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Current Trends in Scientific Instrumentation for Conservation Practices and Research: Lessons from an International Survey

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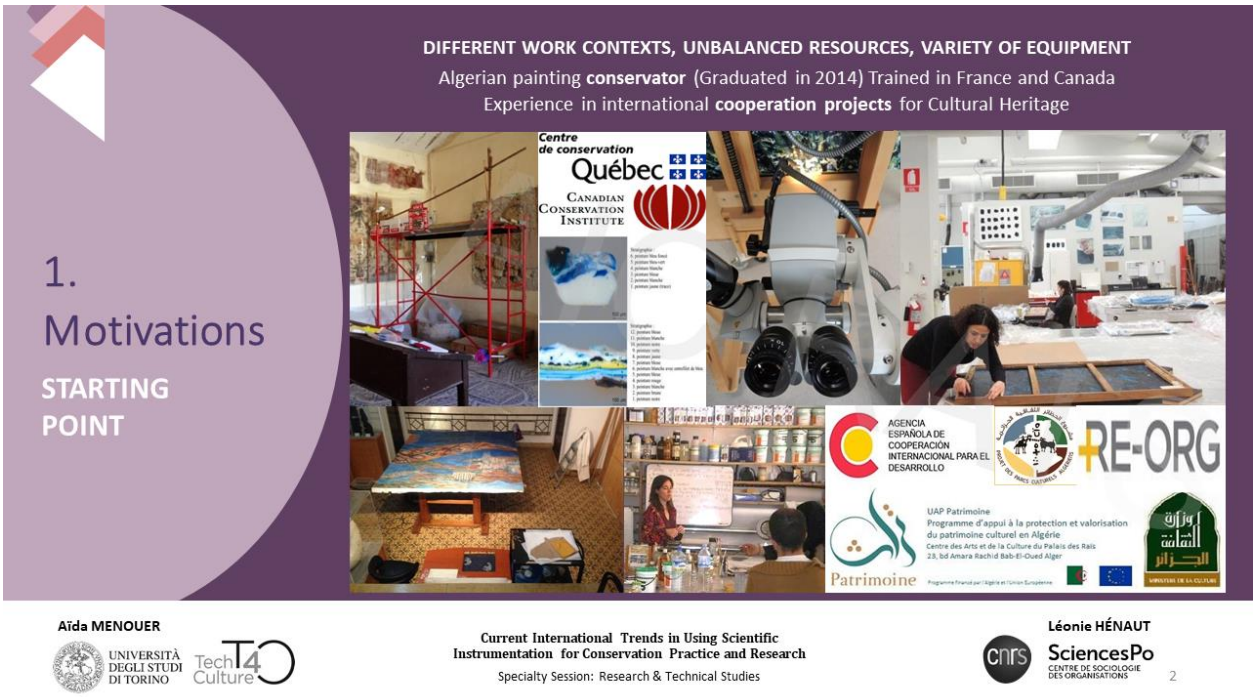
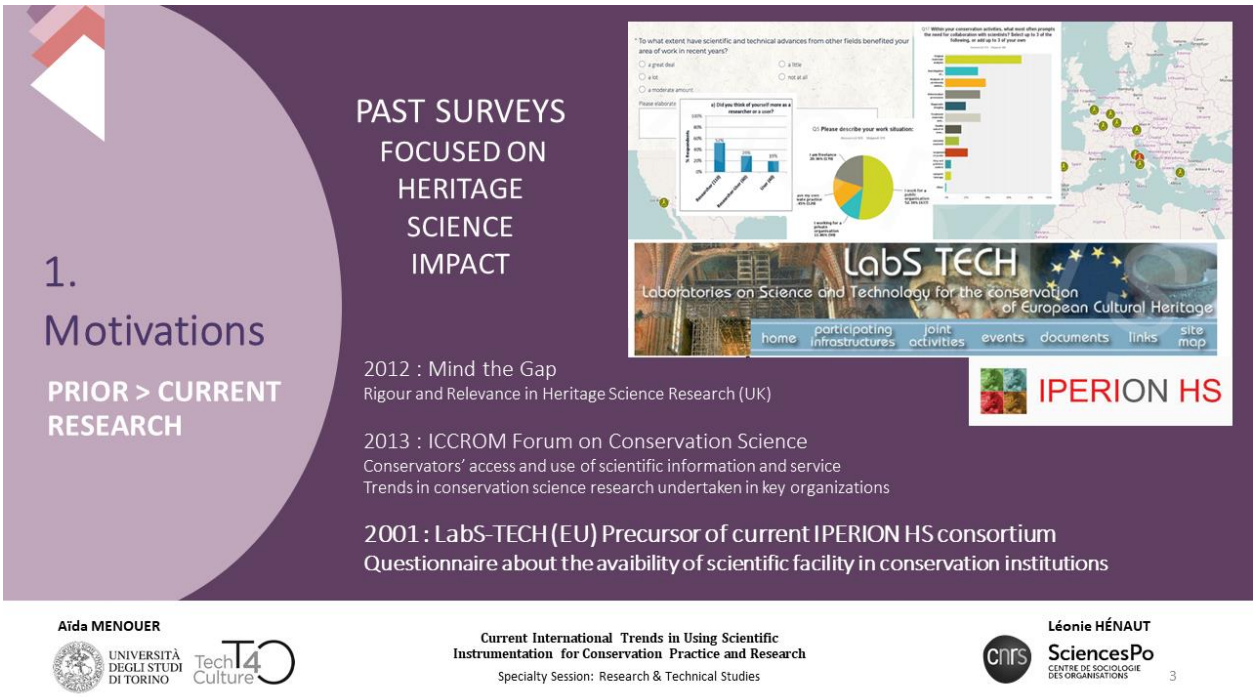
Annotated Presentation

Good afternoon, I am Aïda Menouer. My presentation is based on an international survey on the use of scientific instrumentation for conservation that I have conducted as part of my PhD dissertation. Before I start, I would like to acknowledge the contribution of my co-author, Léonie Hénaut, who is a sociologist. She helped me with the analysis.

In this talk, I will first present the motivations behind such a survey; second, the methodology; third, the most important findings from the statistical analyses.



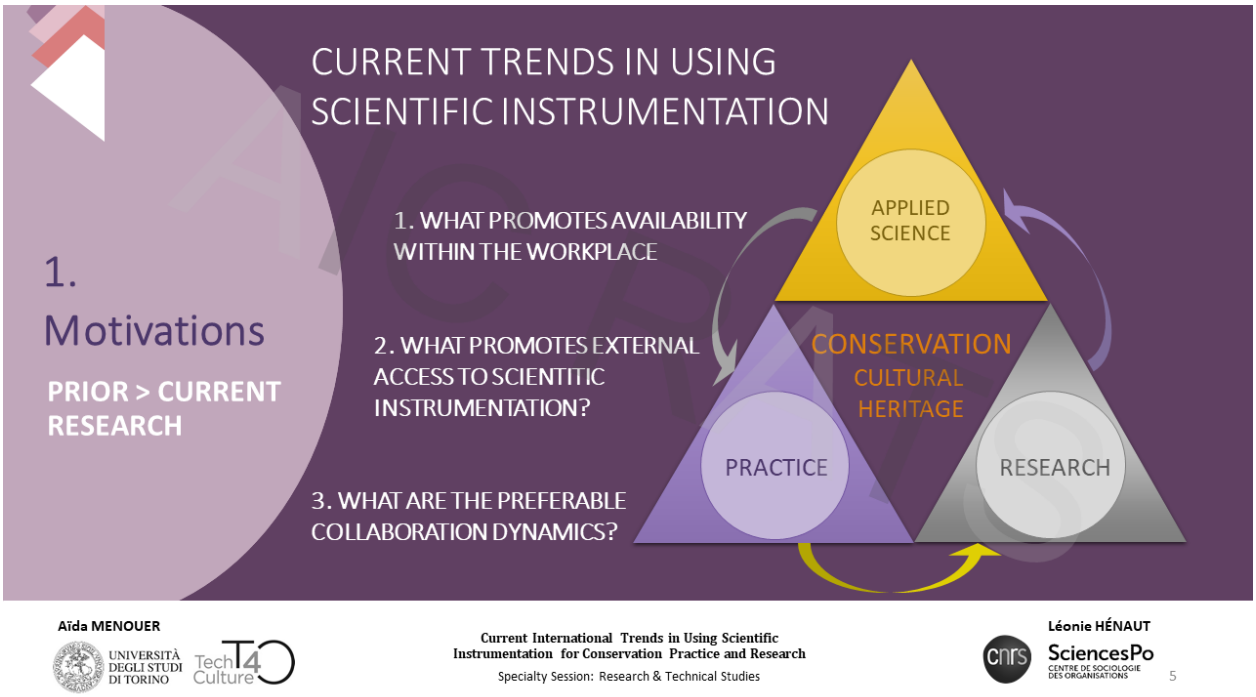
Let me first explain how I came to the realization that I wanted to study scientific instrumentation for conservation and its variations across the globe. Well, I am an Algerian painting conservator, I have been trained in France (I joined one of the elite Master programs in conservation at Sorbonne University) and in Canada (I was an intern at the Centre de Conservation du Québec). During my studies and early career, I have been exposed to very different work contexts, unbalanced resources, and a variety of equipment – from the smallest conservation private practice studio I had in Algeria, with scarce technological resources, to the most ambitious research centers, with international cooperation projects and high-tech equipment. Witnessing such variation was intriguing or even disturbing to me. Was there any minimum equipment required to do conservation practice and research? How do conservators and conservation researchers get their work done?



Past surveys mainly focused on studying the impact of scientific research on conservation practice. I refer here to two initiatives: in 2012, the "Mind the Gap" project aimed at assessing the rigor and relevance of heritage science collaborative research in the UK; in 2013, an ICCROM forum has been devoted to the global issues encountered in conservation science. To our knowledge, the only survey which aimed at describing and assessing scientific instrumentation in conservation practice has been conducted in 2001, in the context of the European Collaborative Project Labs-Tech that was the precursor of the current project IPERION HS. This 2001 survey targeted 114 institutions located in 26 countries, most of them in the Global North.

In our study, we propose to go further in the understanding of conservation practice and research facilities by extending prior research in two directions:

- First, we propose to include emerging countries to get a better picture of the global distribution of scientific instrumentation, beyond the usual focus on Northern and highly developed countries.
- Second, we propose to go beyond a descriptive inventory of scientific instrumentation to include the study of the variations in their availability, and therefore understand to what extent these variations are associated with particular collaboration dynamics.

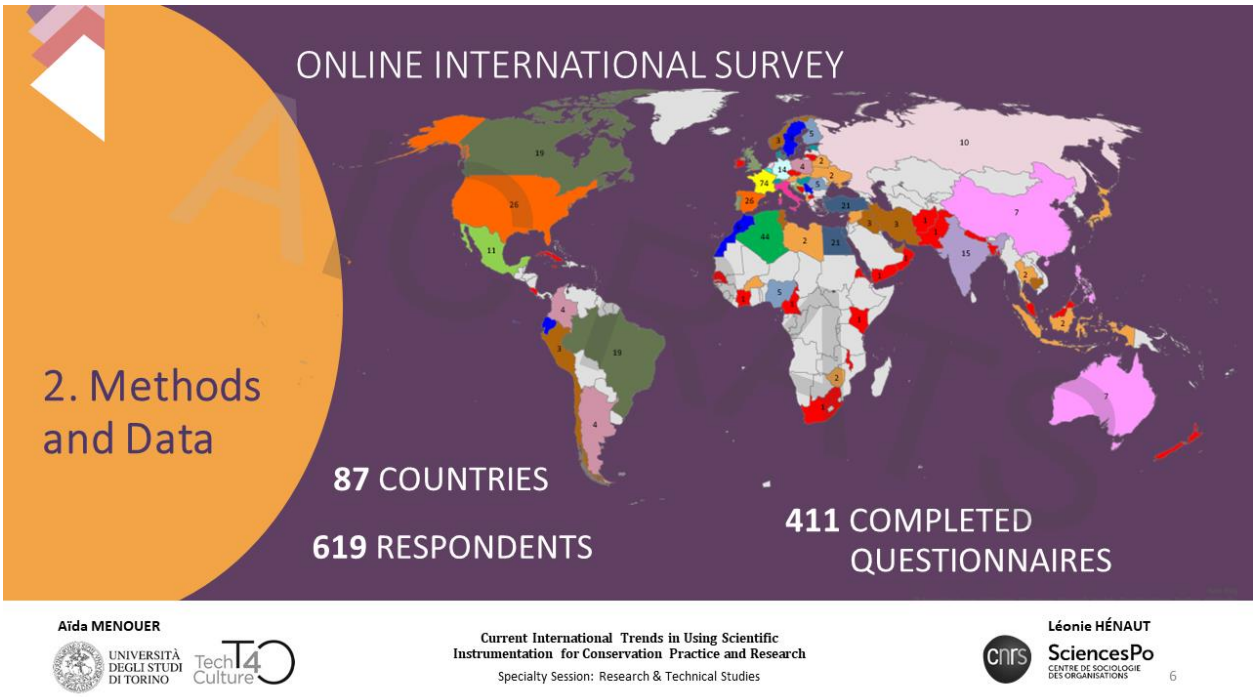


We approach conservation as a network of activities, instrumentation, professionals and workplaces that are at the crossroads of conservation practice (in which actors solve practical conservation issue), research (in which actors produce knowledge), and applied science (in which actors use research findings to support practitioners' interventions).

In this project, we are investigating the interactions between these three spheres of activity, through the examination of the instrumentation used in conservation workplaces.

More precisely, we are going to address three questions:

- What promotes the availability of scientific instrumentation within conservation workplaces?
- What facilitates the access of scientific instrumentation outside the conservation workplace, in other facilities?
- What are the most desirable collaboration dynamics between conservation workplaces in terms of scientific instrumentation accessibility?



Through an international online survey in 2021, I managed to collect contributions from 619 respondents (or 619 conservation workplaces) located in 87 countries, of which 411 completed questionnaires in a way that was satisfying for the purpose of the statistical study. Obviously, one has to keep in mind that any survey would provide only a snapshot of the reality we would like to study.

The surveyed population was defined as follow: the professionals who may be concerned with scientific and technological applications in their practice for the conservation of cultural property, which ranged from conservators, conservation scientists, heritage architects or engineers, curators or field archaeologists, to any other potential "user" of conservation equipment and scientific instrumentation.

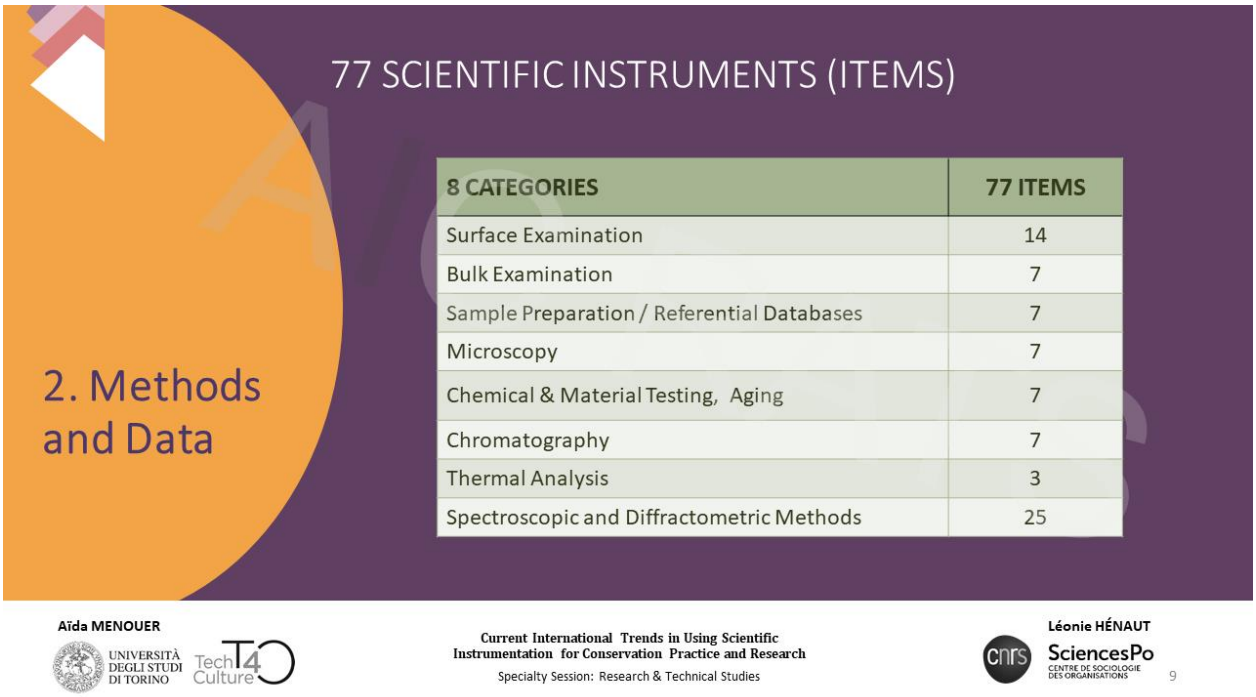
Snowball sampling method was used for three months, from March to November 2021.

Online questionnaire was translated and disseminated in seven languages, with:

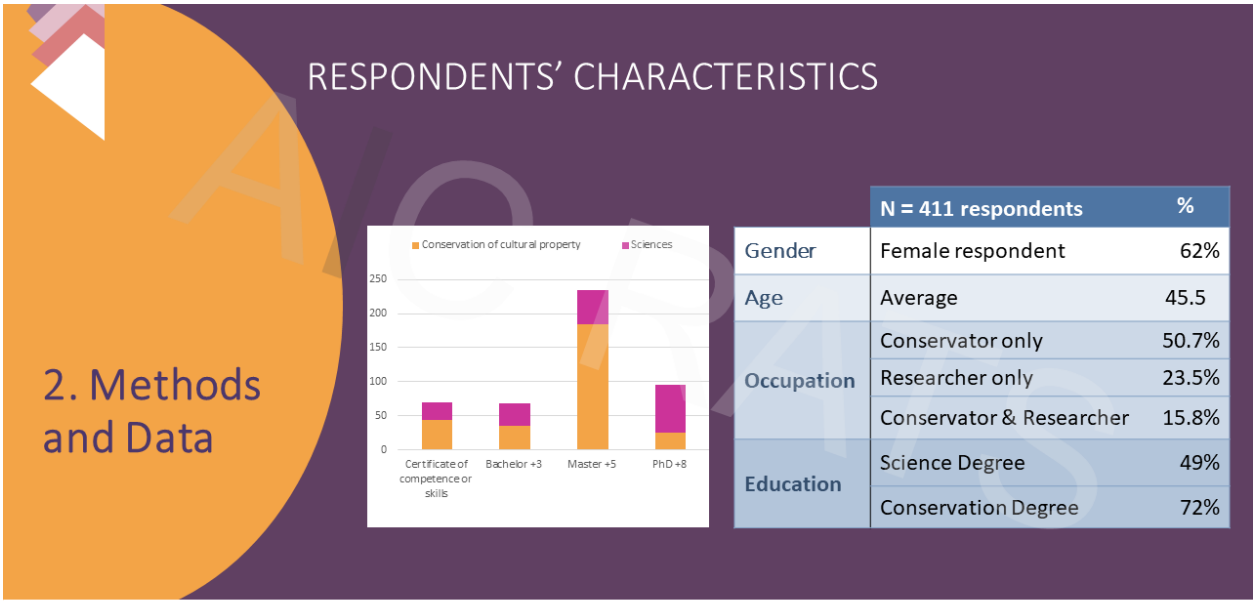
- 2775 two thousand seven hundred seventy-five emails were sent;
- 64 sixty-four associations reached;
- 40 forty social media posts published;
- and 242 two hundred forty-two messages were distributed on Facebook and LinkedIn.

Unfortunately, the American Survey Software used Alchemer® which had a negative and unexpected impact when applied to USA Sanctioned countries such as Cuba, Democratic Republic of Korea, Iran, Sudan, and Syria. This effect was mitigated by sending PDF-fillable forms to participants from these countries and responses have been collected from Syria, Iran and Cuba.

On average, respondents took 25 minutes to answer the questionnaire, which unfolds in five sections and totals 33 questions. While the first two sections are related to the workplace characteristics and the type of activities performed in the workplace, the last two are related to the respondents' profiles and their opinions. The third section represents the core of the questionnaire, as it includes a fairly exhaustive long list of 133 conservation equipment and scientific instrumentation. For each of them, respondents had to answer the following questions: is this equipment accessible in your workplace? (Yes/No). If not, do you access this equipment outside your workplace in another facility? (Yes/No).

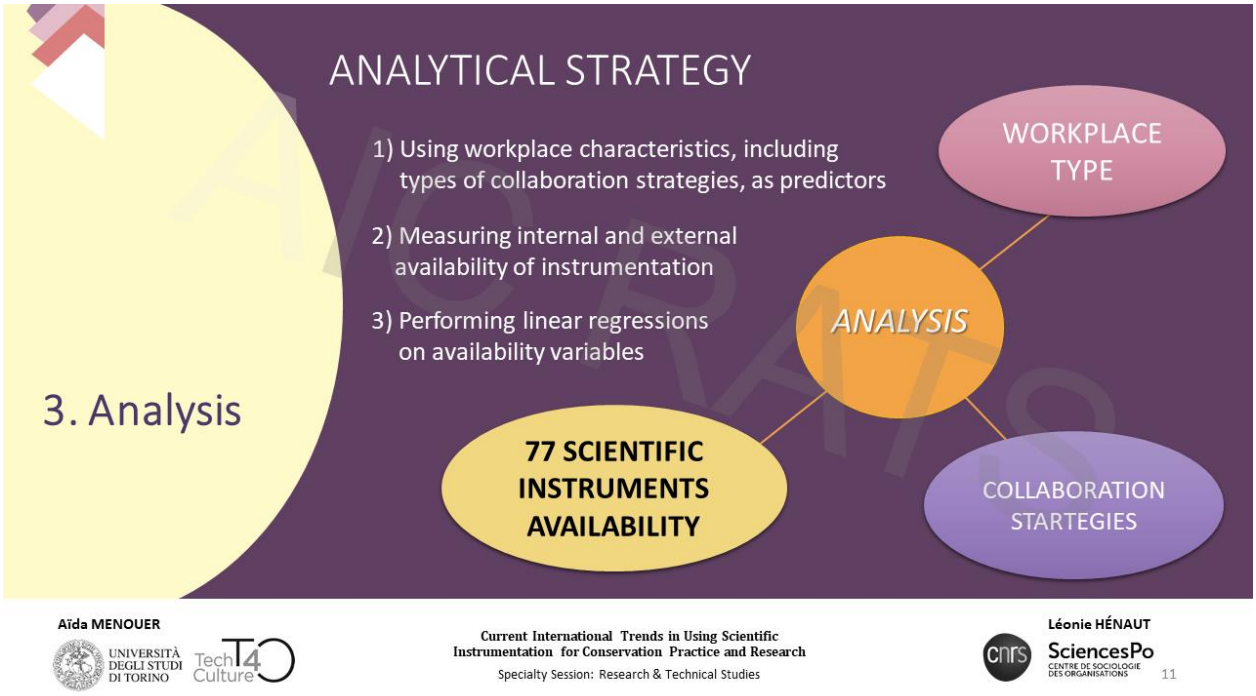


Our analysis here focuses on 77 instruments, which are scientific instruments used in conservation research. They are grouped into 8 categories. Here, the second column shows the number of items in each category.



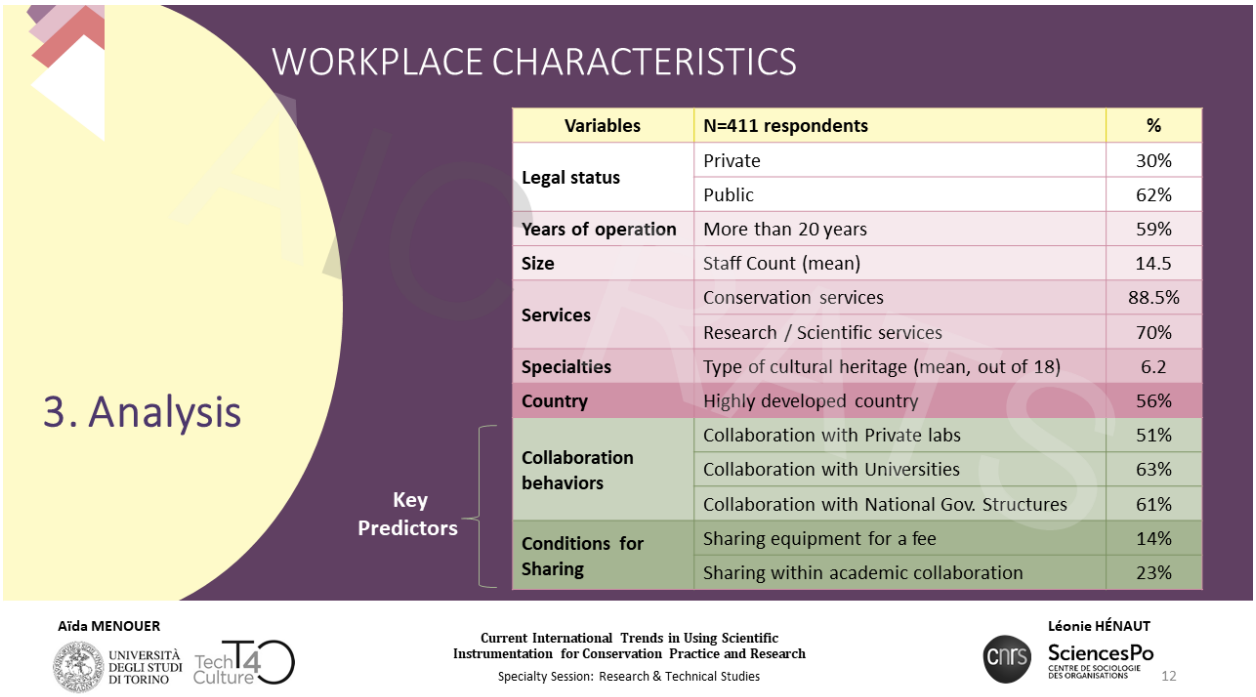
Before we go on with the analysis, let me present the respondents' characteristics. Survey respondents (N=411) are mostly female (62%), with an average age of 45.5 years; 50.7% are conservators only, 23.5% are researchers and 15.8% declared having both occupations. 49% of

respondents hold science degrees (typically, a Master degree or a PhD) while 72% hold conservation degrees (typically, a Master degree).



The analysis now focuses on the inter-relational dynamics of the following elements: workplace type, collaboration strategies, and the availability of scientific instruments.

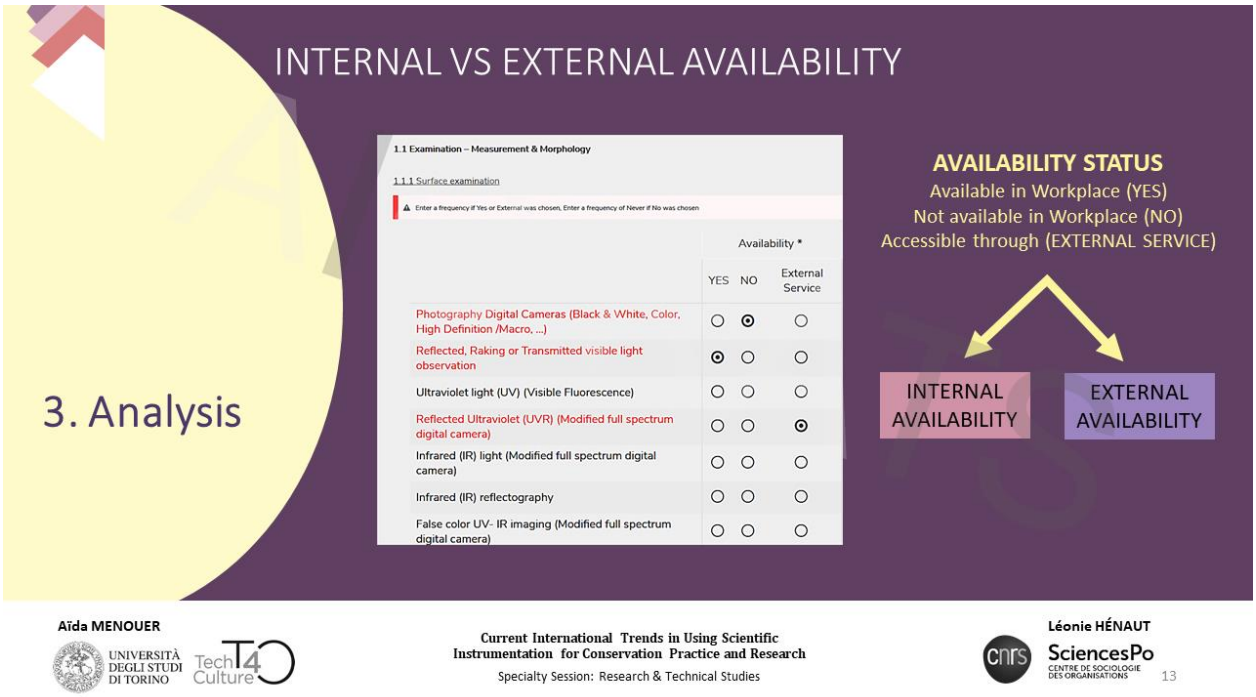
- In the rest of the talk, I will first describe respondents' workplace characteristics, including types of collaboration strategies. These will serve as predictors in my analysis.
- Second, I will show how we measured internal and external availability of 77 instrumentation, which will be our dependent variables.
- Last, I will present our results from linear regressions performed on availability variables.



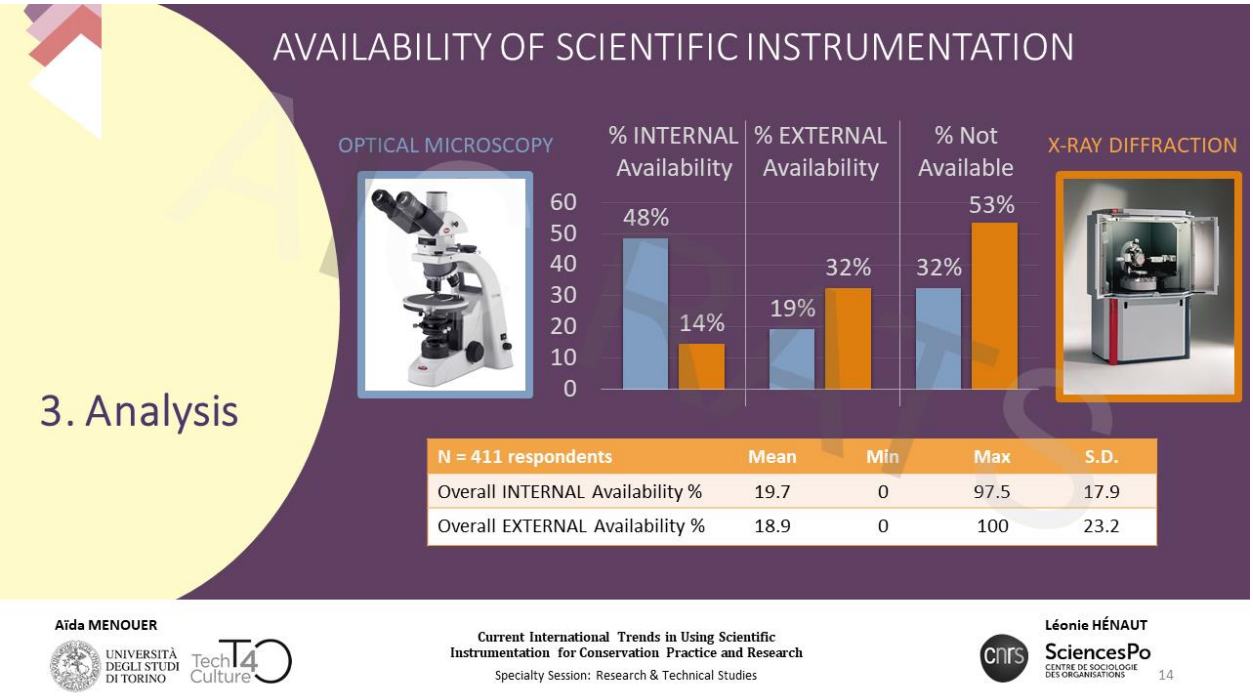
Variables	N=411 respondents	%
Legal status	Private	30%
	Public	62%
Years of operation	More than 20 years	59%
Size	Staff Count (mean)	14.5
Services	Conservation services	88.5%
	Research / Scientific services	70%
Specialties	Type of cultural heritage (mean, out of 18)	6.2
Country	Highly developed country	56%
Collaboration behaviors	Collaboration with Private labs	51%
	Collaboration with Universities	63%
	Collaboration with National Gov. Structures	61%
Conditions for Sharing	Sharing equipment for a fee	14%
	Sharing within academic collaboration	23%

Our respondents are located in workplaces with different features: they are private in 30% of cases, and public in 62%; 59% of the workplaces surveyed have been in operation for more than 20 years; their size, measured by the staff count, totals an average of 14.5 people. In 88.5% of the cases the types of services relate to conservation activities (e.g. preventive conservation, direct interventions on object and monuments…), while 70% are Research/Scientific Services (e.g. Analysis of composing or of alteration materials, engineering surveys…) On average, workplaces take care of six different types of cultural heritage (books, rock art, textiles, paintings, etc.) Another control variable is binary and depends on whether the workplace is located in a highly developed country or not. In our sample, 56% of respondents work in country viewed as highly developed according to the ICOM-CC 2019 classification.

We approach collaboration strategies using five predictors which are not exclusive (respondents can deploy multiple collaboration strategies at the same time): collaboration with private laboratories, collaboration with universities, collaboration with national government structure, sharing equipment in exchange for a fee, and sharing equipment within the context of an academic collaboration.



As we said earlier, for each of the 77 items, our 411 respondents were asked what kind of access they had to this scientific instrumentation. We therefore can distinguish three availability statuses: internal availability characterizes scientific instruments which are available within the respondent's workplace; external availability describes instruments which are accessible outside the workplace at another facility; an instrument is not available when it cannot be accessed by the respondent at all.



Based on the answers to these questions, we calculated the rates of internal, external, or no availability for all 77 items. These rates vary greatly. For example, let's consider two items in our list which exhibit different patterns of availability, the microscope with transmitted and polarized light (see blue bars on the left) and the X-ray diffraction XRD (see orange bars on the right). The microscope is a highly accessible instrument, mainly available through internal access: 48% of our respondents claimed that they can access it in their workplace while 18% claimed that they had external access to it, and 32% had no access at all.

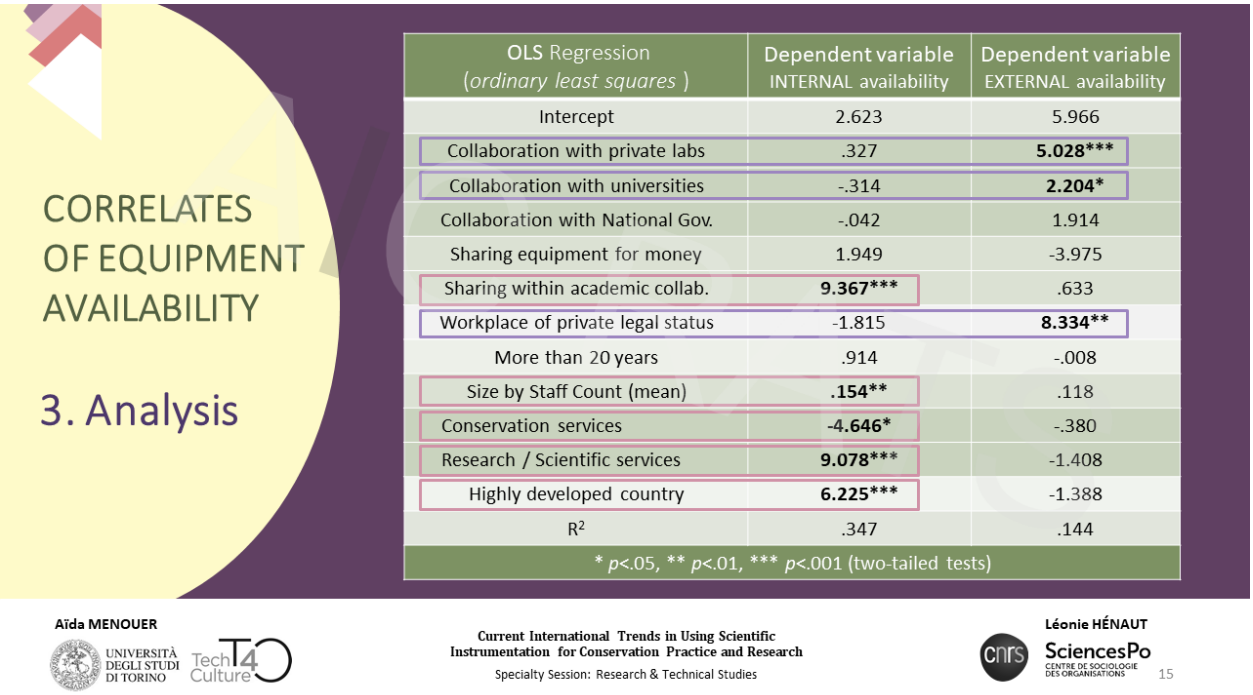
In contrast, 14% have internal access to X-ray Diffraction XRD, and therefore, this second instrument is far less internally available than the previous one, but still relatively available compared to other instruments in the list, and its availability is more likely to be external availability.

Next, we calculated these same rates for each item, each category of items, and finally for the whole set of 77 items, or the overall availability rate. The table below shows that, on average, respondents have internal access to 19.7% of the 77 instruments (this is the average overall internal availability rate), and external access to 18.9% of the 77 instruments (this is the average overall external availability rate).

Yet, these rates vary greatly, as shown in the table. Some respondents said that they had access to zero equipment, while others said they had access to all of them.

These variations between respondents are our object of study. We suspect that internal and external availabilities are correlated with workplace characteristics. Hence, we ask: what types of workplaces would manifest higher rates of overall internal availability and where could overall external availability preferably occur?

Our hypothesis is that this variation between internal and external availability is contingent upon the relationships that workplaces may have with other organizations, especially private laboratories and universities. This hypothesis was tested using linear regressions.



OLS Regression (*ordinary least squares*)	Dependent variable INTERNAL availability	Dependent variable EXTERNAL availability
Intercept	2.623	5.966
Collaboration with private labs	.327	**5.028*** **
Collaboration with universities	-.314	**2.204***
Collaboration with National Gov.	-.042	1.914
Sharing equipment for money	1.949	-3.975
Sharing within academic collab.	**9.367*** **	.633
Workplace of private legal status	-1.815	**8.334****
More than 20 years	.914	-.008
Size by Staff Count (mean)	**.154****	.118
Conservation services	**-4.646***	-.380
Research / Scientific services	**9.078*** **	-1.408
Highly developed country	**6.225*** **	-1.388
R^2	.347	.144
* p<.05, ** p<.01, *** p<.001 (two-tailed tests)		

We performed OLS Ordinary Least Squares standard linear regression on our two dependent variables: (overall) internal availability and (overall) external availability.

The coefficients associated with statistical models are displayed in the table (Note 1).

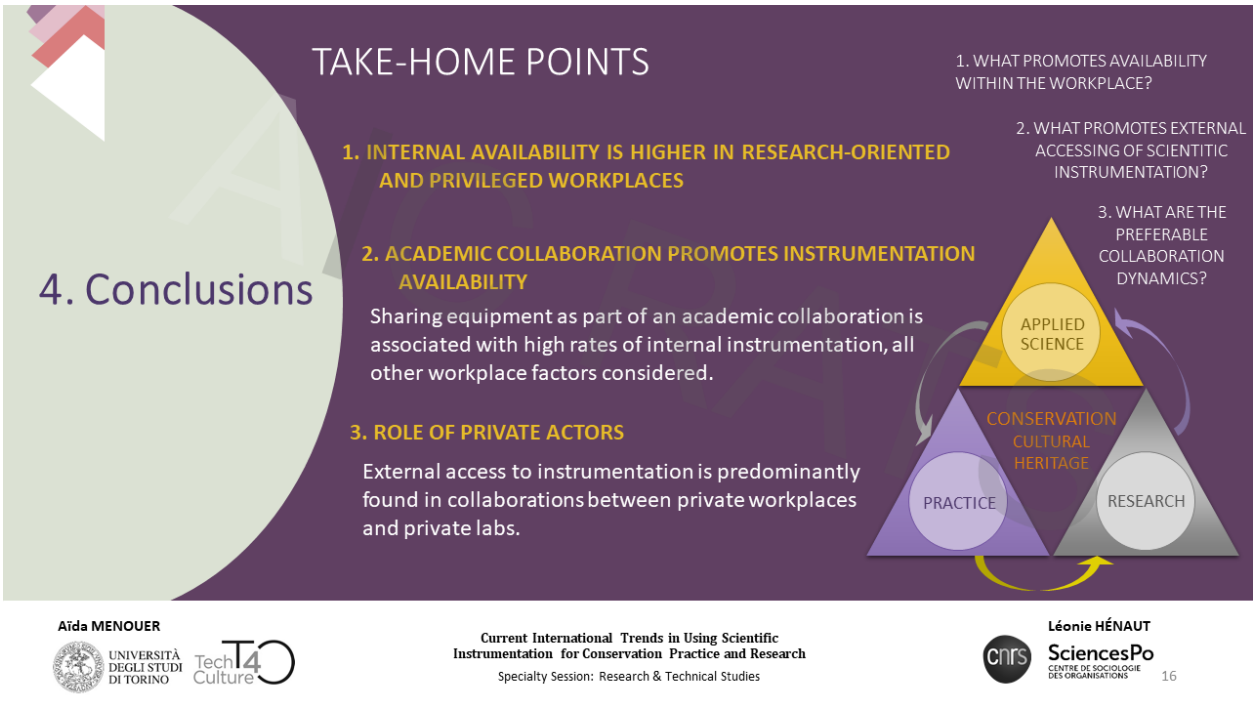
Looking first at the predictors for internal availability in the second column (framed in pink), the results show that a higher percentage of internal availability is positively and significantly associated with sharing equipment in the context of academic collaboration, net of other workplace characteristics.

Additionally, the regression analysis shows that higher rates of internal availability are associated with workplaces performing research and scientific services, not performing conservation services (which you see here as a negative), as well as being a well-resourced structure (large size and highly developed country).

In contrast, the predictors for external availability in the third column (framed in purple) exhibit quite different results. As the numbers show, a higher rate of external availability is positively and significantly associated with collaboration with private laboratories, collaboration with universities and the workplace being a private structure.

Note 1: The numbers in the regression table are the coefficients, not the significance values * p<.05, ** p<.01, *** p<.001 (two-tailed tests)

Correlations are significant when p is inferior to <.05 et super significant when p is inferior to <.001 and we use asterisks to indicate it.

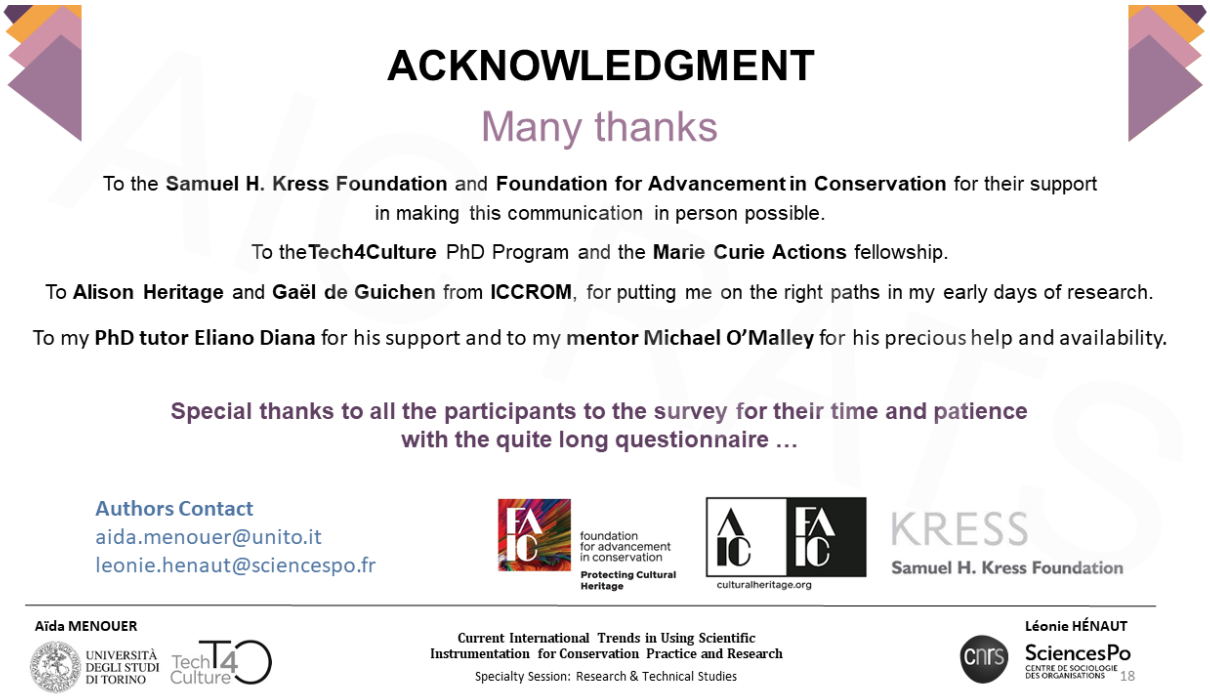


When circling back to our research questions, we have learned that:

1) Internal availability is higher in research-oriented and privileged workplaces.
2) Academic collaboration promotes instrumentation availability. And, more specifically, the sharing of equipment as part of an academic collaboration is associated with high rates of internal instrumentation, all other workplace factors considered.
3) External access to instrumentation is found in the context of collaborative relationships between private workplaces and private labs.

Coming back to the initial motivations for this research, in emerging contexts, as opposed to highly developed countries that can afford costly scientific equipment, we would argue that a more sustainable approach would be to access scientific instrumentation through collaboration and sharing with private labs and universities.

Please consider that we are still working on the data, exploiting various other leads from the rich and nuanced survey questionnaire. Further research will address the frequency of use of scientific Instrumentation, in comparison with other conservation equipment that were mentioned by participants. In addition, opinions and personal views about respondents' own practice are also valuable sources for further understanding the dynamics in the use of conservation equipment.



Thank you for your attention!