, and involves concrete modes of action and intervention"
- Vision/outreach/agenda: "Unassigned".
- Mission/Assignment: "is to promote, incubate and advance multi- and cross-disciplinary cultural research that is engaged and grounded in Singapore and/or Asia".

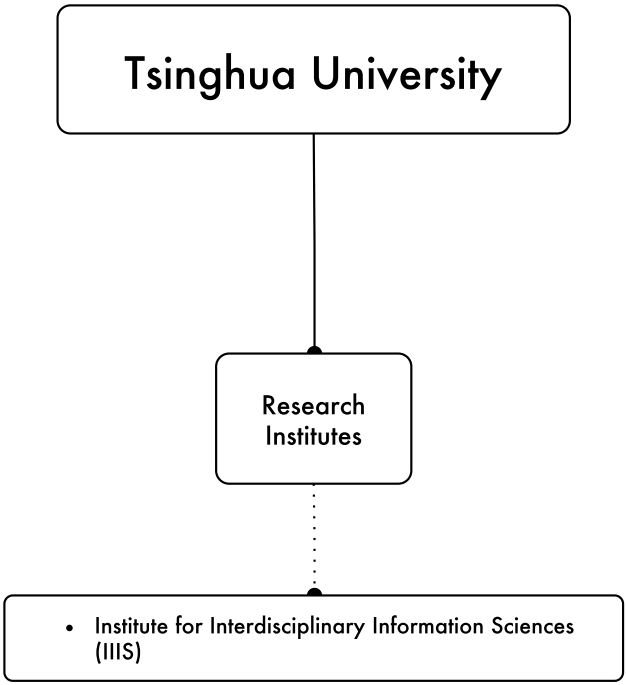


Figure 4.17: List of ITRCs within the Tsinghua University

4.10.10 Flowchart of ITRCs within Tsinghua University

The flowchart describes the ITRC supported by Tsinghua University. The Institute for Interdisciplinary Information Sciences (IIIS) is the single inter/transdisciplinary Research Institution that is founded by this academy. All in all, this university expected to designate a bit more funds to lunch more research centers.

4.10.10.1 ITRCs of Tsinghua University

Institute for Interdisciplinary Information Sciences	
Parent university	Tsinghua University
Acronym of ITRC	IIIS
Country	China
Year founded	12/30/2010
Kind of ITRC	Research Institution
Type of partnerships	Interdepartmental /Associated with University/institute-wide/Cross-school
Current activities	Research and Education
SDGs	Unassigned
Name of building	FIT Building
Address of physical place	1-208, Tsinghua University, Beijing, China 100084
url of project	https://iiis.tsinghua.edu.cn/en/

Table 4.45: IIIS

- Educational activities: "Academic programs such as Master"
- Areas of focus in research/research theme: "Theoretical Computer Science, Quantum Information, Security Computing, Network Science and Machine Intelligence"
- Vision/outreach/agenda: "aims to become one of the leading research centers on interdisciplinary information sciences in the world as well as to offer a habitat for the research and education of computer science and quantum information science in China".

- Mission/Assignment: ”devoted to promoting the innovative development of information science and cultivating the next generation of scientific talents with extensive background knowledge in China”.
- Fund: ”Unassigned”
- Affiliation: ”Theoretical Computer Science (ITCS), Center for Quantum Information (CQI), Tsinghua-Ant Joint Research Laboratory for Digital FinTech (JRLDF), and Tsinghua University-China Quantum Technologies Corporation Joint Laboratory for Quantum Network (JLQN)”

4.11 Discussion

It is evident that there has been hardly any field of research aimed at compiling a list of interdisciplinary and transdisciplinary study centers, or ID/TD research centers and reviewing other cases in order to explain success and failure of the centers. The results indicate that excluding MIT (see 4.8), Oxford (see 4.12) and ETH Zurich (see 4.14), the other universities do not offer their researchers and students more than three types of research centers; subsequently, they have to dedicate more budgets to the establishment of new research centers. The study demonstrates a correlation between ranking the universities and having interdisciplinary and transdisciplinary research centers and as the ranking goes up, the number of centers increases. The analysis reaffirms the demands of this century's interdisciplinary and transdisciplinary approaches, since challenges are so complicated, and emphasis on a specific discipline or cross-disciplinary is not enough to address the issues. The data suggest that ITRCs needs to be more precise in kind of educational approaches want to step forward for educating the next generation of students and teach them how they can interact with different disciplines and skills.

4.11.1 Interpreting the Data

The result of two word-clouds on the focus areas (see 4.6) and the educating systems (see 4.7) of the 140 ITRCs, severely responds the aim of important strategies ongoing within the ITRCs according to my major research question (see 1.5). As the word-cloud of focus area was self-explanatory, the most frequently used words were more highlighted like "Science" and "Engineering". On the other side, in educating systems word-cloud, ITRCs provided their students with diverse types of activities, which "Programs" and "Master" posses the highest frequency as 81 and 48 respectively. Despite the fact, "Non-educating" placed as a third repeat word with 44 times reputation. The findings of current activities at the 140 ITRCs (see4.5, it can be easily inferred that the proportion of research and education activities is approx-

imately 23 times as great as that of education, and four times as big as the proportion of research. The correlation between "Non-educating" word frequency as a third position and "Ratios of education" with approximately 100 centers out of 140 strongly demonstrates that ITRCs approached to having educational plan but needed to be more precise in which kind of educational system they want to step forward for training their students or researchers and does not mean that the centers have not attended to it. Overall, it indicates that, as a discipline is more important, more expertise is incorporated to address the issue.

One of the sub research questions is a clear definition for ID and TD center which is obtained during the exploration of the 140 ITRCs within the top ten universities. Each center reacts to solve its problems based on the kind of required disciplines and the answer to the question is deprived of digesting "Missions" and "Visions" of these centers. The description of the two keywords helped me to the trade-off between the meaning of interdisciplinary and reaction as an interdisciplinary. According to definition of inter/trans-disciplinary (see2.1) and explanations of mission and vision of ITRCs (see4.10), this particular definition might not only fit a discipline-scale in research centers, but also it could be appeared on the human-scale in people lives. Support the idea of (Guimarães et al., 2019, p.3) "An intertwined question is how someone starts to think and feel as an ITD individual". Throughout my research, I also found myself as an interdisciplinary person, as I had to deal with many unfamiliar devices, apps, coding, and new subjects.

The results regarding who are the world's ID/TD leading success centers is presented in the world infographic result (see 4.3). The United States of America has a remarkable number of centers and is a leading country for interdisciplinary and transdisciplinary centers and the next pioneer countries are the UK and Switzerland respectively. Nonetheless, in the world, there are many other ITRCs that do an important job for ID/TD and their efforts can not be neglected. The limitation of the result (see 4.4) is that the USA placed over 90 ITRCs because four out of ten top ten universities are located inside this country and just the Massachusetts Institute of

Technology (MIT) posses 58 of them. The scale of success for ITRCs is not considered for one center but it is assumed based on the leading university.

The kind of activities to understand indicators of success/failure of centers and how it could be measured is another subcategory of the thesis research question. The findings of the qualitative and quantitative study answer this question from the list of attributes. (see 3.1). As a center has done more publications activities and attempted to bind the center with more affiliations (see 4.10), the Centre's success will be greater. A year of foundation is another important reality that can impact the success of a research center (see 4.2). The effect of foundation's year in a center is conditional meanwhile if a center was established for a long time, it means that this center has gathered much more accurate disciplines and becomes an expert to lunch an inter/trans-disciplinary project. In line with the hypothesis of success/failure, the number of participants and facilitating researchers inside the center were effective. Regarding the failure of ITRCs, it is quite complicated to assess the failures, because delving a failure will not have happened until you will be a member of an ID/TD project or either survey expertise of a center. There is also a lack of common understanding and a particular interpretation as a reason for interdisciplinary and transdisciplinary failure, and cooperation takes a longer time.

4.11.2 Acknowledge the Limitations

Delimitations are features that can restrict the study parameters under the researcher's control (Simon & Goes, 2011). In this section, limits are given to remind the readers about the area covered and not covered by this analysis.

The generalizability of the results is limited by the number of ITRCs that is valued during the project. In the sense of qualitative and quantitative data of success/failure, these results might not have enough impact on the clear rules for assessment. Because there are a large number of ID/TD research centers around the globe that are running nonstop of generating effective

interdisciplinary and transdisciplinary and this thesis could not cover all these centers. Thus, the larger the number of ITRCs, the more one can generalize the results. Moreover, the assessment of the ITRCs failure was beyond the scope of this study, as it is better to examine a failure closely and in detail of the centers with spending more time on it.

The reliability of these results is influenced by the assessment of the 140 ITRCs in the 10 top universities in the world. Since the top ten institutions have always been a leader in generating knowledge and contributing it to the industry, their authenticity has been proven. Accordingly, picking up the centers from these universities guarantees the produced data.

Due to the lack of available data, the results on the year of foundation (see 4.2 cannot confirm that always years of the foundation is a valid character for a way of success/failure. Despite the fact, that year of foundation is one of the indicators of success/failure of an ITRCs, a common understanding of a particular interpretation about ID/TD research takes a while. The fact is that some centers had established since long time ago and tried to integrating disciplines to have a clear vision of a project, but the process consumes a long time and it does not demonstrate success/failure. Therefore, the lack of pieces of information on their websites is an unexpected obstacle that emerged during my research process and is caused by less validity of the result.

The methodological choices were constrained by interdisciplinary and transdisciplinary research centers within the ”Top 10 Universities” since any ITRCs from outside of the frame was not admitted. In the quantitative and qualitative analysis, some of the other limitations in the methodology became essential characteristics of the case classification which must be reliable and not shielded out of boundaries.

It is beyond the scope of this study to delve rational strategies that are in process in universities that are fostering ID/TD research centers. Although, there are more indicators of these centers that could be measured to figure out proper findings in this research.

4.11.3 Recommendation

Further research is needed to establish more ITRCs not only within the universities ranking but also from out of institution' rankings. My experience during the assessment of centers and concerning the crucial research questions (see 1.5), has proved that ITRCs which are not directed within an heading university, typically works on "Studies" of interdisciplinary and transdisciplinary research which means that these kinds of centers usually intend to find a solution to implement the disciplines appropriately not to unified disciplines such as math, engineering, science altogether to lunch an ID/TD center and develop a particular goal. By pasting these research centers, most of the findings would be altered. There is an important exploit for me that I feel like to state it before any other researcher desires to follow the analyses. The keyword of "Studies" for ID and TD within the research centers was so fundamental during the exploration a new ITRC. Based on my methodology (see 3.1), I began to find out ITRCs inside the top ten universities and I did not use the keyword "Studies". The result in the google search engine popped up any kind of ID/TD research within the university which was proper for my aim but there should be an ID/TD research center that belongs to "Studies" of ID/TD. The difference between these two kinds of ITRCs is that one works on a distinct goal and the other works on finding a way to run an ITRC.

Further research is needed to determine the effects of nonmutual cooperation on solving-problems in ITRCs.

Future studies should take into account the reasons "Why" the ITRCs that attended the educational system (see4.5 have not been precise in kind of educational plan or training, not only among the academic areas but also within non-academic boundaries. To respond 'Why', I believe that the situation is changing dramatically in our society and why these centers prefer to integrate more ordinaries is that probably expertise has a meaningful influence on problem-solving. Moreover, it is not a place to prepare but it is a place to grab and tackle issues. The amount of funding a center can

receive could be other claims of these centers' disagreement since, if they work on less care discipline, fewer investors will probably find it interesting.

5

Conclusion

The research performed in this thesis is part of the TrUST project (Sonetti, n.d.), that aims better understand current strategies for inter/trans-disciplinarity at the Interdisciplinary/Transdisciplinary Research Center (ITRCs). The first objective of this thesis was to investigate empirically what policies have been established among the first 10 "THE" ranked universities to activate ITRC. 140 ITRCs were added to enlarge the sample.

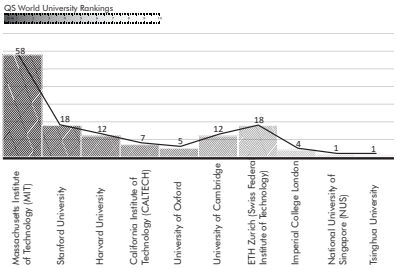


Figure 5.1: The total number of ITRCs inside the top 10 first academic institutions around the globe (see 4.2).

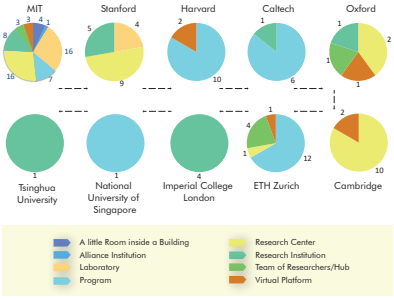


Figure 5.2: The different kinds of ITRCs one per color within the top 10 universities. The number against the color indicates the different quantity per each research center. (see 4.3).

The results determined a correlation, between ranking of the universities and 140 ITRCs, 'as the Number of Centers Rises, the Ranking is Rising' (fig 5.1). Moreover, if the low ranking universities intend to compete with the high ranking ones, they are required to allocate more budgets for employing more researchers. Excluding MIT, Oxford, and ETH Zurich, most universities have at least 3 kinds of research centers, as shown in (fig 5.2). Consequently, they have to devote more budget to establishing new research centers.

The second objective was to find out a shared definition of Inter-Disciplinary and Trans-Disciplinary research as meant by these centers. Results showed that the mission and vision of most of the centers are strongly connected to the willing to be Inter/Trans-disciplinary, but not always translated into effective collaborative practices (see 4.10). Plus, the label of ITD may not only fit within a discipline-scale but also at individual and human-scale, thus making it difficult to detect via a computational tool / quantitative data analysis. For these reasons, further work envisages to couple the results of this thesis with qualitative data resources, engaging with single researchers at different roles within the same centers.

The findings of this thesis concerning the third question of who are the world-leading countries of ITRCs indicate that the the United States of America, with over 90 ITRCs, has a striking position in the world ranking for ITD centers, followed by UK and Switzerland (fig 5.3).

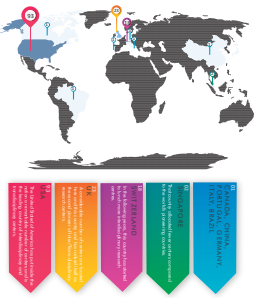


Figure 5.3: World map infographic of 140 ITRCs (see 4.4).

This thesis provides the framework to understand what could be indicators of success/failure of research centers and how it could be measured. Depending on the context, factors such as mission, vision, year of foundation, publications, affiliation, the main topic could behave either positively or negatively for effective ITD. In most of the cases, there are not dedicated educational / training activities for ITD scholars, although on the website, universities state they have some.

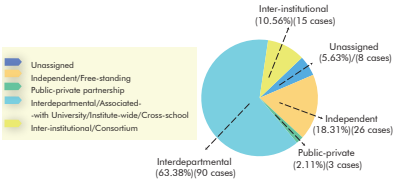


Figure 5.4: Type of partnerships between 140 ITRCs (see 4.5).

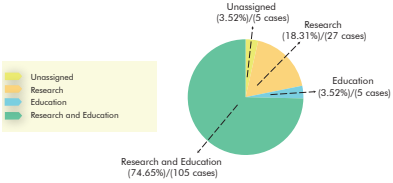


Figure 5.5: Current activities at the 140 ITRCs (see 4.6).

The kind of partnership in between ITRCs (fig 5.4), shows a high percentage of connections and low percentage of ones. In general, it is an undeniable fact that, in most ID and TD centers, different kinds of departments need to have collaborated with one another, consequently, this type of communication comprises the biggest ratio.

Research and Education activities (fig 5.5) are approximately 23 times greater than Education ones, and four times bigger than Research ones. All in all, it can be easily inferred that the proportion of research and education activities is approximately 23 times as great as that of education,

and four times as big as the proportion of research.

	Unassigned	1920-1930	30-40	40-50	50-60	60-70	70-80	80-90	1990-2000	2000-2010	2010-2020
MIT	**14**	-	-	**4**	**2**	**3**	**8**	**6**	**4**	**13**	**3**
Stanford	**8**	-	-	-	**2**	**1**	-	**2**	**2**	**1**	**2**
Harvard	**9**	-	-	-	-	**1**	-	-	**1**	-	**1**
Caltech	**1**	**2**	-	-	**1**	**2**	-	-	-	-	**1**
Oxford	-	-	-	-	**1**	-	-	-	-	**1**	**2**
Cambridge	-	-	-	-	-	-	-	-	-	**4**	**6**
ETH Zurich	**10**	-	-	-	-	-	-	-	**1**	**3**	**4**
Imperial College London	-	-	-	-	-	-	-	-	-	**2**	**2**
National University of Singapore	-	-	-	-	-	-	-	-	-	-	**1**
Tsinghua University	-	-	-	-	-	-	-	-	-	**1**	-

Table 5.1: Table of the foundation year for 140 ITRCs within the 10 universities (see 4.7

The table demonstrates the establishment period of the 140 ITRCs within the top ten leading universities. In recent years, the number of ITD centers is increasing, meaning that universities are gradually understanding the need for a mission-based approach, and therefore an ITD capacity building inside existing structures.

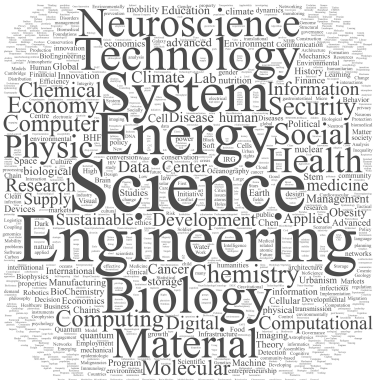


Figure 5.6: Word-cloud of focus areas of the 140 ITRCs (see 4.8).

Figure 5.7: Word-cloud of the most approachable educating systems of the 140 ITRCs (see 4.9).

The word cloud in (fig 5.6) compares 140 centers for ID and TD studies all over the world and emphasizes the number of words used frequently in the studied centers. ITRCs principally focus on science, engineering, energy and system, biology, technology, material, health, neuroscience, physics. More rarely the focus is on climate change, cancer therapies, management studies,

etc.

The diversity of educational activities that ITRCs have offered to their students and researchers in (fig 5.7). Such centers have provided their students with diverse types of activities which are arranged in descending order from programs, which have the highest frequency, to non-educating, which is offered just in 8 centers.

The study of academic literature on ITD issues shows that several discourses and interpretations occur in engaging with ID and TD definitions. Interdisciplinary and Transdisciplinary Research in scholarly literature is described as: a) conceptual and analytical research topic; b) a working method (needing process traceability); c) a phenomenon prone to change in history and geography.

One way to tackle this diversity was to classify the definition of what, how, where, where, why ITD was happening (see 3.1.3.2). The ITRCs which is not governed within a heading academy usually acts on "Studies" of interdisciplinary and transdisciplinary research, instead of practice it. These kinds of centers normally aim to integrate effectively the different disciplines, not to put them in hierarchy toward a specific research purpose.

While the number of ITRCs limits the generalizability of the results, this thesis provides new insights for assessing the impacts of interdisciplinary and transdisciplinary research centers' over the academic institutions' performances.

Based on these conclusions, we can suggest that ITRCs aspiring for a long-term strategy of ITD educational system should open up methods and contents of ITD-tailored course, not only for the academics but also for non-academic people. To better understand the implications of the thesis' results, future studies could address at what degrees does the factors analised do affect the success and/or failure of an ID and TD research, enlarging the sample to non-academic ITRCs. In addition, an interesting area

for dynamic decision making both at individual and at research centre scale is related to the degree of networks cooperation.

In general, this study has contributed to the literature about ITD by pointing out the narratives coming into place after quantitative analysis on open public sources.

Articles only

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