SERVICE DESIGN FOR BETTER COMMUNICATION AND MANAGEMENT PRACTICES - IN THE CONTEXT OF SCIENTIFIC SERVICES IN CORE FACILITIES

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Dissertation

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Honour Pledge

I declare that the present research proposal for my master's dissertation is of my own authorship and has not been previously used in another course or curricular unit of this or any other institution. References to other authors (statements, ideas, thoughts) scrupulously respect the rules of attribution and are duly indicated in the text and the bibliographical references in accordance with the referencing rules. I am aware that the practice of plagiarism and self-plagiarism constitute an academic offence.

Abstract

This dissertation aims to outline a service redesign process on a core scientific facility that provides scientific services. Core facilities are laboratories implanted in research centres of Academia, offering services with cutting-edge technology and technical experts to support research activities.

According to the literature, these platforms must improve their offerings due to systemic, strategic errors, mainly in communication and management issues. Service design stands as a new tool to innovate, requalify, and, in this way, improve the core facility's performance.

To study and test this concept in the field, a case study is proposed in one core facility, aiming to improve management and communication issues identified in the literature review for other core facilities. A thorough document analysis of the core facility's processes and observational ethnographic analysis were undertaken. In addition, several facility users/stakeholders were interviewed. The interviews were analysed, and the insights obtained were utilised to generate the service concept of the services included in the ideation phase of the service design process. Throughout this method, all processes, stakeholders, and bottlenecks were scrutinised and analysed. Several improvements were implemented in the facility.

The knowledge gained with this study will be presented as new frameworks and bullet points covering detailed areas to address and how to manage them. This knowledge can be considered a roadmap for further research on this topic, to be implemented in other core scientific facilities.

Keywords: core scientific facility, services, technology, service design.

Resumo

Esta dissertação tem como objetivo delinear um processo de design de serviço num sistema de serviços cientificos (habitualmente designado por plataforma científica, no contexto da Universidade do Porto). As plataformas cientificas são laboratórios e unidades estruturais pertencentes à Academia (a institutos de investigação ou universdades). As plataformas científicas oferecem serviços com tecnologia de ponta e técnicos especializados para suporte em atividades de investigação cientifica, nomeadamente análises e interpretação de dados.

De acordo com a literatura analisada, as plataformas cientificas devem melhorar os serviços oferecidos, quer a nível sistemico quer a nível estratégico, principalmente em questões de comunicação e gestão. O "service design" surge como uma nova ferramenta para inovar, requalificar e, desta forma, melhorar o desempenho das plataformas e torná-las mais holisticas e centradas nos seus agentes.

Para estudar e testar este conceito no campo, foi proposto um estudo de caso numa plataforma científica, com o objetivo de melhorar aspectos particulares relacionados com a comunicação e gestão e daí explorar novas ações para inovar. Nesse sentido foi efetuada uma análise documental exaustiva dos processos da plataforma cientifica assim como uma análise etnográfica observacional. Além disso, vários utilizadores/agentes das plataformas foram entrevistados. As entrevistas foram analisadas e os dados obtidos foram utilizados para desenvolver o conceito de serviço, incluído na fase de ideação do processo de "service design". Ao longo deste método, todos os processos, agentes e problemas foram escrutinados e analisados. Várias melhorias foram implementadas no funcionamento da plataforma cientifica.

O conhecimento adquirido vai ser apresentado através de novos diagramas e numa restrita lista de pontos chave referindo areas pertinentes para seguir e intervir, e como interver. Este conhecimento pode ser considerado um modelo para investigação futura a ser realizada sobre este tema, e passível de ser implementada em outras plataformas científicas.

Palavras-chave: plataforma cientifica, serviços, tecnologia, service design.

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1. Introduction

1.1. Motivation

Scientific core facilities are laboratories implanted in research centres of Academia, offering services with cutting-edge technology and technical experts to support research activities in several fields of science (Farber & Weiss, 2011). Over the years, scientific core facilities have struggled to render the resources offered in maximum return, thus showing poor results and not reaching the standing deserved to show to Academia and the industry related. In addition, and directly associated with these struggles, funding and management issues also pose significant challenges to overcome and boost. Aiding on communication and management matters related to these issues will bring scientific core facilities better results, added prestige, more funding and overall improved assistance and support to research and industry-related activities.

Nevertheless, the challenges are frequently a force of motivation. As Stefan Green, director of a core facility, says in Gould, J. (2015): "Every project and problem is different. You think you know a lot, but you quickly realise that you don't," (...) "For me, that is both frustrating and rewarding." P495-496 (Gould, 2015)..

1.2. Core facilities: Background Concepts

To set the scene for the literature review, some important concepts are explained and detailed to understand the research question's pertinence.

What are core scientific facilities?

Core scientific facilities are laboratories, generally implanted inside research institutes, that perform analysis and scientific consultancy in specific scientific fields according to the technology and human expertise offered. These centres share resources and provide access to state-of-the-art equipment and technologies on a fee basis while also developing new protocols and, in this way, transferring this technical knowledge and expertise to other scientists (Farber & Weiss, 2011); (Kos-Braun et al., 2020). Core facilities also play an important role by connecting institutions and nurturing collaborations within interdisciplinary research fields (Kos-Braun et al., 2020).

Users (or clients)

According to the operating mode, core facilities can be classified as full-service, hybrid-service or self-service. In a full-service manner, the technical staff of the facility perform the analysis and data treatment. In self-service mode, users can perform the analysis alone after a general or

specific training period. Finally, the hybrid mode can be both with either training and assistance or just assistance (with or without data treatment) and further discussion of results.

Most users in core facilities are internal, being from the same research institute or other surrounding institutes and universities, all related to academia. As stated before, in the hybrid or self-service mode, these users can be trained and use the facilities as qualified users with special access. Other types of users can exist, as from the industry, directly related to research or not. These external users usually have different kinds of access and other services provided, including scientific consultancy and elaboration of reports.

In both cases, users can be considered clients depending on the particular management of the scientific facility.

Types of analysis performed

Regarding the type of analysis performed, core facilities cover a wide range of scientific fields, as shown in Figure 1, for some examples of fields existing in several academic facilities.

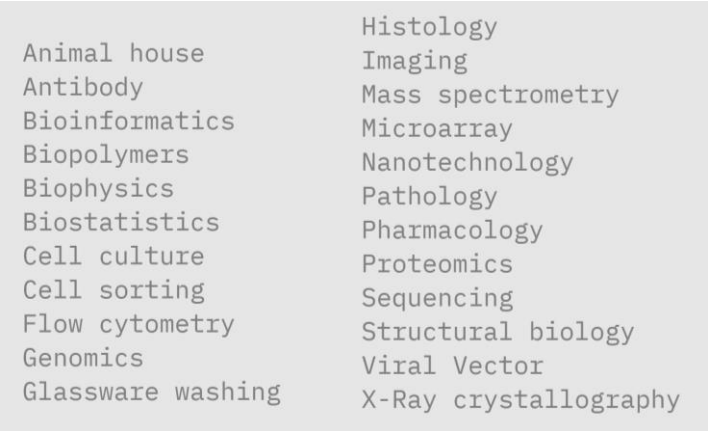

Figure 1 - Different types of core facilities examples

1.3. Framing the problem in core facilities

Scientific core facilities are typically established to support and prioritise the internal research needs and requests of the institutes they are a part of, especially when those institutes are highly subsidised by institutional government funding. As a result, the services are often less open to external customers. Many times, these are not considered relevant for initiating and building collaborative networks. Nor are they seen as essential amplifiers for developing the services or even as good sources of profit. However, to be part of more extensive infrastructures (and to be suitable to receive more funding), institutes and their core facilities are encouraged and sometimes even required to open up to external users, thus contributing to the communication of science to society and the overall "openness" and usefulness of government funding for all. Funding agencies are

also interested in this openness to avoid duplication and underutilisation of equipment, especially in geographical proximity.

1.4. Expected contribution of research and main gap to be filled in the area

Aligned with the current situation referred to above, this dissertation provides an opportunity to contribute to the research development concerning services related to Academia. So, it is the perfect chance to start developing and "professionalising" scientific services, allowing the knowledge to be available to the entire social community, thus benefiting both the industry and academia. In this context, the expected contribution of this research and the main gap to be filled is to develop and improve services in scientific core facilities with better communication and management practices with the aid of service design. More explicitly, this work aims to open up and suggest new methodologies/practices and validate them in the field, constituting a reference for future improvements. In summary, the research proposal will help the scientific core facilities to become more professional.

1.5. Research question

The Research question proposed is: How can Service Design be used for better communication and management practices in the context of scientific services in core facilities?

Based on this research question, further more specific questions may be raised:

- What are the inter-relationships among different stakeholders of the core facilities?
- Which communication channels exist between all stakeholders in core scientific facilities? How can the existing channels be improved? Which new channels need to be created?
- How can core facilities improve the user experience for their users?

Below is an example of a conceptual framework where several implications are drawn regarding core scientific facilities' key aspects and their relationships.

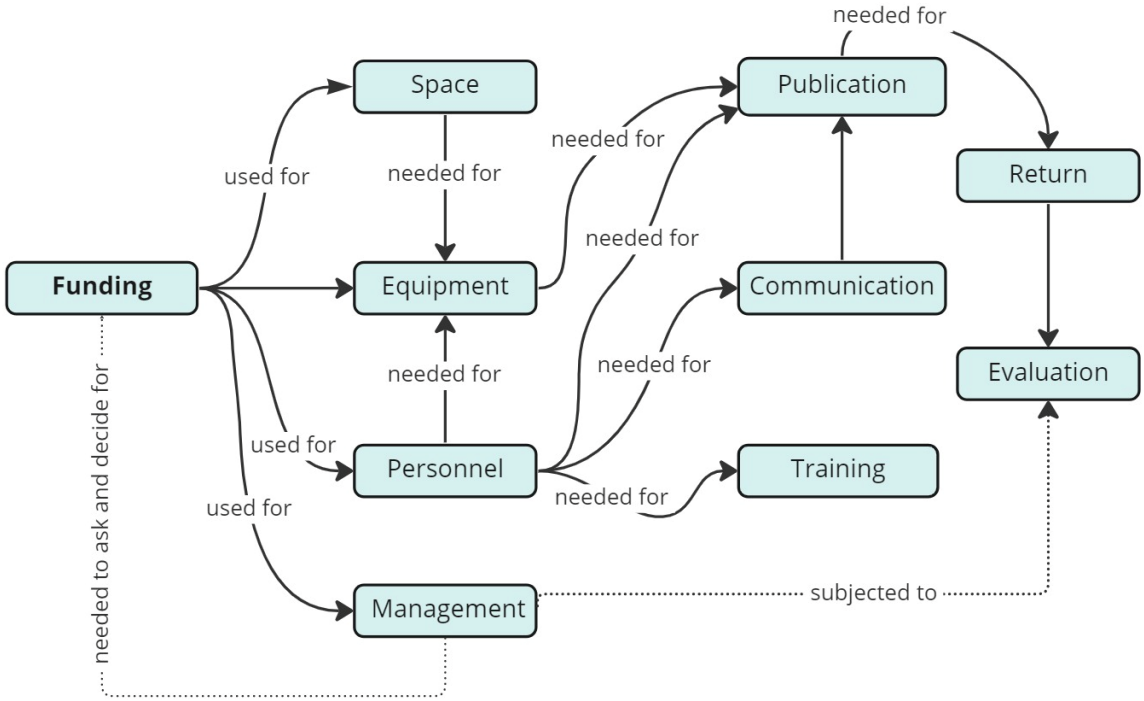

Figure 2 - Main effects and relationships of core facilities' key aspects (adapted from Kos-Braun, 2020)

1.6. Scope of the work and structure

This work could be positioned on merging several subject areas, such as innovation, business management, decision sciences and service design. The dissertation will cover a literature review about core facilities reality and critique in the first two chapters, then elaborate on the methodology and research design proposed in chapter three to align a methodological plan to cover the proposed gap and the results in chapter four. Finally, in chapter five, the study's conclusions will be discussed.

2. Literature review

This chapter will shed light on the current state of the core facilities reported in the literature analysed. Simultaneously, service design concepts and their development will be covered and, whenever possible, linked to the current research question framed.

2.1. Scientific core facilities' reality

Scientific core facilities are essential for academia and the institutes they belong to due to the uniqueness of the services provided (Farber & Weiss, 2011). Scientific core facilities are a tool or platform that allows scientists to collaborate: to access cutting-edge technologies, and share data on research projects. To illustrate some completely far-apart examples of core facilities, one can refer to the GenBank facility, which provides access to genetic sequence data, and the Sloan Digital Sky Survey, which allows astronomers to access data about the universe (Gallacher, 2016). Through scientific platforms, it is possible to increase scientific research's speed and efficiency by allowing scientists to share data, knowledge and resources more easily (Gallacher, 2016). Moreover, core facilities protect against bias, favouring transparency, rigour and reproducibility (Kos-Braun et al., 2020). Consequently, many institutions must develop and highlight their core facilities to strengthen their research positioning (Haley, 2009). Haley et al. list several examples of US universities with significant investments in their core facilities for this purpose (Haley, 2009). Strategic management of these core facilities is believed to be crucial for this development and to achieve enhanced productivity and return. The core facilities' specific reality and area of expertise influence the management model applicable and where and how to innovate and develop (Haley, 2009).

To understand better core facilities reality, especially concerning expenses, below are listed some aspects where scientific core facilities have major costs:

Table 1. Core facilities' expenses - adapted from (Angeletti et al., 1999)

Human resources	Equipment & infrastructure	Methodologies & Data Analysis	Other costs
Skills and activities of facility's staff; Training students, researchers, and postdoctoral fellows in the operation of community-use instruments; Teaching data analysis and interpretation skills;	Instruments; Setting up and calibrating instruments; Maintaining databases; Evaluating new instruments; Mid-range instruments and laboratory support apparatus;	Planning and performing experiments; Performing tests and quality controls; Troubleshooting problems, instruments, experiments and methods; Method and instrument validation;	Accounting, billing, and secretarial work; Service calls and service contracts; Consumables;

Human resources	Equipment & infrastructure	Methodologies & Data Analysis	Other costs
Technology courses and advanced technology meetings for resource staff; Education programs; Protocols with special programs for visiting the facility; Seminars, workshops, tutorials, and personal discussion sessions for research scientists;	Computers, programs and software; Instrument parts and updates; Downtime, depreciation; Calibration standards; Special consumables such as chromatographic columns and lasers;	Instrument maintenance; Preventive and routine maintenance; Optimising experimental conditions for new projects; Setting up and testing new methods and technologies; Discussing experimental design and data with research scientists;	Books, journals, memberships

2.2 Scientific core facilities' problems and suggested improvements

The publications that appeared relevant to this research topic were further scrutinised, and the problems generally occurring in core facilities were summarised, as shown below in Table 2. Future research or suggested improvements were also evaluated, considering their validity for implementation. The reasoning for choosing these two dimensions for each paper was first to compare the subjects mentioned in the literature and then assess if any common paths for future research aligned with the proposed research question.

Table 2. Synthesis of core facilities' problems and suggested improvements

Publication	Synthesis – what are the main problems reported in the publication	Suggested improvements and comments (future research)
(Farber & Weiss, 2011)	• Funding is not enough – results in outdated equipment and inadequate staffing levels; • Poor management, leading to inefficiencies, decreased productivity, and lower morale among staff; • ineffective collaboration and communication • more training and education are lacking to ensure services are more effective and accessible.	• Centralization and consolidation strategies; • Unrestricted access to scientific core facilities; • Increased efficiency and importance for social communities by working on the following matters: o Information to the public about the core facilities o Competencies of management o Knowledge of the competition/benchmarking o Legal issues – rules, policies, control of expenses
(Kos-Braun et al., 2020)	• Insufficient professional development for staff;	• Establishment, together with the users of the facilities, of 4 quality checkpoints to ensure research quality:

Publication	Synthesis – what are the main problems reported in the publication	Suggested improvements and comments (future research)
	• Unclear communication channels and responsive customer service; • Ineffective management practices for facilities and for data acquired. • Lack of quality in data due to lack of standardised protocols, lack of tracking performance metrics, and inexistent regular assessments; • Insufficient or inexistent maintenance, calibration, and updating of equipment and infrastructure; • Lack of funding (is transversal to all problems).	○ experimental design check of the experience; ○ sample quality control to reject poor sampling; ○ data analysis check; ○ final check before publication by all stakeholders (Kos-Braun et al., 2020). • Use of online chats and blogs with users. Implement dedicated training on communication with staff members. • Use specific software for management issues and to free staff from other tasks.
(Hockberger et al., 2018)	• Lack of funding to remain sustainable over time; • Absence of integration with the research community (communication and relationships); • Outdated regarding new technologies and techniques; • Not sufficient evaluation methods of the services: no metrics or assessment;	• better internal funding and business operations; • improved discoverability and access; • better planning; • enhanced professional development (Hockberger et al., 2018). • Align the core facilities' mission with the institution's strategic plan, aligning all stakeholders with the proposed goals.
(Haley, 2009)	• Ineffective visibility, communication and collaboration of core facilities with other departments or institutions; • Unproductive operations, governance and management structures to ensure accountability, transparency and responsiveness; • Scarce review and evaluation of the services; • Low decision-making and investment (Haley, 2009).	• Use of a framework with four areas regarding general strategic management issues and a deeper focus to cope with the more striking realities of specific core facilities: ○ Visibility and Vision; ○ Operations and Management; ○ Review and Evaluation; ○ Decision-making and Investment.
(Lippens et al., 2019)	• Costly equipment and technological complexity; • Unfulfillment of specialised technical expertise and continuous investment in training and equipment upgrades; • Unresponsiveness of core facilities to the needs and expectations of researchers; • Lack of adaptation of services and equipment to meet changing demands; • Ineffective communication and collaboration with researchers; • Limited funding, staff, and equipment to provide high-quality services.	• More collaboration with other departments or institutions to provide better and more comprehensive services; • Change research mindset to favour knowledge sharing and all stakeholders' participation. • Update of devices; • Customization of services to meet customers' requirements; • Optimization of the methods and workflows for a trendier perspective of an all-in-one service", allowing workflow from experimental design to data.

Publication	Synthesis – what are the main problems reported in the publication	Suggested improvements and comments (future research)
(Gallacher, 2016)	• Inexistent sustainable funding leads to uncertainties and impacts the ability to maintain staff, equipment, and services over time. • Ineffective or inexistent management tools; • Lack of collaboration and integration to meet user needs and expectations;	• Include clear policies and procedures, performance metrics, and regular assessments; • Provide continuous user training and education, implement standardised protocols, and track performance metrics; • Collaborate with other departments or institutions to provide more comprehensive services.
(Angeletti et al., 1999)	• Deficiency of rigorous quality control to ensure accuracy and reliability of research results; • Deficit of offer for user education and training; • Low service quality and unresponsiveness; • Small Cost-effectiveness: core facilities have to balance the need for high-quality services with cost-effectiveness, which requires careful management of staff, equipment, and resources; • Lack of communication and collaboration.	• Boost shared instrumentation use; • Combine instrumentation awards with salary benefits; • Increase coordination and funding for technology additions for research programs; • Training programs and workshops about the technology available or to be acquired; • Support operating costs for updates in instrumentation; • Deliver professional progression and career development for the facility's scientists; • Include facility's scientists in planning research programs by using available and future technology resources of the facilities; • Recognize contributions of core facilities scientists in publications; • Join efforts to get funds for new instruments and operations costs; • Connect with other research faculty and stakeholders on assets and limitations of technologies in order to integrate/update new technologies.

In conclusion, despite numerous problems reported, scientific platforms have the potential to revolutionise scientific research by enabling collaboration, data sharing, and more efficient dissemination of research findings. Nevertheless, establishing and maintaining scientific facilities requires significant resources and collaboration between scientists, funding agencies, and other stakeholders (Gallacher, 2016), so more has to be done to progress.

2.3 Innovation in core facilities

The technologies present in core facilities are the epicentre of its services. All the data generation, scientific tools and expertise, done as training, consultancy or collaboration, constitutes a service open to innovation that can be driven and optimised as "customer service" (Lippens et al., 2019). More and more users from core facilities are seen as customers with a more participative interaction due to the general expansion of the services, not only in size but in the overall offering as an activity. This provides an opportunity for customers (often researchers) to work together with the facilities and aid (and co-create) in developing the facilities by exploring new technologies and posing scientific questions and new challenges (Lippens et al., 2019).

On the other hand, besides aiding and triggering the innovation on the facilities, it is the users who will ultimately judge the innovation: whether it has a purpose or not. In fact, there has to be some attention on implementing things that, in the end, only constitute value to a narrow range of users. Therefore, instead of solving a particular problem from one user, it is better to join forces with a community of users and co-create with them to look at the innovation from the end user's point of view. This is indeed the best strategy for innovation in core facilities (Lippens et al., 2019).

Running day-to-day operations in core facilities involves detailed work and consistently implementing robust, precise, narrow procedures. This mindset and way of working often contradict the context needed for innovation, which usually requires inspiration and flexibility. This is why innovation is so challenging in services such as core scientific services: managers and technical staff are often too busy and dedicated to solving day-to-day problems that there needs to be more space and time for overseeing the services from above.

While the quality of service provided measures everyday performance, innovation is evaluated subjectively and may not yield immediate results. However, it is valuable because it allows for learning and a change in mindset, even if it involves failure. Innovation requires a shift in culture, flexibility, and dedicated management with infrastructure and strategic planning support. Moreover, the COVID pandemic has altered the dynamics of how businesses and staff operate, requiring a continuous reimagining of operations and processes within the work environment. The reinvention of work methods and incorporation of technology stand as pivotal aspects in this continuous transformation journey (de Lucas Ancillo et al., 2021). New collaboration strategies and good partnerships in a positive work environment with a motivated team are also necessary for successful innovation in core scientific facilities.

Another critical aspect of the innovation process is, interestingly, the timing. The right moment to innovate is vital – if too late, one can lose opportunities to competition, and if too soon, one might not get all aboard and not have the proper context.

In summary, as in all sectors of life, innovation is needed to remain competitive. "Leading institutes from academia have realised that innovation has become a novel and extra mandate for their cores, on top of the daily service activities" (Lippens et al., 2019). Moreover, these leading institutes have realised that innovating is more than buying new equipment. Not innovating is not a choice if core facilities want to stay competitive.

2.4 Service Design

The beginning of research on innovation is often attributed to Schumpeter's work in 1934. Schumpeter argued that innovation plays a crucial role in driving economic development in society (Patrício et al., 2018), as it involves uniquely combining new and existing knowledge.

Service design poses itself as a discipline that aids innovation not only by adding new features or services but also by developing and changing existing ones. Indeed, service design is a means to improve, by implementing change, in services' quality. With service design, it becomes possible to innovate by creating transformative services that enhance the well-being of individuals in all types of services, regardless of disciplinary boundaries (Patrício et al., 2018).

Simply put, service design is the design of services in practice (Clack & Ellison, 2019). It is a process of co-creation and involves necessarily all actors and particpants of the activities. As it concerns improving internal processes, it impacts the organisational structure of the services, so it is directly related to management issues. The idea of innovation through service design aims to achieve a competitive advantage for the services and, ultimately, deliver better services: more affordable, accessible and pleasant, as the focus is always on the final customer's needs and objectives. Service design appeared as a new subfield within the design field, specifically to address the context of the services. It is an interdisciplinary field between operation, management, strategic management, marketing, business design interaction, and design information systems. Service design is seen as an exploratory and creative process that seeks to understand ambiguous problems or opportunities that arise from service delivery. Service design draws on the principles of design thinking, which involve exploring new possibilities, generating ideas, reflecting on outcomes, and implementing solutions (Blomkvist et al., 2010; Brown, 2008). Moreover, like design thinking, service design is presented as a human-centred, holistic, creative, and iterative method to create new service features (Meroni & Sangiorgi, 2016).

The service design process involves several stages, namely: exploration, ideation, reflection and implementation. The exploration phase involves defining the problem and understanding the

actors involved within their context. The ideation phase is the phase that follows to generate new ideas and concepts for services.

Then, the reflection stage iteratively develops and tests service prototypes. Finally, the stage of implementation helps with organising the new service solution. Service design plays a crucial role in the entire service development process as it connects, improves (Yu & Sangiorgi, 2018) and gives meaning to each phase.

Exploratory phase

As referred to, the exploratory phase of the service design process is the initial stage, where research designers have to gather information about the problem they are trying to solve and the context in which the service will be used (Yu & Sangiorgi, 2018). This phase typically involves research, analysis, and synthesis to gain a deep understanding of the users, their needs, and the ecosystem surrounding the service.

During the exploratory phase, researchers may engage in a variety of activities, as listed in Table 3 below:

Table 3. Exploratory phase methods

Methods	Explanation
Contextual inquiry	It involves gathering customer data in the field where people work or live.
Applied ethnography	Involves iterative-inductive research, watching what happens in the natural setting and listening to what is said, asking questions and producing a richly written account; has a holistic approach; allows a descriptive understanding (Simonsen & Kensing, 1997). It can be based on observation (participant or non-participant) or interviews (unstructured, semi-structured).
Lead user innovation	Lead users are typically early adopters and so can be involved as co-creators in the process.
Participatory design	Comprises active user involvement throughout the entire development process.
Interviews and surveys	Better for needs that the customer can verbalise knowledge; can be qualitative (to define the problem, identify variables as a first stage) or quantitative (for analysis of attribute importance and performance).

The overall goal of the exploratory phase is to develop a comprehensive understanding of the problem space and identify opportunities for improvement. Customer involvement efforts should concentrate on identifying customer needs and the desired outcomes rather than solutions. So, it is needed then to transform customer feedback into innovation by concentrating on the

outcomes customers aim to accomplish while using a new product or service (Ulwick, 2002). This is the basis for the exploratory phase.

Ideation phase

After gaining a comprehensive and precise understanding of the customer's perspective, the next step is to create and formulate innovative ideas and novel service concepts based on the insights gathered during the exploration phase. This phase does not aim to avoid errors but to explore as many potential options as possible (Brown, 2008; Patrício et al., 2018). The ideation phase serves precisely to create a large number of ideas at a high conceptual level, followed by a selection process to identify the most promising concepts for further development. Developing a "service concept" involves taking it to a more detailed level by designing all the necessary elements of the service system and the service experience for the user.

As Goldstein states, the service concept can be "seen as a clear and shared understanding of the nature of the service to be provided" ((Goldstein et al., 2002) (p. 125).

The service concept helps designers and researchers to understand how customers and service providers view the services – as more than the mere sum of components. Indeed, a service is not only composed of physical entities (facilities, equipment, other) but a blend of processes, human skills (job design, capabilities, other) and other resources that must be suitably integrated to yield the planned or designed service- the final outcome that the service seeks to achieve. In addition, the service concept brings strategic intent to planning a service design, including its market position relative to competitors and the type of customer relationship required. The service concept provides the framework for these linkages (Goldstein et al., 2002).

Reflection phase (prototyping)

Once the solution has been developed on paper, it must be validated before being launched as a genuine service in the market. This validation process ensures that the service concept meets the customers' requirements and is feasible to implement (Foglieni et al., 2018). In order to test the value of new service ideas to customers and stakeholders, it is then necessary to create prototypes. This comprises an iterative process of testing, improving, and retesting the role of people, processes, and physical evidence in the overall service experience. Through prototyping, customers and stakeholders can fully comprehend how intangible services look and function. The main objective during this stage is to create a clear and vivid vision of the service concept in customers' minds. Additionally, prototyping provides valuable feedback on customers' perceptions of the service, which can be used to develop new service ideas or improve existing ones (Fisk et al., 2013). To test physical products, prototypes are created based on the envisioned and suggested

ideas and then tested with customers or experts (lead users) to receive feedback and enhance the prototypes until they fully meet expectations.

Implementation phase

The final stage of service design is implementation. It involves putting the new service concept into operation and making it available to all based on a reliable and thoroughly tested service concept developed during the earlier stages (Fisk et al., 2013). Implementation is a critical stage as it involves putting the new service concept into practice. It requires changes in the organisation's processes, people, procedures, and technical systems. It is essential to ensure that all stakeholders are on board and that all the necessary resources are in place to successfully implement the new service concept (Foglieni et al., 2018).

Furthermore, while numerous methods and techniques are available for generating ideas and developing service concepts, the later stages of service specification, prototyping, and implementation could be better supported by existing methods and techniques (Blomkvist et al., 2010).

Service Concept and Frameworks

Service design strongly focuses on exploration and ideation phases through developing the service concept. Patricio et al. also proposes a new interdisciplinary approach to designing services – the Multilevel Service Design (MSD)(Patricio et al., 2011). This approach was applied to two different services: a new retail grocery store service and a bank service. It described its design through a co-creative process and then studied its effects. MSD comprised three stages through the creation of relevant frameworks, namely:

1. the design of the company's service concept by the elaboration of a customer value constellation (CVC) composed of service contributions to the overall value constellation experience (VCE);
2. the design of the company's service system architecture (SSA) and navigation (SSN) for the overall service experience;
3. the design of each service encounter with the aid of the Service Experience Blueprint (SEB) for the overall service encounter experience (Patricio et al., 2011).

The MSD method can successfully be applied in other diverse service context, opening new possibilities for developing or redesigning new services (Patricio et al., 2011). Interdisciplinary contributions help to build a robust design that can effortlessly be understood throughout different fields. In this method, it is necessary to explore with detail the importance of customer-to-customer interactions. In fact, these interactions are rising due to social networks and, therefore, can affect the co-creation process, being very important (Patricio et al., 2011).

Multiple other case studies of service design projects have been studied, even in startup contexts, and specifically how they impact service innovation (Korper et al., 2020) (Patricio et al., 2011). In these case studies, it was observed that co-design teams together with in-house design teams are more effective in translating latent user needs into relevant and innovative design concepts than individually (Steen et al., 2011). However, it is a significant challenge for companies to identify, comprehend, and adopt knowledge about the processes that create value. The primary reason is that customer value is known as "sticky information" that is difficult and costly to transfer from the customer's context to a company in a way that can be effectively rendered (Patrício et al., 2018).

Customers have the best understanding of their own context and, in most cases, know what they want. Therefore, companies should not merely listen to them; they must invest in achieving active participation to gain a deeper understanding. This could mean that customers actively participate in innovation within their own context. Additionally, companies could spend more time observing and experimenting within the customer's context to generate innovative ideas. (Edvardsson et al., 2006).

In summary, throughout all phases of the service design process, co-creation with all players and a holistic understanding of the user experience captured, it was possible to discover that service design can really empower new service development processes (Patricio et al., 2011).

Another essential aspect to consider in service design is technology issues. According to Larivière et al. (2017), technology has significantly transformed the service context (Larivière et al., 2017). New technologies are reshaping the market and how customers manage and engage their consumption of products or services. The Internet of Things (IoT) plays a crucial role in collecting vast amounts of data, enabling interconnected entities to exchange information and empowering people and devices with valuable insights (Ng & Wakenshaw, 2017). This new service context, characterised by constant information flow and data analytics, must be considered when innovating through service design (Patrício et al., 2018).

Given that interactions are the core of service systems, future service design and innovation researchers must delve more broadly and deeply into the nature of service relationships. In the most straightforward contexts, interactions between service actors can be categorised into four service dyads: human-to-human, human-to-machine, machine-to-machine, and human-to-nature (Larivière et al., 2017). Although human-to-human relationships were the foundation of the service economy, modern technology has given rise to new service relationships between humans and machines and relationships between machines themselves, which must be considered (Larivière et al., 2017).

Regarding customer interactions, looking at the user's experience is essential. This can be defined as a customer journey's outcome involving multiple interactions at several touchpoints (Sarmento & Patricio, 2014). The experience is shaped by the events that occur during the journey, and specific stages of the process may significantly influence the overall assessment. For example, a positive service interaction early on in the journey may significantly impact the overall experience rating more than during later stages (Voorhees et al., 2017). Even minor details in the customer journey can significantly affect the overall assessment of the service experience.

Therefore, the primary objective of any service design and innovation endeavour should be to make service systems more human-centred, and innovation should start precisely from there.

2.5 Literature Review synthesis

The research question proposed in the beginning aimed to address ways for improving services in scientific core facilities with the aid of service design in communication and management practices. Therefore, the logic for the literature review analysis was to discover common points of interest (advantages, fears, limitations) in core scientific facilities regarding their modus operandum and their positioning in relation to both research institutes and industry.

2.6 Literature Review critical discussion

The literature analyzed proposes several guidelines for improving fundamental pillars for general core scientific facilities. Among the several issues on which the literature emphasised, for a comparative analysis were chosen the following eighteen issues and compared in their occurrence in Table 4 in some literature:

- Communication (regarding how the communication of the services performs between staff, users and customers, managers, direction, academia, etc.)
- Management of the services, especially regarding the "modus operandum";
- Training of users, customers, but also staff and managers;
- Visibility (how external entities perceive the services facilities);
- People, i.e., all personnel involved in the functioning of the services;
- Technology, meaning not only the technology offered through the service but how it is using technology to evolve and develop in services' processes;
- Strategy and planning regarding all decision-making, including the design or redesign/ recovery of the services;
- Space available and needed;

- Funding and its repercussions on services' offerings;
- Evaluation of the performance or changes introduced in the services, including evaluation from users and clients;
- Software and Digitalization, as for software implementation and digitalization as a means of improving the offer or processes of the services;
- Quality, namely the quality of the data generated, as well as the quality and rigor of the service provided, including data regarding the processes involved);
- Legal – all rules and regulations limiting the services scenario;
- Customer experience;
- Interviews/ ethnographic interviewing;
- Frameworks presented as a tool to improve and generally understand the service concept (Journey map and others);
- Customer-to-customer interaction, including through social media;
- Market and Competition, meaning all the benchmarking one service platform has to consider;

Table 4. Key factors influencing core scientific facilities' performance that can constitute improvements for future reinforcement actions

Key factors (effects present are labelled x)	**Article**			
	(Farber & Weiss, 2011)	(Kos-Braun et al., 2020)	(Hockberger et al., 2018)	(Haley, 2009)
Communication	x	x	x	x
Management	x	x	x	x
Training	x	x	x	
Visibility	x	x	x	x
People	x	x		x
Technology	x	x	x	
Strategy and planning	x	x	x	x
Space			x	x
Funding	x	x	x	x
Evaluation	x	x	x	x
Software and Digitalization		x	x	
Quality (data, processes)	x	x	x	x
Legal	x	x		x
Customer experience			x	
Interviews/ ethnography			x	x
Frameworks (Journey map, others)		x	x	x
Customer interaction / social media		x		
Market / Competition	x		x	

Table 5. Key factors influencing core scientific facilities' performances are labelled by importance in the context of the literature review through color code

Key factors: Effects are labelled by importance, with a scale from 0 to 5, being 0 not so relevant and 5 being very relevant	**Article**			
	(Farber & Weiss, 2011)	(Kos-Braun et al., 2020)	(Hockberger et al., 2018)	(Haley, 2009)
Communication	4	5	1	2
Management	2	5	2	4
Training	1	5	3	0
Visibility	4	1	2	4
People	1	3	4	2
Technology	1	4	2	0
Strategy and planning	1	3	3	4
Space	0	0	4	1
Funding	3	3	4	4
Evaluation	1	2	5	4
Software and Digitalization	0	5	1	0
Quality (data, processes)	1	3	4	1
Legal	3	1	0	1
Customer experience	0	0	1	0
Interviews/ ethnography	0	0	1	4
Frameworks (Journey map, others)	0	1	2	4
Customer interaction / social media	0	3	0	0
Market / Competition	3	0	2	0

Tables 4 and 5 show the relevance assumed by each of these issues in the core facilites on matters that can be improved. . Firstly, on table 4 were identified in which publications is discussed the issues specified in the columns. Then, since most of the issues were common in the literature analyzed, a rating criterion was undertaken with a score starting from 0 to 5. 0 was considered not

to be so relevantly discussed neither a recurrent issue in the literature. In contrast, a score of 5 was considered to be very relevant and recurrent. The rating is subjective but had in mind the number of times and the depth the issues were discussed.

From Table 5, one can conclude by analysing the columns totally in green that all literature converged on the importance of at least four main topics: communication, management, technology and strategy. As expected from the literature synthesis, these topics are indeed of extreme importance for the design, development and improvement of services and, therefore, could constitute a primary path on which to act.

As for limitations that the literature review comprehends, first, it is worth mentioning that the review is limited in the number of publications and, therefore, might not represent a decent enough sample to take on definite conclusions. However, some limitations can be outlined. Indeed, some are even appointed or implicit by the literature, as for instance, concerning the strategy issues, where (Hockberger et al., 2018) insists that the strategy of institutions to which core facilities belong should align with the strategy of the core facility itself and be less dependent on personal quests of directors or managing stuff.

Another limitation that can be appointed is that the literature did not account for core facilities specificities. Core scientific facilities vary a lot from the field of science they frame themselves. Therefore, these specificities can affect the way of operation, the strategy defined and theoretically all other issues too. To give an example, some core facilities could be online and digital, not being necessary really any physical space. Bioimaging analysis, concerning data treatment, poses an example. This reality was not denoted in the literature. Other specificities could be related to the physical requirements of technology, space and personnel, as happens in biobank facilities, where personnel belonging to the platform's staff may not even be necessary.

One aspect lacking in the literature is examples or references from private for-profit companies that also provide scientific services. In fact, the private sector often seems not to be considered a competitive player regarding core scientific facilities. It would be interesting to understand and compare the way of working, similar problems and improvements done in these companies.

The literature acknowledges the importance of developing frameworks to assist in providing a list of improvements to be made. Yet, no real action plan was clearly defined , all are only general advice and bullet points to address

According to the literature, when requalifying or redesigning a service, it is vital to mind customer-to-customer interactions and the customer (and all other stakeholders) co-creation process so that service improvements can occur. However, the literature does not show the level

of participation of each stakeholder in the processes, and therefore it might limit the participation of core staff in the requalifying process. In addition, the literature does not elaborate much on the opinion of the users/clients of scientific core facilities. The opinion of these stakeholders is not always perceived, and in the papers that refer to interviews and questionnaires, the level of response is low. It would be important to understand why this response rate was so low (Kos-Braun et al., 2020).

Regarding the participation of the staff from core facilities in this process, it is worth comprehending what generally happens in private companies where service design takes place. In private-to-profit companies, the time spent on innovation processes is often seen as "wasted", and very often, company leaders or managers want to secure final results as quickly as possible. The same can happen in the core scientific scenario despite no profit motivation. This divergence phase which constitutes the design of the services, is especially painful for managers and users since they watch people investing time in going entirely poles apart in ways the manager has thought beforehand. (Tschimmel, 2012) argues about how the involvement of managers in service design can be beneficial. On the other hand, the fact that the manager participates in the process can, at the same time, be a bad idea because it limits people's freedom to give opinions and create. Furthermore, the way in which service design tools – such as ethnographic interviewing, customer journey mapping and job-to-be-done analysis, among other tools – proved to encourage people to stay involved with the problem long enough to reframe the opportunity in the companies. In this sense, for the companies subject to this service design process, the tools seem able to produce outcomes that are not expected. The key seems to be the people's engagement in the process (Tschimmel, 2012). This authentic and last longing engagement effect is only possible if the process is fun and delivers good feelings, motivating more for the following phases.

Summary of limitations found in literature regarding core facilities and limitations of Service Design:

1. Limited number of publications analysed – subjective nature of conclusions and not representative of definite conclusions;
2. Core facilities specificities are not fully covered neither with the necessary detail;
3. No references from companies which provide scientific services;
4. Strategy of institutions to which core facilities belong depends on the personal quests of the direction board
5. Frameworks as bullet lists to check and follow improvements are defined, but not really an action plan with concrete actions to take are referred to;
6. The level of action specific stakeholders can act on is not fully covered.

7. The opinion of the users/clients of scientific core facilities is not always perceived, and in the papers that refer to interviews and questionnaires, the level of response is low.
8. Involvement of managers /direction in the service design process can be biased

2.6 Knowledge gap

Given the critical literature analysis and discussion performed, future research is possible to be explored; it is possible to find the gap in where new research can be done. The research gap found in this study was identified by conducting a literature review and noting areas where there were few or no studies or where the existing research needed to be more adequate or updated. In this dissertation, identifying the research gap will help researchers and stakeholders of the core facilities environment focus on issues that have yet to be explored and contribute new knowledge to the field.

The major problems generally affecting all core scientific facilities are identified and validated through consultation with the stakeholders involved – scientists, managers, directors, clients and users. However, what remains to be uncovered are the latent reasons for these causes to be recurrent and, especially, the action plan to be implemented, with references in the field for validation and comparison. Service design can assist in redesigning and requalifying the services since the great majority of them did not start like this. In fact, most scientific services were built from starting point as an extra offering of technology and experts derived from the principal activity – research. Therefore, for sure, in the general case of scientific services, the design of the service did not occur. Moreover, not even the requalification or redesign of the service has been considered. Service design can aid in changing the mindset of the scientific facilities' community, offering new methodological approaches and tools that are often only applied to companies. Indeed, the scientific facilities environment is a unique setting that neither is solely academic nor solely private-for-profit enterprise. Furthermore, hopefully, the knowledge gap proposed to address and study will prove to show that scientific core facilities could be pushed to compete with the industry and overall contribute even better for both the academic scenario it belongs as well as the industry it can assist — all this, with a more human-centred approach.

3. Research Methodology

This chapter presents the research methodology adopted in this dissertation. It starts with an overview of the research approach, followed by the research design and the considerations applied in choosing the most appropriate empirical method aligned with the aim of this study.

3.1 Research Approach

Research can be approached through two fundamental methods, namely: qualitative and quantitative. Qualitative techniques focus on evaluating subjective attitudes, opinions, and behaviours and commonly involve methods such as focus group interviews, projective techniques, and depth interviews (Kothari, 2004). By adopting a qualitative approach, a researcher can gain a deeper understanding of the intricacies of innovation processes, which may not be discoverable through a quantitative approach. Therefore, this study has chosen to exploit a qualitative approach, as it allows for a better comprehension of the experiences and insights of individuals involved through interpreting language and meanings, as opposed to numbers or frequencies.

3.2 Research Design and Method

This section details the research design and research method implemented in this dissertation.

Research design refers to the plan or strategy for conducting research. It includes the overall structure, methods, and procedures for collecting and analysing data. Research design is an essential aspect of the research process as it ensures that the research is conducted in a systematic and rigorous way (Kirshenblatt-Gimblett, 2006). In addition, the results become more reliable and valid.

Of the several types of research designs possible, the proposed research design for this dissertation was a case study design. As defined by Robson, 1993, p146, (Robson, 1993), a *case study* is a research method used to investigate a specific problem or situation, a real-life phenomenon in context (Yin, 2009) It typically involves an in-depth examination of a particular individual, group, or event. The case study can be used to test hypotheses, explore new research areas, or provide insight into complex issues (Rashid et al., 2019). However, conducting case studies presents its own set of challenges, including the significant time investment required, the need for skilled interviewers, and the importance of being cautious when deriving generalisable conclusions from a limited number of cases while also maintaining rigorous research standards. Despite these

challenges, the outcomes of case studies can be highly impactful, as it has the potential to generate novel and creative insights and contribute to the development of new theories (Karlsson, 2016).

Regarding the research methods for this case study, as suggested before, the case study can encompass descriptive, exploratory, but also explanatory methods. As referred to previously, it can definitely be seen as a qualitative field since it is very much associated with a lot of the general qualitative approaches such as interviews and observations, including particularly participant observation ethnography; however, it can be of other sources too. Possibly the other major one that is used in these situations is through documents. A typical case study approach done on-site involves the collection of information by talking to the staff and collecting the data that is being kept regarding the activities performed. Observation is also fundamental since it provides extra information that is not normally translated into documents.

In fact, the reason why people often use case studies is because not enough is known about the area to use any other kind of technique. Designing a questionnaire is impractical unless there is knowledge about what questions to ask. On the other side, one cannot design an experiment without the risk of bias from manipulations from the participants. A case study, on the other hand, is a very open technique since it is possible to start knowing almost nothing about the present status and then jump to asking questions and observing, fitting well with the kind of exploratory approach to data collection. Despite this, it is also descriptive since there will be documentation of observations. In short, the case study proposed aims to bring a holistic approach to the research to undertake and integrate knowledge from various sources while looking at things in their context (Rashid et al., 2019).

3.2.1 Unit of analysis – a scientific core facility from Academia

In this case, the specific individual/group or unit of analysis will be a specific core facility belonging to the Academia – Core Facility X. The case study proposed was conducted using various methods, including interviews, observations, and document analysis. The chosen case study suits the research question, seemed feasible to carry out, and was ethical.

Hevner et all (2004) present a model for Information Systems Research, where the creation of solutions involves both the development of theories and artifacts, and their effectiveness is evaluated through various methods such as analytical, case studies, experimental, field studies, or simulations. This framework integrates aspects of behavioral science and design science, offering not only validity but also practical value. To guide the research approach, this framework was taken in account (figure 3).

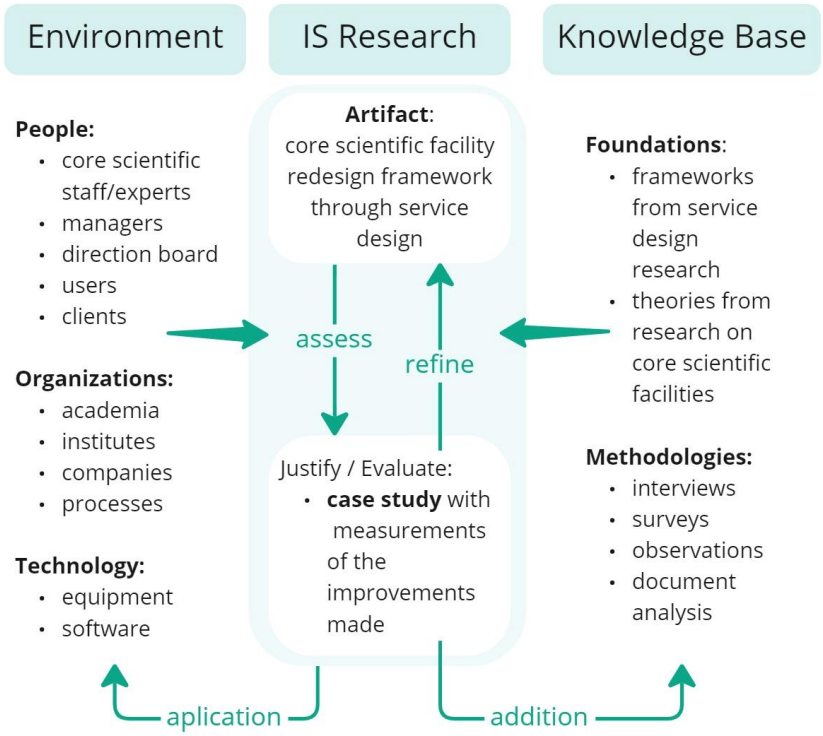

Figure 3 - adapted from Information Systems Research Framework (Hevner et al., 2004)

The case study proposed considering the effects through time (time variation). Time variation refers to the changes in a particular characteristic or phenomenon over time. It can refer to changes in physical or environmental factors, as well as changes in social or economic conditions. In this case study, hopefully, it will produce performance variations with repercussions on the financing situation, since it is expected that improvements in performance bring more clients and therefore increased revenues. On the other hand, understanding time variation is essential as it can help to identify patterns and trends that can inform decision-making and policy development.

Another consideration that the case study must bear is the theoretical replication of settings and processes (Yin, 2009). Theoretical replication refers to repeating a study using the same or similar methods and procedures but with different participants or in a different context to test the generalizability or robustness of the original findings. Theoretical replication might act as an important step in the proposed research process, as it will allow to determine the extent to which the original findings can be replicated and the underlying theory supported. In the proposed research, theoretical replication may be done by conducting a new study with a different sample of participants or applying the same methods to a different dataset. Theoretical replication will help ensure that the study's findings are not due to chance or specific to the original sample or context. Besides, the theoretical explanation will permit to prove enough robustness to be generalisable to other samples or contexts.

3.2.2 Data collection and analysis

The data collection comprised data from interviews and analysis of documents. While also considering the principle of literal replication, the study utilised empirical data obtained from the observational ethnographic analysis, document analysis and interviews. All data was collected in the context of the core facility X, which belongs to an institute of the Academia. The data was collected during 6 months, starting from February 2023 to August 2023

In the first stage, included in the exploratory phase, ethnographic observation was performed daily, during two weeks of analysis, at different time points throughout the day.

Ethnographic observation is a qualitative research method that involves immersing oneself in a particular social or cultural setting to gain an in-depth understanding of the people's behaviours, interactions, and practices within that environment. Participant observation allows to uncover nuanced insights that might be elusive through other research approaches. This method entails prolonged engagement, keen observation, and often a commitment to living among the people under study to grasp the context and meaning behind their actions, ultimately providing rich and contextually grounded data for sociological or anthropological investigations (Aktinson & Hammersley, 1998; Gobo, 2011).

Regarding the analysis of documents, it is essential in any service design process, as it plays a crucial role in gathering insights, informing design decisions, and driving innovation in the service design process. As insight gathering, it helps designers understand the context, customer needs, industry trends, and potential opportunities. It helps identify best practices, enabling designers to learn from successful strategies and adapt them to the service context. It is also determinant for informing design decisions: it can provide a basis for evidence-based design choices and helps address potential challenges. As supporting ideation and concept development, it can assist in inspiring creativity, generating ideas, and guiding the development of innovative service concepts. Finally, it helps evaluate the existing services, identify improvement areas, and optimise the service design.

Several types of documents were examined, including their historical data. These include meeting minutes, registries available for users to register the use of equipment, contractual documents established with users for the formalisation of the services, as well as reports generated from the analysis to deliver to external clients. In addition, all digital documents generated by the scheduler platform were also scrutinised.

Generally, interviews are crucial for gathering evidence in case studies focusing on human matters. These studies require the perspectives of knowledgeable interviewers and well-informed

participants to report and interpret the phenomenon being studied. Interviews can offer valuable insights into the situation being investigated and provide a historical context that can lead to discovering other relevant sources of evidence (Yin, 2009).

For this particular case study, the selection of participants was based on convenience and availability within a previous pool of profiles initially selected and considered interesting to interview (as listed in Annexes - sampling of interviewees). This initial criterion had in mind the experience of the interviewees on working with the facility either as a client/user or as a stakeholder indirectly involved. The criterion considered if these members used several techniques from the scientific core facility, had different levels of experience as well as a minimum frequency of use and familiarity with the facility.

The semi-structured interviews had a consistent script (Appendix). The research topic and intent were revealed to the interviewees on the first contact established to schedule and motivate the interviewee to participate in the study.

The interviews were recorded on consent and took one hour on average. The interviews were conducted in person and through phone calls and Zoom, based on the availability and geographical limitations of the participants. The resulting audio was subsequently transcribed and further analysed through the NVivo R1 software and Read Software for Zoom.

The interviews covered several of the main topics identified by the literature review as fundamental pillars for improving general core scientific facilities, namely: communication and visibility issues, training, technology, people, customer interaction and customer experience, strategy, management and quality affairs.

The first part of the interview consisted of understanding the interviewee's relationship with the core facility and how this relationship started and evolved to understand how the core facility attracts potential new users and communicates with them.

The second part of the interview addressed how the interaction of the users or stakeholders with the core facility runs regarding the training, access and the interaction through different processes. Following this relationship, the interview explored the users' knowledge and overall customer experience, aiming to achieve new insights, opinions and ideas that could lead to improvements, additions or retractions from the core facility's way of working and management.

The interviews were designed with a flexible structure to allow discussions to explore new and intriguing directions, according to the interviewee's participation. All interviewees were allowed and even incentivised to comment and give new insights and suggestions during the interview.

Lastly, the interview finishes with questions regarding the interviewee's opinion on more general topics not so directly related to the user's interaction, such as management and strategy issues.

The sample size was based on theoretical saturation concepts (Francis et al., 2010). This means that, during the data collection, no new ideas or properties emerged from the research units. Therefore, a sample size of 12 participants and individual interviews was deemed sufficient for the scope of the research.

Regarding the interviewees, as referred, they were (initially) tactically chosen and requested to participate with their consent. All participants signed the informed consent document. The interviewees cover several stakeholders present in the core facility scenario. In addition, the interviewees include people with different backgrounds, different hierarchal positions, belonging to different companies or institutes, different status and roles in the company, as well as external users/clients. From the pool of 12 interviewees, 4 were external to the institute to which the facility belongs. Besides users, other stakeholders were also studied., including the core facility staff. Actually, the study had an indirect contribution of participatory design from core facility staff, with some hints of lead users.

A stakeholder map was designed to understand the range and type of stakeholders the core facilities apply to, as shown in Figure 4 below. This stakeholder analysis identifies the key agents involved in the service system, including customers, employees, partners, and regulators.

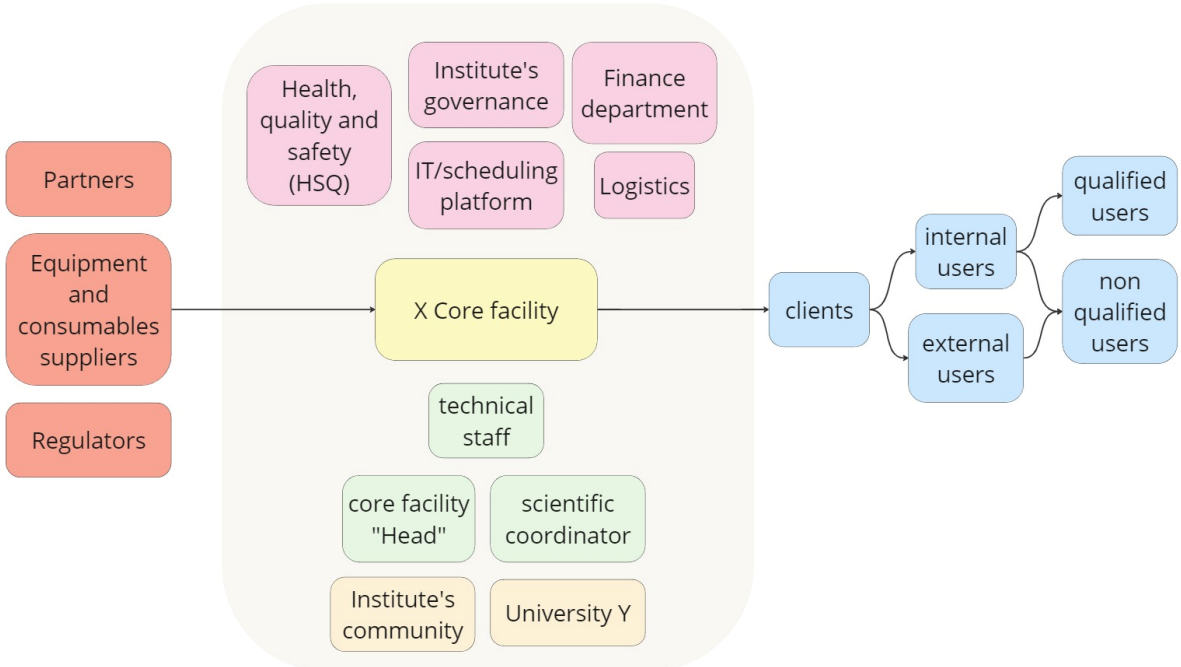

Figure 4 **-** Stakeholder map for the case study of the core facility chosen (Author, 2023)**..**

4. Results

The results presented in this chapter refer to the data and information retrieved from the exploratory and ideation phase of the service design process.

4.1 Observation results

Ethnographic observation, as referred, was done daily, during two weeks of analysis, at different time points throughout the day. The researcher, in this method adopted a non-participant perspective, and simply observed different users working in the facility. The results obtained were clustered in four major categories. Below in Table 6 are grouped the most important comments and notes registered following the observation exercise.

Table 6. Observation notes

Scheduler and time issues	Equipment, tools & rules	Training issues	Other
Most users come just on time or a little delayed to the service analysis they scheduled. Mondays are the calmest days in the core facility, where equipment usually are fully available, even at the last minute. The peak hours of use are in the afternoon. One question frequently asked is whether more people are scheduled after their analysis.	Almost all users comply with the rules for using the core facility: use of personal protective equipment such as lab coat, goggles, and gloves, registering the use of equipment, and turning on/off the equipment. The rule that is most times unfollowed is to wear a lab coat, especially when users come for quick measurements. Some users forget tools or accessories for the analysis that are not contemplated;	Very few users want training or to use the equipment at the last minute. Some users come in pairs or groups – students or colleagues are following up on the analysis and learning with the qualified user. It is common for qualified users to ask questions regarding the equipment and technical analysis. Users who come for training generally do not bring any device for personal annotations or instructions.	It is very frequent that users reach out to the technical staff several times a day regarding doubts about the use of the equipment. Roughly half of the users bring their personal computers and surf the net or work while the analysis is ongoing. It is commonplace to receive visitors - students or external visitors often visit the core facilities to grasp the technology and installations available at the institute.

Observational analysis was instrumental in uncovering some recurrent activities related to the frequency of behaviours and events, as noted above, for instance, the peak hours of use of the facility and regular visits by external members. Another interesting result was the discovery of habits by the facility users, which might indicate key aspects to act on, for example, the training aspect.

4.2 Document analysis

In addition to the ethnographic observation, as referred to, several documents were analysed and identified parts for improvement, update or extinction. Some of these documents are digital and/or included in internal web pages.

Table 7. Document analysis records

Document analysed / designation	**Purpose**	**Problems**	**Improvements suggested from brainstorming exercises with facility staff**
Minutes of meetings	Keeps track of decisions and topics discussed in periodic meetings;	Very infrequent meetings by users of the lab; decisions and actions decided not always followed up.	Digital minutes, saved in the public disc of the core facility; periodic programmed meetings at defined times with a list of topics to discuss; Follow-up on topics discussed in previous meetings by validating the minute.
Equipment "log file" registry	Keeps track of the use of equipment and maintenance programs. It is a physical support for users to register real-time problems occurring during analysis.	Need to be printed out for users; Each piece of equipment has its own personalised registry form.	Extinguish physical registries on paper and turn them into digital, linked to the scheduler portal.
Report 1 from the scheduler (grouped by user)	It is a document created automatically from the scheduler portal, containing the registry and information regarding all scheduled assays performed in a data interval for each equipment. Report 1 groups the assays performed by the user, listing the number of times a user has visited the facility and used a piece of specific equipment.	It requires further processing in data software such as Excel to render the information needed for invoicing by the financial department. Consumables used are not correctly registered when scheduling the equipment, which leads to this information	Adapt the content to generate only the information the financial department needs without further processing and administrative burdens. Integrate information from the physical written registries of each piece of equipment.

Document analysed / designation	Purpose	Problems	Improvements suggested from brainstorming exercises with facility staff
Report 2 from the scheduler (detailed)	As Report 1, it is also generated automatically from the scheduler portal. It contains all detailed information about all reservations done in a specific data interval for each piece of equipment.	being checked on physical registries – in the "log file" of each equipment.	
Clients' contract document – *"Ficha de requisição de ensaios"*	It is a document stating the contractual information established between the (external) client and the core facility, represented by the technical staff, following a request for an assay/service. It contains information about the methods, equipment, analysis date, sampling, sample prerequisites, estimated budget and agreement with confidentiality issues.	It needs to be filled in previously to the analysis; it is only valid in physical form, which implies that to be validated, it needs to be printed and digitalised to be signed. It always needs to be updated at the end of the assays.	Extinguish physical registries on paper and turn them into digital, linked to the scheduler portal. Allow validation of the contract established to be made by e-mail or digital signature.
Core facility's webpage in the Institute's internal Portal	Disclose information about the core facility: inform about the rules for access and use of the platform (user policy), disclose the technologies and resources available, applications, services, training, publications and partnerships.	Information was repeated, links to each technique were unavailable, and publication updates on this pag1e were not done regularly.	Update contents regularly. Separate information regarding applications and technologies. Include links for access to publications.
Monthly maps of services for invoicing – *"Mapas de utilizadores"*	Aggregates information necessary for future invoicing of the services. The maps compiled information regarding all monthly core facility users and clients, with a time of use for each piece of equipment, consumables and methods used.	Aggregating this information through reports 1 or 2 from the scheduler portal is exhaustive and, many times, erroneous compared with the written registries.	Adapt the content of the reports from the scheduler portal to generate only the information needed by the financial department without further processing and administrative burdens. Integrate information from the physical written registries of each piece of equipment.
Assay reports	Deliver the results and interpretation, comments or analysis of the assays requested by the client.	Only available for external clients and performed as an extra service and cost; The layout is rigid.	Change the layout to allow some flexibility for change and adaptation to clients' needs.
Scientific Posters	Give visual information regarding techniques and equipment available for	It needs to be updated;	Update content; Create new posters for new technologies;

Document analysed / designation	Purpose	Problems	Improvements suggested from brainstorming exercises with facility staff
	training moments and visits to the facility by external visitors.	Light exposition and conditions are not the best; Posters are not placed near the equipment.	Change to digital posters; Replace posters closer to the equipment.

4.3. Interviews results

The analysis of the interviews aimed to identify critical variables and gather rich and in-depth information about the users' experiences, perspectives, and meanings attached to certain experiences. It sought insights and suggestions to extract value for further working in the ideation phase. By interviewing users, it was possible to understand their motivations and decision-making processes, exploring the factors influencing their choices and behaviours within the study's context. By interviewing other external stakeholders, it was possible to grasp an outside and unbiased perspective of the services. Additionally, the interviews provided information about the environmental context in which users' experiences occur, including the impact of context on their perceptions and behaviours related to the investigated phenomenon.

The hope was that the interviews results would allow for the discovery of new or unexpected information contributing to theory development or generating novel insights, exploring unanticipated themes, patterns, or perspectives.

Regarding the general emotions perceived during the interviews, from the tone and speed of the conversation, most interviewees showed interest in discussing the questions addressed. When their personal experience from the core facility helped the interviewee answer more thoroughly and allowed them to give suggestions, their emotions and sense of contentment increased.

For gathering emotions from the interviews, it was essential to pay attention to various aspects (Kouamé & Liu, 2021). Some critical elements considered included verbal cues that provided direct insight into their emotions: often, the interviewees said: "good idea", "interesting", and "Better". These verbal cues indicate good feelings, resonance, and understanding of the topics. Another aspect assessed was the tone of voice. Most interviewees showed interest in the matters discussed, denoted by the rise in the volume of the interviewee's voice. The engagement and sentiment scored lower on the external stakeholders' interviewees, as shown and marked by the

Read software, which enabled to analyze body communication. Facial expressions also allow for inferring underlying emotions. Smiles were recurrent when interviewees gave suggestions and talked about their past and personal positive experiences, while frowns and raised eyebrows were more noticed when users referred to bad experiences and problems. Regarding the body language denoted, the posture, gestures, and movements were typical for a conversation. Eye contact indicated interest and engagement.

For some questions, especially regarding, for instance, the facility's human resources, all interviewees denoted periods of silence and pause, which most likely suggested some uncertainty or reflection to allow to answer.

The interviewer's empathy and active listening helped the interviewees respond and encouraged them to open up and ask follow-up questions. In this sense, the open-ended follow-up questions allowed for exploring the interviewee's experiences more profoundly and even elaborating on their feelings.

Emotions are always complex and subjective; people express and interpret them differently. Therefore, although some perceptions were discovered and assumed, it is wise and sensitive to avoid making assumptions based solely on feelings and perceptions.

Hence, the content and insights obtained from the interviews was carefully investigated.

NVivo R1 software allowed to aggregate and visualise the amount of coding through topics and, by this way, to understand which issues were covered and referred by the interviewees as more important. From the hierarchy designed through NVivo, it is possible to visualise that the most covered topics were training, equipment & tools, pricing, and social media presence.

Figure 5 - Hierarchy chart of topics in interviews (Author, 2023, adapted from NVivo R1).

Illustrative quotes:

To glimpse the profundity of the conversations, below, in Table 8, are illustrated some comments related to the most featured topics coded.

Table 8. Cross case/interview analysis on most common topics referred by interviewees

Broad Topic	Topic	Illustrative quote
Communication	Social Media	"I think the facility should have a greater presence in social media, especially in Linked-in."
	Disclosure by poster and flowcharts	"The disclosure should be done in the portal, website, posters, and directly within the research groups and meetings. The posters are outdated in the facility."
	Complaints	"If you use AI tools, you can have an online channel for complaints."
	Merchandising	"I was using a pencil from your facility! Without knowing, I am promoting your facility."
	Business relationship	"It was very easy, and I will say it is, overall, excellent."
	Awareness	"There are few people aware of the facility from the universe of the academia".

	Disclosure through website	"The facility needs its own website; the institute's portal does not work very well. I think it would be useful to have a testimonials area on the core facility's website."
	Recommendation of the facility	"Satisfaction and spreading the word is the best way to share the experience. I defend the idea that a satisfied client will be the best promoter of the service. From the facility's perspective, this can have a disadvantage: sharing some shortcuts and tips to avoid paying the total price or giving advice that might decrease the income for the facility."
	Results disclosure	"I would agree to share my results on social media if my supervisors also agree."
Training	Training	"The training is one of the crucial steps of the facility and one of the reasons it is so successful and interesting. The training received is adequate, in which the basic principles of the equipment and its operation are explained. The follow-up policy for the first users is excellent for building user confidence and ensuring that the procedures are being applied and settled."
Equipment & Tools	Customer Experience	"Online registering is a good idea to save time and resources (paper) as well as to avoid the unpleasant task of interrupting the analysis to print or to get more paper registries".
	Equipment & Tools	"We should have one machine of the platform that you can book the week in advance and another one you can book on the day."
	Roadmap analysis	"Really nice idea, that would be really a nice approach, I believe. Because since you or another technician have experience in analysing the samples, you can analyse with this instrument, and then later on you can use another instrument to validate the research with the same samples, saving time and money while using the same samples."
	Management of disk space	"I think it would be a lot easier if the IT department would write our file names and limit the number of files on the main page because there are too many files to save!"
Pricing & Invoicing	Invoicing	"…The invoicing takes too long to be sent to the customer."
	Pricing	"I do not agree with having discounts based on the number of samples or analysis because it can lead to unnecessary assays."
Artificial Intelligence, Blogs, Chats & Digital Tools	App	"An integrated mobile App for the institute is essential to be implemented. It could include the scheduler, keyword search, people and even a chat."
	Artificial Intelligence	"Artificial intelligence might be used for data treatment, especially for creating algorithms or also in chats to assist users in their questions to the technical staff."
	Blog	"I think chats and blogs could be an interesting feature for first contact, but I really think personal physical contact is crucial."
	Digital request for analysis	"I suggest having a digital and automatic way for asking for analysis and also a system for sending the samples, with the correct conditions."
Time and Scheduler issues	Time and Scheduler issues	"Scheduling online, definitely, but some equipment should revise the number of hours available to reserve, as well as the minimum time to reserve".

	Time and Scheduler issues	"I think, as I say if we had a document where we could see other uses of machines or a document that says "in case this machine has too many people using it during the week, you can also get results based on this from another one"."
Human Resources	Human Resources	"I think the service is better and quicker if the human resources are 100% allocated to the facility."
Strategy of the facility	Strategy of the facility	"I think that the core facility should be independent of the institute until a certain level. Perhaps the facility could decide on the new equipment to buy since it has contact with the users and therefore knows their needs."
Quality issues	Quality issues	"I trust the results from the facility because I know the facility and the people. But it would be even more trustable if the facility were certified or accredited."
Access to facility	Access to facility	"The access is simple and efficient; I think it is essential for internal control and to understand the flux of people in the room, and if there is any problem, it might be helpful to discover the source of errors or issues related to unauthorised or negligent access."
Competition	Competition	"I do not have any idea of companies proving the same kind of services that the X core facility provides, so I do not think there is any competition besides other core facilities from other institutes."

In the following graph, it is possible to compare the number of references for each topic. It is interesting to notice that the topic "training" was the only one which had aggregated occurrences, indicating that it has repercussions on the other issues.

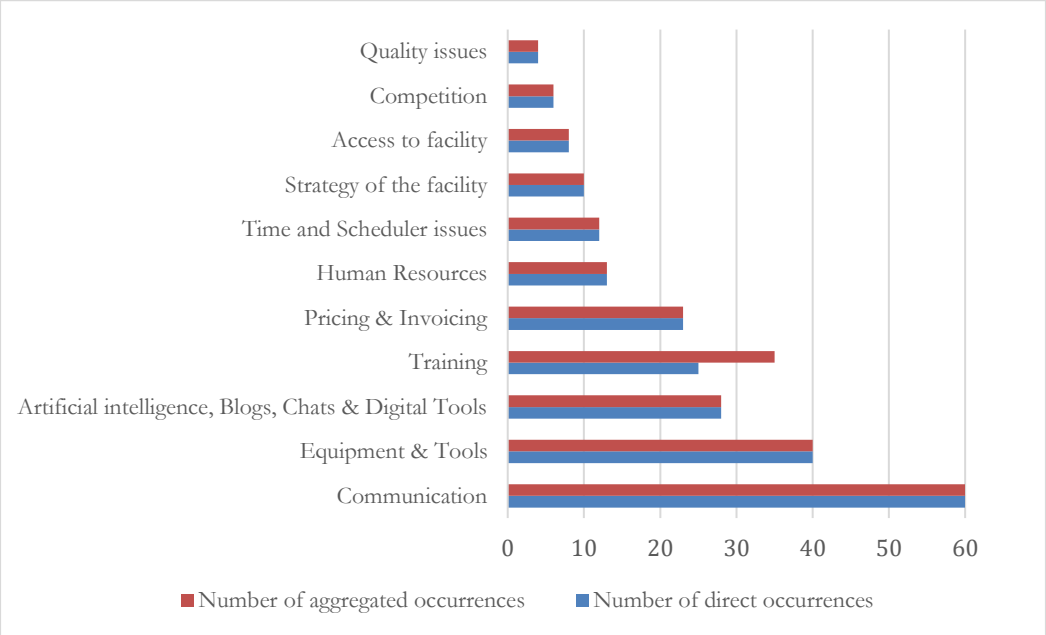

Figure 6 - Most common topics referred in interviews and occurences (Author, 2023)

NVivo R1 software also allowed the clustering of items by coding similarity. The hierarchy framework designed through NVivo aimed to discover possible new dimensions not considered by the interviewees or the researcher, or eventually link topics that were thought to be far apart one another and completely independent. Although some new dimensions could be generated and explored, further analysis did not consider this, since in some cases, the clustering did not make sense, as for instance "awareness" appearing together with "complaints".

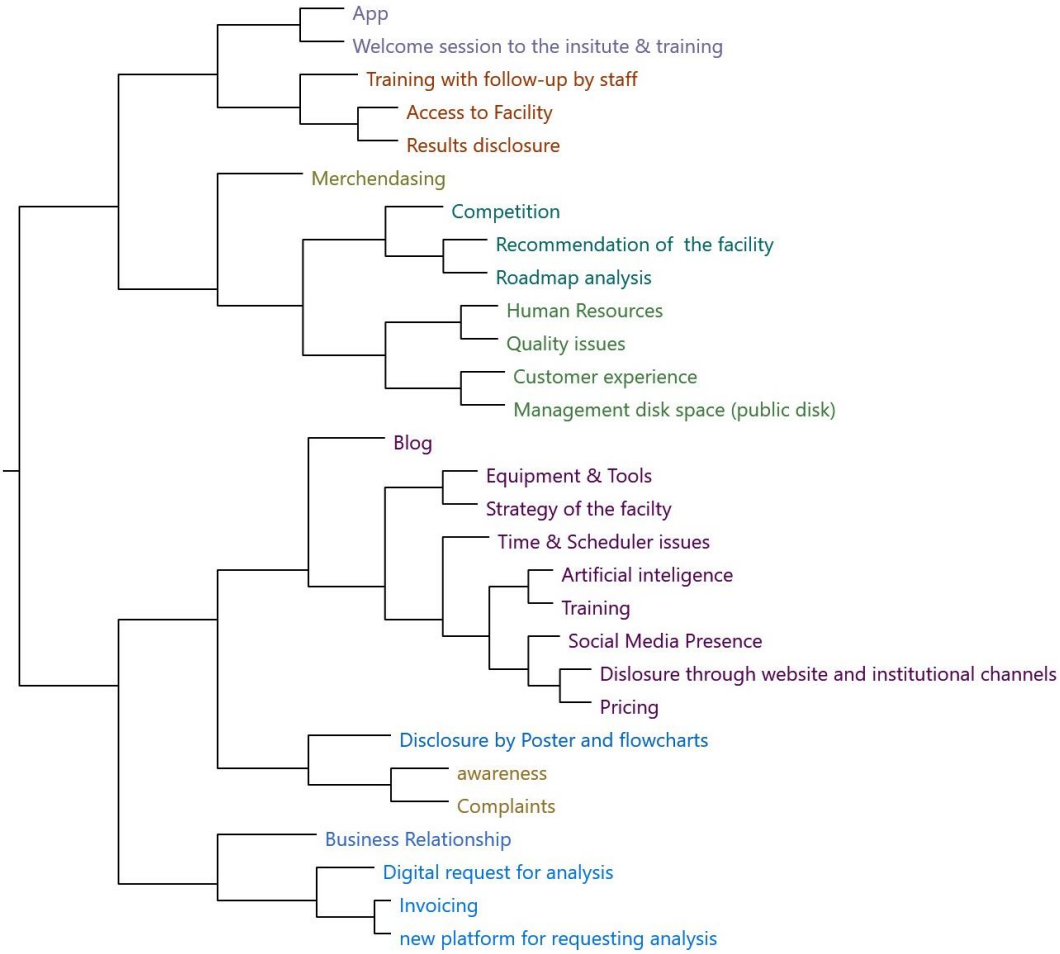

Figure 7 – Items clustered by coding similarity (Author, 2023)

As a qualitative investigation, this study focused on the meaningfulness of the ideas and concepts from the interviews. Therefore, the following results were collected to be potentially explored in the ideation phase. They were grouped according to the main topic addressed, but each comment or feedback could aggregate several topics or ideas. The order presented reflects the importance or number of referrals and and the richness of comments, ideas, and similarities between them.

- **Communication:**
    - **Social media & marketing**

According to the interviewees, the facility's presence on social media is very low or nonexistent. The way things work does not allow updating the facility's news regularly. Therefore, the presence in social media should be reinforced, especially in Linked-in. It could be done through podcasts, reels, shooting some videos of the facility, etc. The reels could even be used to show new

experiences and unconventional analyses done on the facility to show off the techniques. It could divulge the facility by showing small moments of the work done with practical cases.

If images are present from bio-imaging processing, then sharing through Instagram would also be interesting.

All these videos and materials could equally be used internally to promote the facility and its equipment within the research group's meetings and with links on the website and the official newsletter.

Overall, promoting and disseminating the platform through social media is believed to be essential for its visibility and to help increase service awareness. A more prominent online presence would help reach more potential users, especially external ones and collaborators.

The facility should also incentivise users to promote their own work on social media and refer to the facility, as most users are said to be acceptable sharing results through social media. These marketing strategies through social media are aligned with the suggestions of having user testimonials and case studies to show off the facility so that the core facility managers could request feedback and testimonials from satisfied facility users. Then it would be necessary to create a "post" and highlight their success stories, publications, or achievements made possible through the facility's support. The facility could even develop special case studies to demonstrate the impact of the facility's services on research outcomes. Then it would be necessary to share these testimonials on social media platforms to build credibility and attract new users.

- **Disclosure and website**

The institutional channels available – website & portal need to be improved and updated; included in this topic was suggested the design and implementation of a user space for clients to request the services directly online, with the possibility of sending the samples.

Globally, better disclosure of the services and specific information about the technologies needs to be improved, both digitally, on the official website and portal and in the official social media, as well as physically, in the core facilities. The best way defended by users to disclose the facility is physically through information by leaflets and digital content through social media. Fairs and events are also an excellent way to promote the facility. Users argue that brochures are essential to share with users, especially for new users to the facility. Another vital tool is the posters affixed on the wall in the facility. Some users defend that the posters available are outdated, although they are handy for training periods and visitors.

For internal users, especially, interviewees believe it is helpful to disclose by email all equipment with some frequency.The institute's and core facility's websites are one of the tools interviews mention several times. Interviewees believe it must improve significantly – it should be

more easily navigable, visually appealing, and regularly updated with relevant content. It should include a search engine to refine searches within the institute. It should consist of more comprehensive information about the services, contact details, and testimonials from satisfied users. It could highlight their success stories, publications, or achievements made possible through the facility's support.

The institute's website lacks a proper database containing all equipment available from all service core facilities and laboratories.

According to the interviewees, the visual appearance related to the website, logo, and other marketing visual tools of the facility is essential, especially for users who do not know the facility, as it is said, "the first impression matters" and "you do not have a second chance to give a good first impression".

Another question raised is related to access to the institute's internal portal. It automatically blocks all access after the terminus of the user's contract. In this sense, one of the suggestions is for the portal to remain active and open for all users, including external ones, even with different privileges.

Another improvement would be to promote a website with the core facility's potential at the UP level – with a network of universities or research centres so that any company or research centre could get in touch. Indeed, users complain that UP core facilities are not linked; some offer the same services instead of complementary ones.

- **Complaints**

Most users do not make formal complaints, although they defend it could exist a digital place where to expose complaints, as well as suggestions and even recommendations and compliments, especially for external users.

- **Merchandising**

During one interview, the interviewee noticed she was using a pencil from facility X. Without being aware, the interviewee was divulging the facility. Nowadays, merchandising is extremely important. All companies use these marketing tools, and the facility should continue to use them, too, if it wants to stay competitive.

- **Equipment and tools**

Some comments and suggestions were noted regarding all matters related to equipment and tools and management issues related to this. Several users reinforce the need for online registering instead of registering on paper in each equipment logbook to save time and resources (paper). Exclusively online registration is also helpful for automatically recording the correct time of use and user since it could be done when logging in to the equipment.

Another suggestion is to provide more information on alternative equipment – this information could be placed directly in the portal, next to the equipment or through other approaches. It would be helpful if there existed a document stating other uses of equipment or alternatives in case a piece of equipment is being highly used and has limited availability for short-period reservations.

It would also be very interesting if the core facility could provide some duplication of highly requested and overbooked equipment. Therefore, the facility could guarantee one piece of equipment for extended, highly intensive use, booked in advance and another for use "on the hour", with more availability for short use.

Users criticise the speed of the computers linked to each piece of equipment. Users suggest the IT (informatic technology) department regularly update the computers and operative systems, format and clean them from excessive files.

One exciting suggestion was to implement in each piece of equipment a QR (quick response) code to a link for access to the schedule and other important information related to the equipment through the mobile application. It would be a simple, fast and very straightforward strategy to disclose all information necessary for a piece of equipment. It could equally be implemented a QR code of the platform physically on the door that gives access to the facility. The QR code could send visitors or new users on a virtual tour to complement the visit to the facility.

It could equally be present in the portal, next to the scheduler. The data retrieved by the managers from the activation of these links could also be used to promote the facility and internal management.

Interestingly, another suggestion from users was to add physical data and information next to each piece of equipment related to troubleshooting or help in some procedures.

Some users also suggested a novel digital tool for requesting analysis instead of emails. Through the portal or website, there could be a more automatic way to request the analysis and a system for sending the samples with the correct conditions. In this platform, it could have listed the information of all history of analysis from the customers.

- Roadmap analysis

The roadmap idea emerged from the literature review - a sequence of analyses on the same sample (if applicable) with different techniques accessible by the facility. This idea was somehow questionable by users. On the one hand, it would be an interesting concept from the perspective of optimising samples, resources and complementarity of techniques. However, it could be less functional and perhaps expensive when applied in the phase of validating processes – in the initial stage. On the other hand, given the size of the institute and the influx of users, there were some reservations about the ease of implementation/articulation of the availability of the various devices for this "script type" analysis. In addition, users referred that an error in one of the equipment would make the entire process and previous studies unfeasible. Users believe it to be best to standardise only in exceptional cases. Perhaps it could be helpful for some external clients and companies. Another argument was concerning the staff availability for this type of task.

- **Artificial intelligence, Blogs, Chats & Digital Tools**

Interviewees referred to the possibility of implementing blogs, forums or chats powered by artificial intelligence. According to the feedback obtained, these tools could be helpful to gather information from other sources to give a different user experience; blogs and chats are good choices and options to communicate instead of e-mail since they provide faster feedback. Chats similar to WhatsApp could be a different way to communicate. Through forums and blogs, users could communicate between themselves and allow to figure out what would work or what would not work, saving time and money.

The chats are suggested as a channel to clarify doubts or technical difficulties. It could even be linked with Artificial intelligence. It could be an easily accessible tool for immediate communication. Then if further explanation were needed, it could be forwarded to the staff. However, users state that implementing this tool would imply the availability of a response from the person on the other side to answer the questions. The chat could have some triage to solve this, and artificial intelligence could assist.

- **Training**

Researchers often need a complete idea of what can be done at the institute with the available resources. So, a welcome session and additional training moments, such as workshops or a one-day moment of training periodically, is something desired by users, especially internal ones. This welcome training session should be the first thing for new users to do. It could be a standardised procedure of the institute for new members. Users refer to it as equally important as to organise workshops on an extra training period, to complement the training already given in the

context of the analysis, or to get acquainted with new technology. Another similar idea is to promote specially organised training/workshop actions showing the potential of the platform and equipment, with, for example, technicians or researchers who are experts in the techniques or equipment. The idea is to show advanced capabilities and applications, not only the basic principle.

Nevertheless, the margin to improve, users state that the training is one of the crucial steps of the facility and one of the reasons it is so successful and interesting. The training in place is generally constructive, targeted and personal. It is "hands-on" and allows users to take and test their samples, be more at ease to talk to the staff and avoid making mistakes. The training received is adequate, in which the basic principles of the equipment and its operation are explained. The follow-up policy for the first users is excellent for building user confidence and ensuring that the procedures are being applied and settled. Some of the most common errors and warnings should be highlighted in the training to avoid future problems. There should exist physical troubleshooting available for each technique.

Users refer that training facilitates the communication and closeness of the scientific platform member, associated with a piece of specific equipment and applications, to the job to be done by the researcher. It is considered an asset and security at different levels to have a trainer/technician close by in case of a technical problem with the equipment/ software. In addition, the technician will also be able to monitor and reassess the equipment and user operation whenever necessary. Overall, the staff responsible for training is competent and willing to help and explain the concepts and operations. The team provides excellent support, is available, and readily shares ideas and suggestions for improvements.

Some users say it would be interesting to create digital content regarding the equipment and operation principles to refresh the information to users. However, training should never be solely theoretical. Users would agree that training could be both theoretical online and then practical, more "hands-on".

Another feature suggested regarding training is implementing and disseminating a document/poster/flow chart for informing about alternative equipment or assays.

One issue about the training is the online evaluation process – it is not user-friendly. Besides, it is suggested the implementation of a channel for requesting training with preferred timeframes.

All scientific core facilities should offer training as a service, even for users after their PhD, when working in the context of companies. On the other hand, these training sessions could be used for special university credits framed within the context of specific graduate courses.

- **Pricing, Invoices and related issues**

Regarding the pricing, interviewees refer that the pricing of the services is not accessible for easy reference. For external users, the pricing should be readily available on the website of the core facility. Though, some users rather defend that for external users, the prices of analyses should be disclosed only by request as a quotation.

For internal users, the services' prices should be disclosed directly on the equipment registries and be made more aware directly in the research group.

Feedback from the interviews confirms that invoicing takes too long to be sent to the customer. Even internal users state to have a different idea of the prices of each service because the invoices arrive at later stages with all the fees together regarding all equipment and services used.

In most opinions, having discounts with more sample analysis makes sense. However, some users believe there should be no discounts because it can lead to unnecessary assays. Some users defend the existence of packs of analysis by numbers that could be applied: (e.g. ten samples x€, 10-30 samples y€ and >30 pieces z€). It could also be used to add other assays in other techniques.

Another issue users question is the pricing of the service depending on the hour of analysis: if the research is done on the weekend or after hours, should it be more or less expensive due to the technical support?

An alternative and completely far-apart suggestion is to have the pricing by equipment rather than a prepaid method. It was suggested that all internal groups pay in a poll for all of the missions and analysis; instead of giving users individual prices, internal group users of the institute could have a given, pre-defined analysis time per week.

- **Human Resources**

As for the facility's managers, some interviewees defend that the managers should be very sensible people to educate and simultaneously impose rules without pushing away new users.

- **Time and Scheduler issues**

Concerning scheduler issues for the equipment in the facility, most interviewees agree that there could be a more efficient and streamlined scheduling system with a mobile app. Some internal users suggest the incorporation of notifications about scheduling and information about "on-the-hour" cancellation and availability. When the appointment ends (for example, 15 min before), there could be an alert if another user follows.

Regarding scheduling rules, it was suggested that some equipment should revise the number of hours available to reserve and the minimum time to book to avoid abusive

appointments during whole mornings, afternoons, or even all day during the same week and make other users unfeasible to reserve.

Overall, scheduling in an app rather than through the portal could be more straightforward since researchers are always on the move in the lab, and the portal scheduler is reported to not work as well on mobile devices. Nevertheless the general acceptance, some users refrain from this online option because it could lead to less seriousness by allowing anyone to reserve freely without judgment of agenda and planning.

- **Strategy of the facility**

Regarding the facility's strategy related to working and marketing, all interviewees believe the core facility should be open to all, both internal and external users. The capacity should be evaluated to ensure the priority for internal users. However, for instance, it could have a day of the week open for external users.

The facility has equipment of high functionality and quality that clients from the industry should render profitable. However, it is essential to mention that the equipment must be certified and the techniques valid to be attractive and credible to companies. It is economically advantageous for companies to pay for a service rather than acquire equipment, so the facility should take advantage of this.

The facility cannot be totally independent of the institute since it depends on funding from the institute. This conditions all other decisions from the facility, including purchasing new equipment. However, users think that the facilities should be more independent from the institute, at least to buy new equipment and update the computers and software.

Current financing programs defend the philosophy of 1/3. This means that institutions should have 1/3 sales and services provided, 1/3 basic research and 1/3 competitive projects to be suitable for financing. According to one user, this should be considered by the institute and its core facilities.

- **Access to facility**

Users believe access to the facility is simple and efficient; It is essential for internal control and, therefore, must be restricted. The rules implemented help to understand the flux of people in the lab. Also, if there is any problem, it might be helpful to discover the source of errors or issues related to unauthorised or negligent access.

Regarding access to the results files, some users agree with the facility's use of public internal disks instead of USB pens. If users have issues regarding the confidentiality of their

samples, they can use internal codes in addition to the sample code necessary to be given by the facility.

- **Competition**

Most interviewees have difficulty naming other direct competition regarding core facilities. They do not have ideas of companies providing the same kind of services that the X core facility offers.

- **Quality issues**

Regarding quality issues, users generally trust the results from the facility because, as referred to, they know the facility and the people. But then again, it would be even more trustable if the facility were certified or accredited, especially for external services for companies.

4.4 Ideation results – theoretical frameworks

In the ideation phase, the service concept of the services was designed, resulting in several frameworks/blueprints to help understand the value for the customer. Some interviewees helped and criticised the development of these frameworks. Creating service blueprints helps to visualise the end-to-end user journey and the various touchpoints users have with the facility. Likewise, these frameworks help identify potential bottlenecks, gaps, or areas for improvement within the service delivery process. One can identify opportunities to streamline processes, reduce waiting times, and enhance the overall user experience by mapping out the service journey.

After collecting all the data from the previous phase, the first framework designed was the customer journey. Additionally, a profile of an average customer of the services was created through the personas (figures 8 and 9).

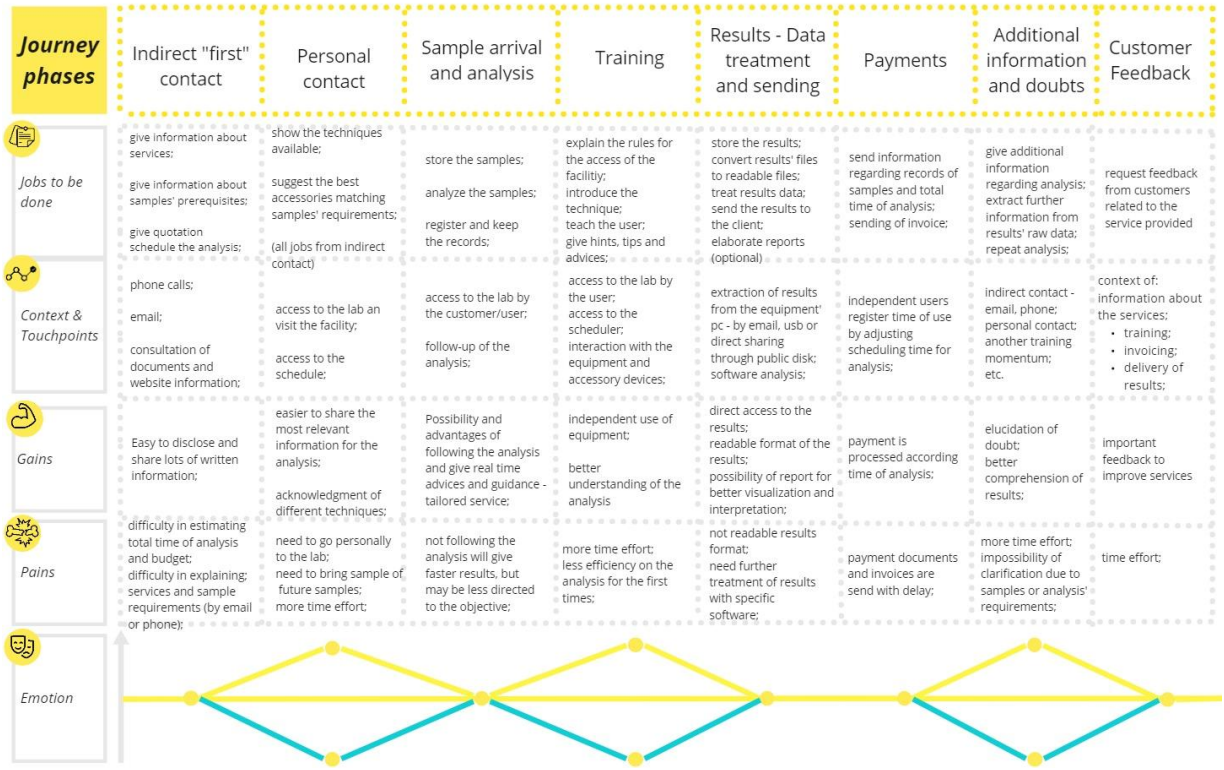

Figure 8 - Customer Journey for X Core Facility (Author, 2023).

Understanding the customer's journey helps in the process of creating a persona profile of an average customer. Two types of clients were considered for the core facility chosen as a study case: internal and external. Each persona represents a different motivation. Dário represents the most common user of the facility: a PhD student with frequent interactions. In contrast, Clara represents an external user with less frequent interactions with the facility but perhaps more exigent requirements.

NAME: Dário Redondo
GENDER: Male
AGE: 29
FAMILY STATUS: Single, no kids
LOCATION: Cuba
LIFESTYLE:
Sports - running, gym, martial arts
Reading and studying
Travelling (hiking)

EDUCATION: MSc Biology
OCCUPATION: PhD Student
EXPERIENCE in the lab: 3 years

NEEDS AND ASPIRATIONS
Publish enough papers to defend PhD
Resources to find techniques and equipment for pursuing analysis
Work less hours a day

NAME: Clara Neves
GENDER: Female
AGE: 38
FAMILY STATUS: Married, one son
LOCATION: Portugal
LIFESTYLE:
Sports - Yoga, gym,
Movies, plants and photography
Travelling (snorkelling)

EDUCATION: MSc Chemical engineering
OCCUPATION: technology
EXPERIENCE : 10 years

NEEDS AND ASPIRATIONS
Contribute to achievements in science
A work with meaning (extra value) and adequately rewarded
Have more free time

Figure 9 - Personas representing the real customers of the service (Author, 2023).

By delineating the customer personas, it became possible to delve into and uncover their unique customer experience. Understanding the intricacies of the customer experience is crucial for providing exceptional service and gaining a competitive advantage for the facility. To facilitate this process, a model framework, depicted in Figure 10, was employed to capture, identify, and systematise the comprehensive and multifaceted information that shapes the customer experience (Teixeira et al., 2012). This approach, known as "customer experience modeling" (CEM) as described by Patricio et al. (2011), uses a concise notation and offers an intuitive visual representation of the customer experience. The model framework defines several key parameters, as indicated in Figure 7.

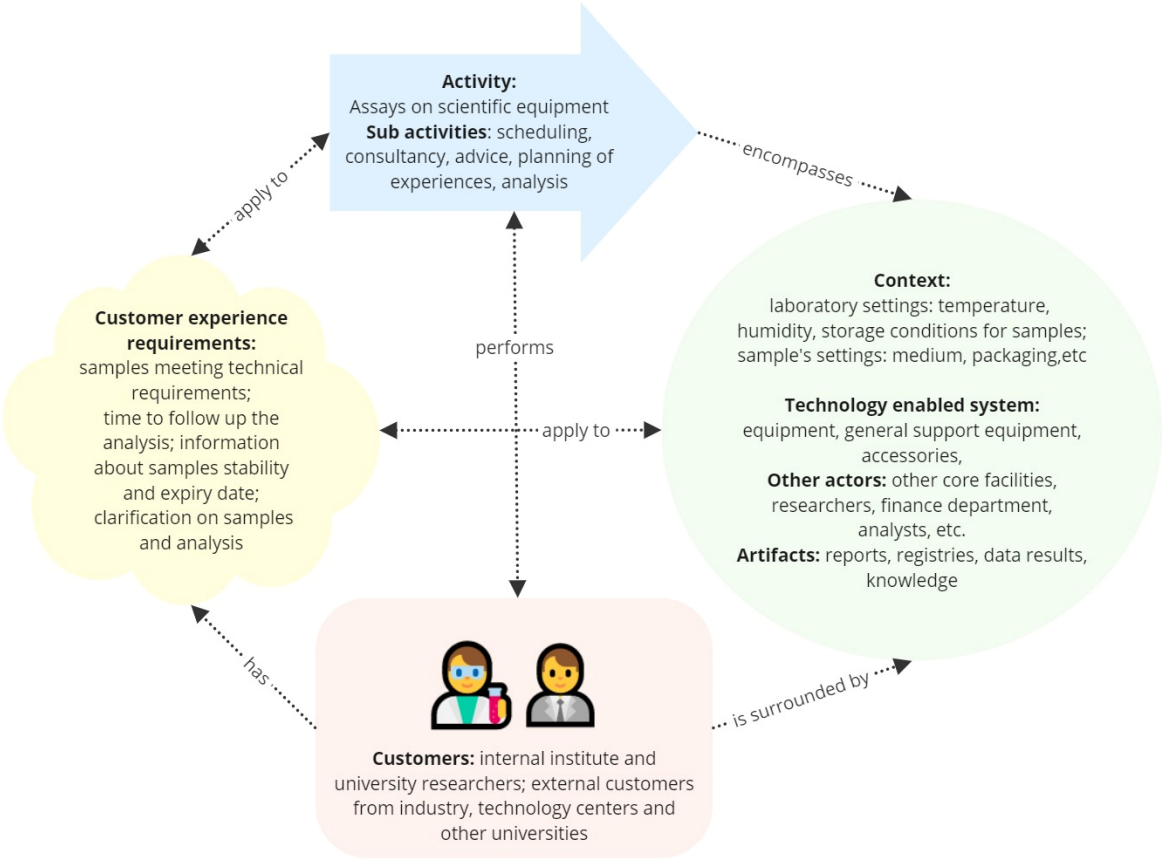

Figure 10 - Customer Experience Modeling (Adapted from (Teixeira et al., 2012))

In essence, with this holistic nature of the customer experience information onboard, it was possible to understand the customer experience better and provide valuable insights to support the rest of the service design process.

An additional noteworthy aspect is the co-creation of the customer experience through interactions with various service elements. It was possible to detect this in the interviews performed while listening, for instance, how the interviewees used to behave and adapt, facing some less "user-friendly" characteristics of the service provided.

This proves customers co-create unique experiences through interactions with a service provider across different touchpoints, responding differently to the designed elements.

Service concept and service system design/product architecture

When (re)designing a service for the ideation process, as proposed by Patricio et al., one can consider three levels for the MSD (multilevel service design) (Patricio et al., 2011):

- "Service concept" for each customer group;
- "Service system" for the customer journey;

- "Service touchpoint" for each interaction;

The "service concept" represents the collection of benefits the service aims to provide the customer, encompassing the service itself and the established partnerships.

Within this service concept, one can define the "Value Constellation Experience" (VCE), which in turn leads to the "Customer Value Constellation" (CVC). The VCE derives from the Service Value constellation (Figure 11) and offers a comprehensive understanding of the values associated with the service being offered. It is co-created through the interactions between the customer and all the service organisations involved in facilitating a particular customer activity. By breaking down the different activities that constitute the value constellation experience and identifying the most significant experience factors, it is possible to gain valuable insights into the overall customer experience by designing another framework – the "Service Encounter Experience" (refer to Figure 13).

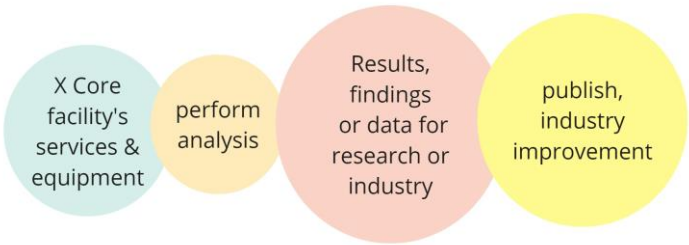

Figure 11 - Service Value Constellation (Author, 2023)

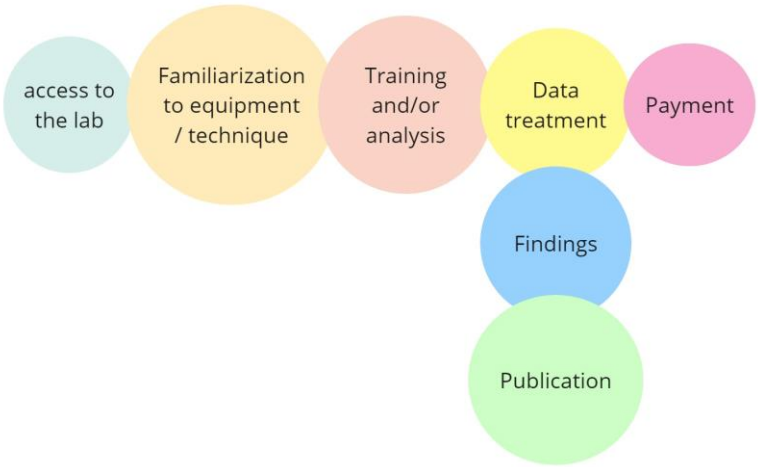

Figure 12 - Service "Value Constellation Experience" (Author, 2023)

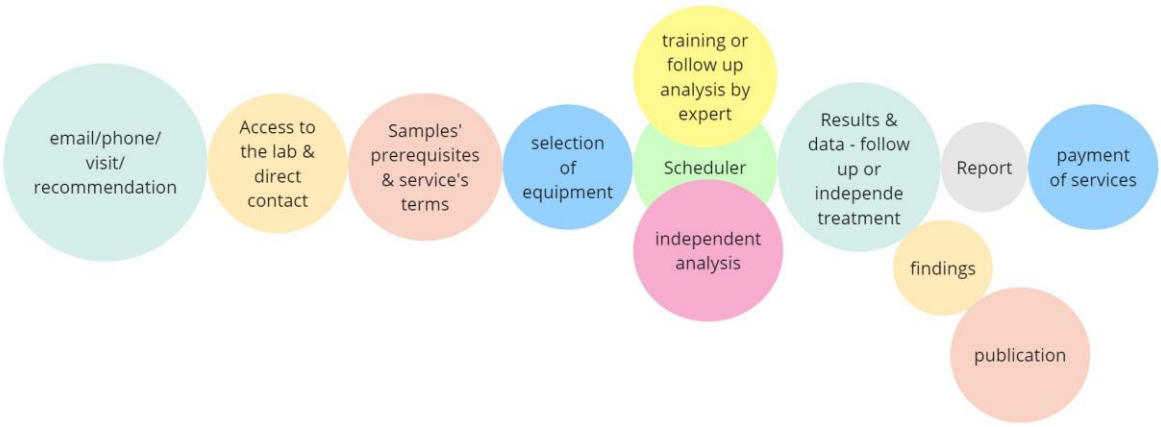

Figure 13 - Service Encounter Experience (Author, 2023)

Next, based on the "service value constellation", the improved Customer value constellation (CVC) is presented below, representing the service offerings and the interrelationships. It follows this flower model representation where the principal customer activity is in the middle. A colour code for the different parameters /actors involved was represented for better understanding. In yellow are represented the main activities involved in the service offering, in blue are the main players and stakeholders involved, and, finally, in orange are represented other stakeholders indirectly involved.

Figure 14 - Customer Value Constellation (Author, 2023)

Following the Customer Value Constellation, the Service System Architecture (figure 15) was built. In this framework, is present not only the idea presented before of all the players involved and their relationships, but also an organisation of the sequence of activities and who performs them.

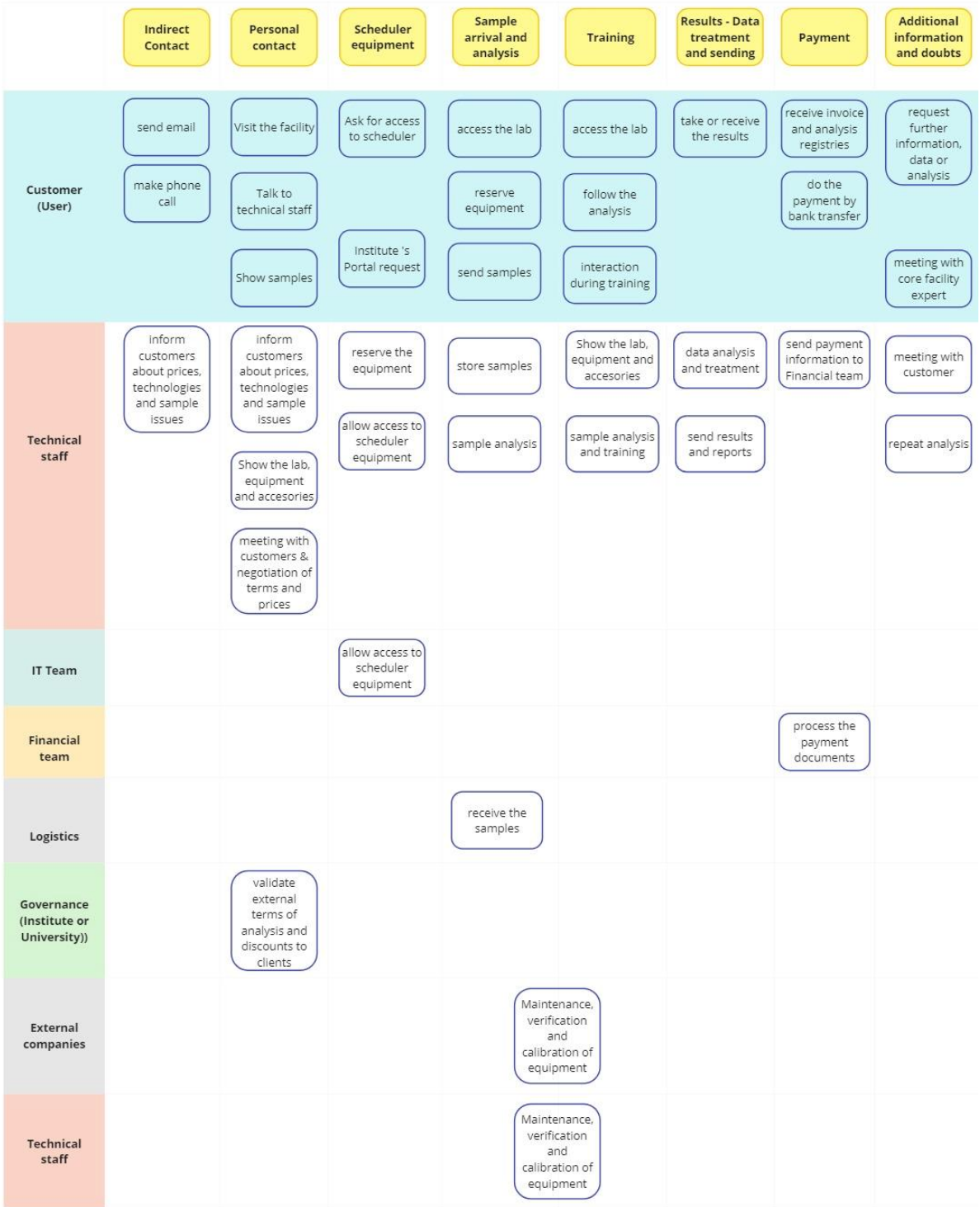

Figure 15 - Service System Architecture (Author, 2023)

Next, very similar to the Service System Architecture, is presented the usage Service System Navigation Architecture (figure 16), which can be useful because it specifies how the overall user interface breaks down into the interaction contexts: how they are grouped, how they are presented to the users, and how users navigate through them. Here it is possible to have an idea of all the **touchpoints** - which occur whenever a customer interacts with the service provider across multiple channels or stages.

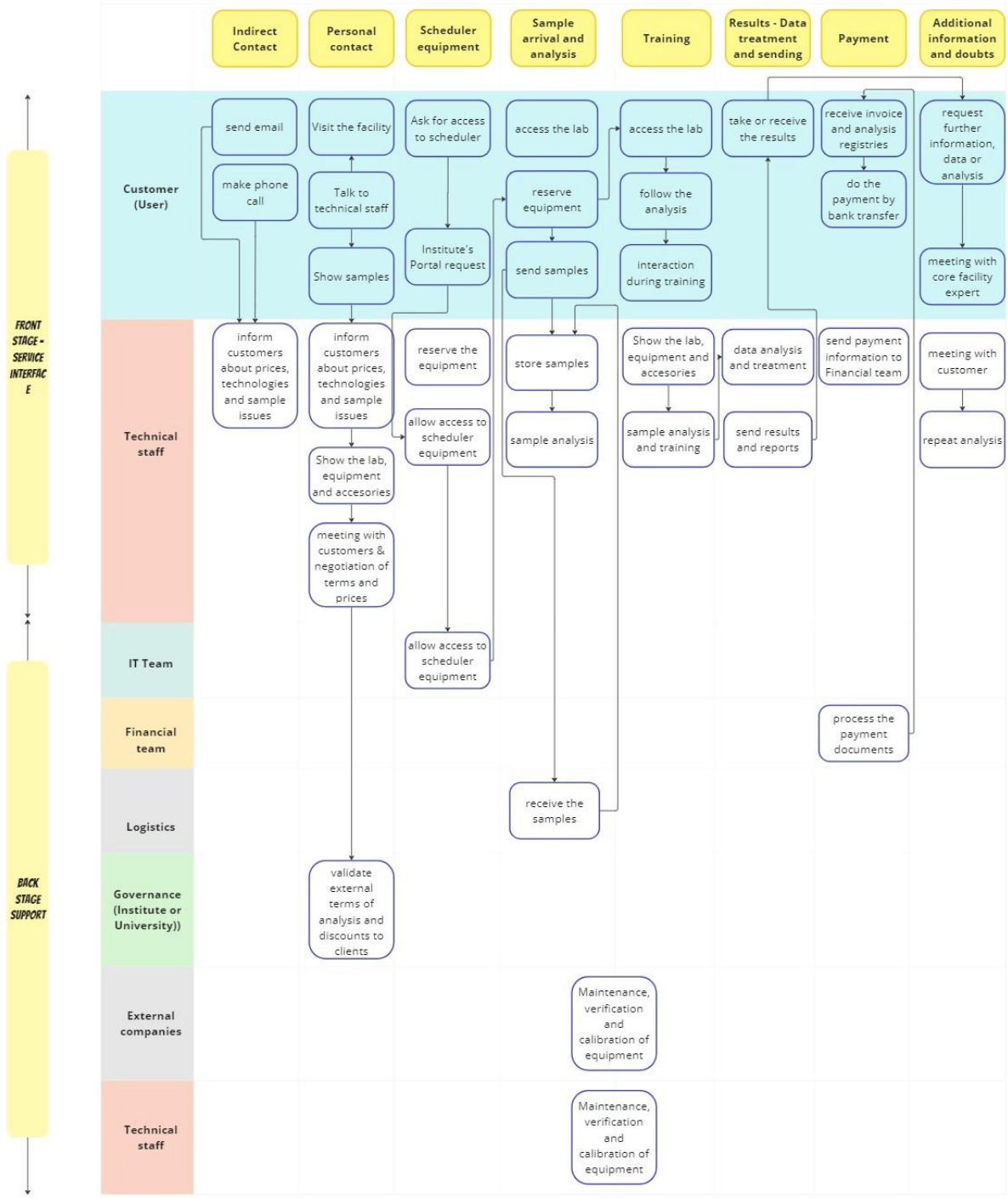

Figure 16 - Service System Navigation (Author, 2023)

Finally, to show and understand the service encounter experience, the Service System Blueprint was also designed, allowing to realize the relationships between the customer and other "backstage" players involved as well as critical key steps of the process (figure 17).

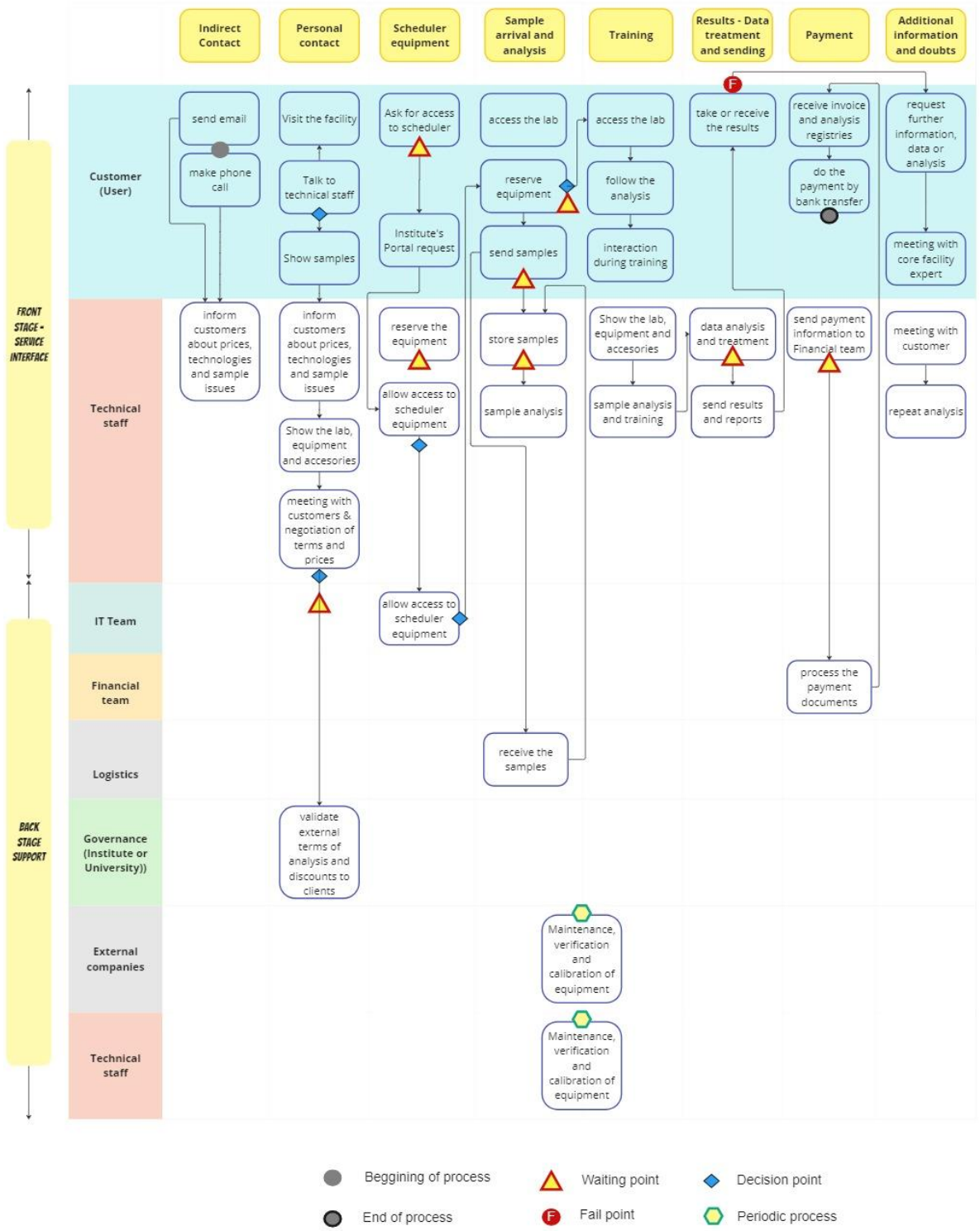

Figure 17 - Service System Navigation (Author, 2023)

To respond to significant problems reported not only by users, staff, and other stakeholders of the core facility, another framework was built to help explain the journey in a core facility but from the eyes of the financial department. In that sense, the framework below was designed.

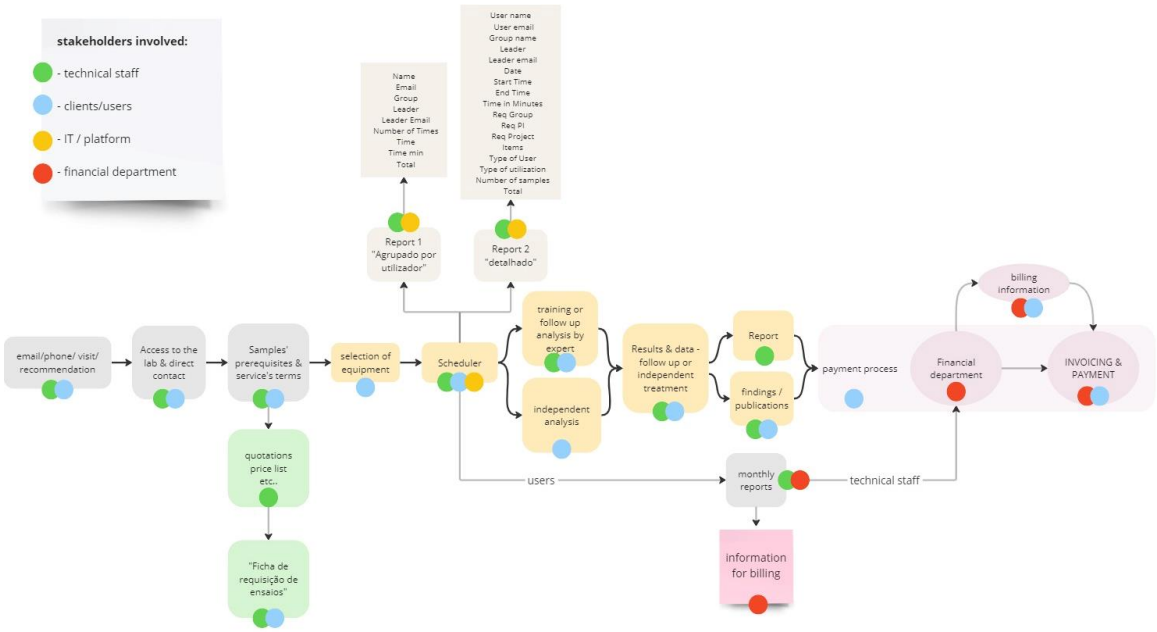

Figure 18 – Journey from the eyes of the financial part (Author, 2023)

4.5 Reflection and towards implementation results

The study focused more on the exploratory and ideation phase of the service design process since, to the end date of this study, it was impossible to achieve and show complete results from the reflection and implementation phases. It was not possible to create complete prototypes. However, some minor prototyping and testing of service improvements were undertaken, and new offerings based on the insights gathered were implemented. These "minor" prototypes tested were process flows, physical reports, posters and new digital features. The prototypes were tested with a subset of users of one of the equipment available for services in the facility and gathered feedback to refine and iterate on the designs. Only some results and implemented ideas will be more thoroughly detailed since others are still ongoing.

- Prices, Scheduler Portal & Reports

Following the feedback obtained in the first phases, one aspect tested and implemented was the new features in the internal webpage portal for scheduling. First of all, the prices of the services were analysed and updated. The price criteria were adjusted to meet the institute's practices and requirements. The adjustment was calculated with the support (in a co-creation setting) of internal

users, technical staff and group leaders. The prices were established considering several aspects, namely:

- The consumables' actual prices;
- Average inflation over two years;
- Average costs in maintenance over two years;
- Average use rate of equipment;
- Staff cost per hour.

With the new prices defined, the prices were automatically inserted in the portal scheduler, becoming visible to each user when booking the equipment. The reservation information is also followed by an email to the user. Complementing this process, the reports generated by the portal for internal management and invoicing were changed, improving the data retrieved by allowing to create reports with data regarding the user and the requester (payer). These new reports were described to be much more helpful for both technical staff and the financial department since they require less burden on administrative tasks for invoicing the analysis.

- X Core facility's webpage in the Institute's internal Portal

The webpage's contents with information related to the X Core Facility were updated, and the information regarding applications and technologies was separated for new users to understand better. Ongoing is the request for links to be available for access to publications.

- Meetings and minutes of meetings

Periodic meetings at a defined time were scheduled between facility users and other laboratories to increase collaboration: to discuss and give feedback on the problems of the core facility and improvements for the services, to meet the internal users' needs and desires, for a seamless experience.

For these meetings, the implementation of digital minutes was defined and saved in the public disc of the core facility; the first 5 minutes in each session addressed the follow-up on the topics discussed in previous meetings.

- Assay reports

The predefined layouts of the reports documents for external clients were adapted to allow flexibility and adaptation to clients' particular needs. Some reports were already produced accordingly to external clients' wishes.

- New equipment, Lab layout and Scientific Posters in the X Core Facility

The addition of new equipment and technologies to the lab implied a refurbishment of the physical space in the lab. Some equipment changed place due to the technical requirements of new equipment acquired. However, the new location in the lab for the existing equipment had in mind the users' opinions, ease of access, and a better customer experience. For example, one piece of equipment that needed compressed air for drying operations was replaced next to the compressed air pistol, thus allowing users to readily dry the accessories needed without travelling with samples across the room. In agreement with users' feedback and the general change in the labs' layout, the posters for each piece of equipment were replaced closer to each piece of equipment, thus allowing users to readily check the posters for doubts and for visitors to understand the principles of the technologies.

- QR (quick response) codes in the equipment of the facility

QR codes for each piece of equipment, with links to information regarding the person responsible for the equipment, specifications for samples, registry sheets, instructions, maintenance plans and history, are under development, and the implementation is ongoing.

5. Discussion

Figure 19 resumes the significant ideas and feedback from the service design process and the principal actions implemented. To understand the communication and management issues proposed in this dissertation, the initiatives that addressed these aspects were also highlighted.

Figure 19 - Summary of feedback, ideas and implemented actions in X Core Facility (Author, 2023)

The service design process was not completed. Even though, it proved to be very valuable for application in the X core facility, not only it facilitated to grasp of new ideas for implementing, as it turned the services more centred on the users.

The results obtained showed that users have a crucial part in the design of the service. They have opinions regarding not only their own work but also considering the rules and management practices of the facility.

The interviews showed that internal and external clients have, in fact, different needs. X core scientific facilities' offers need to be adjusted to their needs in all aspects, namely: the promotion of the services, the assistance in the service, complementary related services, and new digital tools offered.

In accordance with the literature review done, X core facility also needs to innovate to attract new users. Users demand new tools and features, easier access for requesting and scheduling analysis, and increased general awareness of the technologies. Users need a superior user experience. Also, users need to be retained by offering complementary services and analyses that are not initially requested.

Communication and management issues proved to be important areas for redesigning the services in core facilities. Having open channels for communication with clients in several ways seems an excellent approach to understanding them and delivering a better service. After all, services need to be personal. One can confirm the communication issues on the topics referred to in the interviews related to disclosure, training, pricing, equipment and tools, merchandising, etc. All these topics somehow covered communication issues – informing users, staff and other stakeholders, such as the suppliers, financial and IR department, and institute administration, among others.

Management issues are present in all strategies and decisions for new implementations, either in the rules imposed or in the ways of working with new tools and features proposed.

6. Conclusions

The primary objective of this study was to investigate and comprehend the integration of service design in the process of improving the communication and service offering of a scientific facility. In order to fulfil this aim, a qualitative approach was adopted, employing a Case Study as the chosen research methodology (outlined in Chapter 3). The study was conducted at an academic core facility. Within this case study, facility users were interviewed, and theoretical frameworks were designed. The findings from the exploratory phase were thoroughly analysed and discussed in Chapter 5.

Overall, qualitative interviews provided in-depth information that helped to gain a nuanced understanding of participants' experiences, perspectives, and the context in which they were embedded. Additionally, they provided valuable insights and suggestions, some of which were promptly implemented.

Service design proved to be a powerful tool for improving core scientific facilities' user experience and efficiency. In this sense, one can say that, as in any enterprise, it can potentially lead to better outcomes and more productive environments. In this case, the outcomes are increased, improved and more diverse scientific results.

Finally, to directly answer the research question proposed in this study, it was possible to prove service design as a novel tool for improving communication and management issues in core facilities. All processes and topics covered in the interviews and in the frameworks developed helped in the first point to get acquainted with latent communication difficulties and, in the second stage, to improve them by collaborating and co-creating with users. Service design helped the X core facility to hear out better and ultimately communicate with its users. For example, the newly refurbished website and the suggested mobile app are underway to make it easier for researchers to find information about available services, request support, schedule the analysis, track the progress of their experiments and payments and even receive updated notifications.

6.1 Limitations

One of the significant challenges encountered in this study was the difficulty in recruiting users to participate in the interviews. This was primarily due to reasons such as time constraints, limited resources, or simply lack of interest, which could pose limitations and hinder efforts to achieve a more representative sample. However, the study captured a sufficient diversity of dimensions within the different kinds of users' types. Additionally, it is essential to note that the nature of the subject matter introduces inherent limitations, as the overall process is dynamic and constantly evolving. On the other hand, users may only recall some steps of their interaction with

the core facility so accurately, and therefore is also a possibility of overlooking certain aspects, even though they were explicitly asked to discuss their interactions up to the present moment.

Given the constraints and limitations inherent in this study and the relatively scarce existing research on the innovation processes within core facilities, it is evident that further in-depth investigation is necessary to acquire a more comprehensive understanding of each core facility's reality. Additional research efforts are required to explore deeper into the intricacies and nuances of innovation processes inside institutes and academia, in research in general, and to uncover valuable insights that can contribute to a richer understanding of this field. For instance, for a more comprehensive study of the deep understanding of the needs, expectations, and pain points of the facility's users, it might be necessary to conduct more user research, such as surveys, interviews, and observations, and gather insights into their experiences, challenges, and desired outcomes. All this information from the users must be updated from time to time and tuned on the implementations designed. This information is necessary to inform service design decisions throughout time and tailor the services to meet users' specific needs.

6.2 Further research – future initiatives

As for future research, or future prototyping and implementation strategies, new dynamics are possible to be explored with service design in X core facility or other core scientific facilities:

- User-centered design of laboratory equipment: Service design methods can be used to create laboratory equipment that is more user-friendly and efficient. For example, teams of designers and scientists (core facility staff or users) might work together to create new types of "merged" equipment that is easier to use, requires less maintenance, and produces higher-quality and more diverse results. The exact process can also involve the equipment supplier's team of vendors and installers together with the core facility staff.
- Streamlined scheduling processes: scheduling, as reported in the interviews, is a complex process and a bottleneck of services, so service design methods can streamline scheduling processes, allowing collaboration between the IT department and users to develop or enhance current scheduling software, making it even easier for researchers to reserve time on equipment and reduce conflicts and delays, by receiving attuned notifications.
- Collaborative research environments with co-created workshops: service design methods can create collaborative research environments that promote knowledge sharing and innovation in co-created workshops, organised involving facility staff, users, and other stakeholders. For example, the staff team from the facility might create a space for researchers to work together on interdisciplinary projects, with access to shared equipment

and resources, as a "hands-on" technical workshop. These workshops can provide platforms for further collaboration in research, ideas generation, and problem-solving. It would be interesting to have special sessions where participants are encouraged to share their insights, perspectives, and suggestions for enhancing services and addressing their own challenges. Similarly, fostering collaboration among other core facilities, research groups, or even external organisations would be stimulating. Creating workshops together and establishing partnerships would leverage synergies and enhance the range of services offered. In this context, exploring opportunities for shared resources, joint projects, or cross-facility training programs would be possible, thus leading to a broader service portfolio of the facilities.

- More prototyping and testing can carry on by developing more prototypes of service improvements and new offerings based on insights gathered. As the ones already underway, the prototypes could be in the form of physical mock-ups, process flows, or digital interfaces. Furthermore, the prototypes could be tested with a subset of users and gathered more feedback to refine and iterate. Rapid prototyping and testing will allow for quick validation of ideas and enhance a more user-centric approach.
- New digital solutions: leveraging digital technologies to enhance service delivery and user experience is one of the major challenges in service design applied in core facilities. Exploring the development of suited online platforms, mobile applications, and other features on the webpage will enable users to access information conveniently, book easier the equipment or services, track the status of their requests, and overall communicate better and through different channels with the facility staff. Furthermore, digital solutions and artificial intelligence can promote automation in several processes, applicable to streamlining administrative tasks and reducing manual effort.
- Service performance measurement and continuous feedback loop: it would be necessary to establish metrics and key performance indicators (KPIs) to assess the effectiveness and efficiency of the services provided by the core facility. These KPIs would have to be defined in agreement with the institute's direction and complemented with the ones already in place (with the user's satisfaction survey). The KPIs would allow to regularly monitor and analyse metrics to identify improvement areas and measure the impact of service design interventions. The data obtained would be able to be used to inform decision-making and prioritise initiatives for enhancing service quality. In harmony with KPIs, other mechanisms to gather ongoing user feedback, such as post-service surveys or feedback forms, could be developed and implemented in order to actively and rapidly listen to user

feedback and use it as a basis for service improvements. One critical aspect would be communicating how user feedback is utilised in the service facility to demonstrate a commitment to continuous improvement and responsiveness to user needs.

- Staff training and empowerment: since training was such a crucial aspect to have in mind for the facility's users, training to the staff could equally reveal to be revolutionary, especially if there were developed opportunities for the facility staff to enhance their service design and innovation skills. Organising special training sessions for staff would encourage a culture of innovation and empower staff members to propose and implement service improvements, fostering a supportive environment valuing creativity, continuous learning, and experimentation.
- In addition to staff training, more initiatives considering external engagement could be nurtured. For instance, engaging with the broader research and industry community would be thought-provoking to stay informed about emerging trends, challenges, and opportunities. Staff could attend conferences, workshops, and networking events to exchange knowledge, gather insights and disclose the facility. Hosting or participating in hackathons, innovation challenges, or industry-academic collaborations would allow to promote the facility's services.
- User referral program: going in the direction of some suggestions, it would be interesting to implement a user referral program where existing users would be incentivised to refer colleagues or collaborators for utilising the facility's services. For this user referral initiative, it would be necessary to design offering benefits, such as discounted rates, priority access, or additional training opportunities, to users who successfully refer other new users. This could help expand the user base through personal recommendations.

In conclusion, integrating service design principles into the X core facility opens new and fascinating possibilities for the future. However, it has already, in the present reality, created more user-centric services, fostered innovation, and aided in continuously improving the user experience. Service design will undoubtedly enhance the facility's reputation and contribute to its advancement. Moreover, it can be further exploited and replicated in other core facilities, adjusting it accordingly to each one of the facility's realities.

References

Aktinson, P., & Hammersley, M. (1998). Ethnography and participant observation. *Strategies of Qualitative Inquiry. Thousand Oaks: Sage*, 248-261.

Angeletti, R. H., Bonewald, L. F., de Jongh, K., Niece, R., Rush, J., & Stults, J. (1999). Research Technologies: Fulfilling the Promise1. *The FASEB Journal*, *13*(6), 595-601. https://doi.org/https://doi.org/10.1096/fasebj.13.6.595

Blomkvist, J., Holmlid, S., & Segelström, F. (2010). Service design research: yesterday, today and tomorrow. http://urn.kb.se/resolve?urn=urn:nbn:se:liu:diva-80953

Brown, T. (2008). Design thinking. *Harvard business review*, *86*(6), 84.

Clack, L. A., & Ellison, R. L. (2019). Innovation in Service Design Thinking. In M. A. Pfannstiel & C. Rasche (Eds.), *Service Design and Service Thinking in Healthcare and Hospital Management: Theory, Concepts, Practice* (pp. 85-92). Springer International Publishing. https://doi.org/10.1007/978-3-030-00749-2_6

de Lucas Ancillo, A., del Val Núñez, M. T., & Gavrila, S. G. (2021). Workplace change within the COVID-19 context: a grounded theory approach. *Economic Research-Ekonomska Istrazivanja*, *34*(1), 2297-2316. https://doi.org/10.1080/1331677X.2020.1862689

Edvardsson, B., Kristensson, P., Magnusson, P., Matthing, J., & Gustafsson, A. (2006). *Involving customers in new service development* (Vol. 11). World Scientific.

Farber, G. K., & Weiss, L. (2011). Core facilities: Maximizing the return on investment [Note]. *Science Translational Medicine*, *3*(95), Article 95cm21. https://doi.org/10.1126/scitranslmed.3002421

Fisk, R. P., Bennett, R., & Harris, L. C. (2013). *Serving Customers: Global Services Marketing Perspective*. Tilde University Press.

Foglieni, F., Villari, B., Maffei, S., Foglieni, F., Villari, B., & Maffei, S. (2018). How to (re) design services: from ideation to evaluation. *Designing Better Services: A Strategic Approach from Design to Evaluation*, 27-45. https://doi.org/https://doi.org/10.1007/978-3-319-63179-0

Francis, J. J., Johnston, M., Robertson, C., Glidewell, L., Entwistle, V., Eccles, M. P., & Grimshaw, J. M. (2010). What is an adequate sample size? Operationalising data saturation for theory-based interview studies. *Psychology & Health*, *25*(10), 1229-1245. https://doi.org/10.1080/08870440903194015

Gallacher, J. (2016). What's the good of a science platform? *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *374*(2083), 20160127. https://doi.org/doi:10.1098/rsta.2016.0127

Gobo, G. (2011). Ethnography. In *Qualitative research* (pp. 15-36). Sage.

Goldstein, S. M., Johnston, R., Duffy, J., & Rao, J. (2002). The service concept: the missing link in service design research? *Journal of Operations Management*, *20*(2), 121-134. https://doi.org/https://doi.org/10.1016/S0272-6963(01)00090-0

Gould, J. (2015). Core facilities: Shared support. *Nature*, *519*(7544), 495-496. https://doi.org/10.1038/nj7544-495a

Haley, R. (2009). A framework for managing core facilities within the research enterprise. *J Biomol Tech*, *20*(4), 226-230. https://www.scopus.com/inward/record.uri?eid=2-s2.0-77953671721&partnerID=40&md5=57f6112f71f8bf7f6d0beadbaf825386

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *28*(1), 75-105. https://doi.org/10.2307/25148625

Hockberger, P., Weiss, J., Rosen, A., & Ott, A. (2018). Building a Sustainable Portfolio of Core Facilities: a Case Study. *J Biomol Tech*, *29*(3), 79-92. https://doi.org/10.7171/jbt.18-2903-003

Karlsson, C. (2016). *Research methods for operations management* (Vol. 2). Routledge London. https://doi.org/https://doi.org/10.4324/9781315671420

Kirshenblatt-Gimblett, B. (2006). What is research design? The context of design. *Performance Studies Methods Course Syllabus*.

Korper, A. K., Patrício, L., Holmlid, S., & Witell, L. (2020). Service design as an innovation approach in technology startups: a longitudinal multiple case study. *Creativity and Innovation Management*, *29*(2), 303-323. https://doi.org/https://doi.org/10.1111/caim.12383

Kos-Braun, I. C., Gerlach, B., & Pitzer, C. (2020). A survey of research quality in core facilities. *eLife*, *9*, e62212. https://doi.org/10.7554/eLife.62212

Kothari, C. R. (2004). *Research Methodology: Methods and Techniques*. New Age International (P) Limited. https://books.google.pt/books?id=8c6gkbKi-F4C

Kouamé, S., & Liu, F. (2021). Capturing emotions in qualitative strategic organization research. *Strategic Organization*, *19*(1), 97-112. https://doi.org/10.1177/1476127020935449

Larivière, B., Bowen, D., Andreassen, T. W., Kunz, W., Sirianni, N. J., Voss, C., Wünderlich, N. V., & De Keyser, A. (2017). "Service Encounter 2.0": An investigation into the roles of technology, employees and customers. *Journal of business research*, *79*, 238-246. https://doi.org/https://doi.org/10.1016/j.jbusres.2017.03.008

Lippens, S., D'Enfert, C., Farkas, L., Kehres, A., Korn, B., Morales, M., Pepperkok, R., Premvardhan, L., Schlapbach, R., Tiran, A., Meder, D., & Van Minnebruggen, G. (2019). One step ahead. *EMBO reports*, *20*(4), e48017. https://doi.org/https://doi.org/10.15252/embr.201948017

Meroni, A., & Sangiorgi, D. (2016). *Design for services*. Routledge.

Ng, I. C., & Wakenshaw, S. Y. (2017). The Internet-of-Things: Review and research directions. *International Journal of Research in Marketing*, *34*(1), 3-21. https://doi.org/https://doi.org/10.1016/j.ijresmar.2016.11.003

Patricio, L., Fisk, R. P., Cunha, J. F. E., & Constantine, L. (2011). Multilevel Service Design: From Customer Value Constellation to Service Experience Blueprinting [Article]. *Journal of Service Research*, *14*(2), 180-200. https://doi.org/10.1177/1094670511401901

Patrício, L., Gustafsson, A., & Fisk, R. (2018). Upframing Service Design and Innovation for Research Impact. *Journal of Service Research*, *21*(1), 3-16. https://doi.org/10.1177/1094670517746780

Rashid, Y., Rashid, A., Warraich, M. A., Sabir, S. S., & Waseem, A. (2019). Case Study Method: A Step-by-Step Guide for Business Researchers. *International Journal of Qualitative Methods*, *18*, 1609406919862424. https://doi.org/10.1177/1609406919862424

Robson, C. (1993). *Real World Research: a Resource for Social Scientists and Practitioner-Researchers.*

Sarmento, T., & Patricio, L. (2014). Incorporating the customer experience along different iterative cycles of service design. ServDes. 2014-Fourth Service Design and Innovation Conference,

Simonsen, J., & Kensing, F. (1997). Using ethnography in contextural design. *Communications of the ACM*, *40*(7), 82-88.

Steen, M., Manschot, M., & Koning, N. D. (2011). *Benefits of Co-design in Service Design Projects* [Benefits, Co-Design, Service Design, Cases]. http://www.ijdesign.org/index.php/IJDesign/article/view/890/346

Teixeira, J., Patrício, L., Nunes, N. J., Nóbrega, L., Fisk, R. P., & Constantine, L. (2012). Customer experience modeling: from customer experience to service design. *Journal of Service Management*, *23*(3), 362-376. https://doi.org/10.1108/09564231211248453

Tschimmel, K. (2012). Design Thinking as an effective Toolkit for Innovation. ISPIM Conference

Ulwick, A. W. (2002). Turn customer input into innovation. *Harvard business review*, *80*(1), 91-97, 126.

Voorhees, C. M., Fombelle, P. W., Gregoire, Y., Bone, S., Gustafsson, A., Sousa, R., & Walkowiak, T. (2017). Service encounters, experiences and the customer journey: Defining the field and a call to expand our lens. *Journal of business research*, *79*, 269-280. https://doi.org/https://doi.org/10.1016/j.jbusres.2017.04.014

Yin, R. K. (2009). *Case Study Research: Design and Methods*. SAGE Publications. https://books.google.pt/books?id=FzawIAdilHkC

Yu, E., & Sangiorgi, D. (2018). Service design as an approach to implement the value cocreation perspective in new service development. *Journal of Service Research*, *21*(1), 40-58. https://doi.org/10.1177/1094670517709356

Annexes

Informed Consent Form Model

Name: Ricardo Vidal Silva

Student number: up200300913

Date: 21-03-2023

University: University of Porto

Education: Master's degree in "Innovation and Technological Entrepreneurship."

University supervisor: Teresa Sarmento

Purpose of the Project & project description

This document wishes you to participate in a master's thesis research project that primarily aims to obtain knowledge on issues related to core scientific facilities. According to the literature, these platforms must improve their offerings due to systemic, strategic errors, mainly in communication and management issues. Service design stands as a new tool to innovate, requalify and, in this way, improve the platform's performance.

To study and test this concept in the field, a case study is proposed in one core scientific facility, aiming to identify the causes of recurrent errors and explore new actions to constitute the core scientific facility as a reference for validation in the field. In this letter, information on the project is given, as well as a description of what your participation will involve.

For any inquiries, please contact:

Ricardo Vidal Silva,

Email: up200300913@fe.up.pt

Telephone: +351 911154292

Main supervisor:

Teresa Sarmento

Email: teresa.sarmento@ceiia.com

Senior Researcher | Service Design

FEUP / CEiiA

Purpose of your participation (why have you been asked?)

You have been asked to participate in this research project because you work or have worked in close contact with a scientific core facility. Possibly you are or have been a user/client in the past; therefore, your perception of the experience as a customer/user will be valuable. On the other hand, as someone not part of the facility, your outside perspective also provides insightful information.

What does participation involve for you?

Suppose you choose to take part in this project. In that case, this will involve giving an interview (preferably recorded, but not necessary) with Ricardo Vidal in person or over a video conferencing/chat software (which will be encrypted). The interview will be semi-structured, with several questions sent beforehand (if you wish). However, because it is your expertise and opinions that the project is interested in, new questions may arise during the interview that may be put to you. Apart from the interview, your name, age, expertise, and role in your occupation will be confirmed with you. The information you give will be stored securely, with access only available through Ricardo Vidal. The data gathered will be used to enrich the research and will only be published in an anonymised form. Quotes and information will not be traceable to you or your company; instead, you or your company will be referred to as, for example, "an expert informant with knowledge/experience in a core facility" or "An informant from a core facility in Portugal interested in technology" or similar expressions.

Participation is voluntary

Participation in the project is voluntary. If you choose to participate, you can withdraw your consent at any time without any reason. All personal information about you will then be deleted or made anonymous. You will have no negative consequences if you choose not to participate or withdraw from the sample interview later.

Your privacy – how will be stored and used your personal data

We will only use your personal data for the purpose(s) specified in this informative letter. Your personal data will be processed following data protection legislation (the General Data Protection Regulation and Personal Data Act GDPR). Personal data will not be made public as stated in the form section titled "What does participation involve for you?". If you agree to be recorded, audio files from the interviews will not be shared beyond Ricardo Vidal and Teresa Sarmento. Ricardo Vidal will be responsible for the research project, but Teresa will have access to the personal data

and supervise aspects of the data collection, storage, management, and interpretation. Digital transcripts, notes, and audio files will be stored in an encrypted password-protected file and on an encrypted and password-protected computer that only Ricardo Vidal can access. If you consent to be interviewed but do not want to be recorded or withdraw your consent during or after the interview, the recording will be deleted immediately. In other cases, the recording will be anonymised and deleted before the end of the research project.

What will happen to your personal data at the end of the research project?

The project is scheduled to end in early June 2023. Due to the time required to finish writing research publications, the audio recordings will be deleted. Any notes, texts or other related information from the interviews will be anonymised and archived before August 1st, 2023. All interview data, including personal data, will be stored securely and anonymised as stated in the section "Your personal privacy – how we will store and use your personal data".

Your rights

- As long as you can be identified in the collected data, you have the right to:
- access the personal data that is being processed about you
- request that your personal data be deleted
- request that incorrect personal data about you be corrected/rectified
- receive a copy of your personal data (data portability)

What gives us the right to process and analyse your personal data?

We will process your personal data based on your consent.

Where can I find out more?

If you have questions about the project or want to exercise your rights, contact:

Ricardo Vidal, up200300913@fe.up.pt, +351 911154292

Yours sincerely,

Ricardo Vidal

Supervisor Teresa Sarmento

_____

_____

Consent form

Consent should be given in writing (or electronically, via email).

I have received and understood information about the project of the dissertation entitled "Service Design for better communication and management practices - in the context of scientific services in core facilities" and have been allowed to ask questions.

I give consent:

*☐ to participate in the interview

*☐ to have written and electronic notes taken

*☐ for my personal data to be stored until the end of the project on August 1st 2023

☐ to have the interview be recorded

☐ to receive an update about the thesis at the end of the project

* Mandatory

Signed: Date:

_____

_____

Question script - individual interviews/focus groups

Demographic questions:

Age: _____

Gender: Male □ Female □ prefer not to say □

Profession /user status concerning the facility:

- □ Qualified user
- □ Unqualified user
- □ Internal client
- □ External client
- □ PhD student
- □ Researcher
- □ Pos-doc
- □ Teacher
- □ Scientific staff
- □ Entrepreneur
- □ Other

Communication & Visibility

- How did you become aware of the scientific platform?
- Which would be the best strategy to reach out to users, in your opinion? How do you suggest publicising the facility and the services to reach other users?
- What is your opinion on the business relationship established concerning the quotation, contract and billing processes?
- What do you consider about the facility's presence on social media, the institute's website, etc.?
- Would you agree to share experiments done on the core facility through social media?
- Would you favour using blogs or online chats to communicate with other users and facility staff?
- What do you think about the visual marketing tools for the facility, such as a symbol, photographs, pamphlets, etc.?

Training

- Give an opinion on the training received.

- (What kind of training do you prefer? Do you prefer personalised, hands-on training done with samples and including a follow-up with the user for the first time? Or would you consider a more generalised training done online, with follow-up, physically, by the trainer? Do you prefer shared or individual training?) *make this question depending on the answer to the previous question.*

Access

- Give an opinion on the process for gaining access to the facility.
- What do you think about the access to the files of results performed in the core facility?

Scheduling and registering

- What changes/improvements would you suggest for the scheduling process?
- (What do you think about a streamlined scheduling process through an app?) *Make this question depending on the answer to the previous question.*
- Would you favour using an exclusively online registry for the analysis instead of a paper registry?

New features and services

- What do you think about a "roadmap analysis" on several techniques? A roadmap for the analysis is, for instance, a sequence of analyses on the same sample (if applicable) with different techniques accessible by the facility. Do you think offering a "roadmap analysis" which includes other core facilities is interesting? How?
- What do you think about purchasing a bundle of assays for several equipment?
- Is there something lacking in the facility that you want to see improved? Any suggestion?
- Do you think the facility should also offer training as a service for external users?

Technology

- Does the technology offered need to be updated?
- What kind of technology do you believe needs to be added to the facility?
- Would you consider using artificial intelligence in the core facility to support your research? Any suggestion on how?

People (Human resources)

- What do you think about the staff's attendance?
- As an unqualified user, how do you evaluate the technician's skill for the assay? (*make this or the following question depending on the interviewee)*
- As a qualified user, how do you evaluate the technician's support?
- What do you think about the staff's number of elements? Do you think it is enough?

Prices

- What do you think about the prices of the services?
- What do you think about sharing costs with shared training?
- What do you think about having discounts based on the number of analyses/ equipment?
- Do you think the disclosure of the price is sufficient?

Customer interaction and experience

- What is your level of satisfaction with the general service provided?
- Would you recommend our services to others? How would you share or recommend your experience?
- Where or to whom do you expose your complaints?
- If you have made a complaint, how do you evaluate the complaint result?

Other questions

- As a qualified user, how do you consider equipment availability? (*make this or the following question depending on the interviewee)*
- As an unqualified user, how do you consider the availability of the technician responsible for the assay?
- Have you published any scientific findings with data obtained/analysed in the platform? How important were those findings for publication? How did you share those results?
- How did you acknowledge the facility (if applicable)?

Strategy

- Do you think the facility should only be used for academic purposes?

- Do you think it is competitive with other facilities or companies?

Management

- What skills and background do you think the facility manager should have?
- What level of independence should the facility's management have from the institute?

Quality

- What do you think about the Good laboratory practices (GPL) implemented in the facility?
- How do you classify the level of quality, concerning confidence in the results, provided by the facility?
- Would you trust the facility more if it were certified or accredited by ISO quality norms?

Consentimento informado

Estamos a solicitar a sua participação para um estudo no âmbito de um trabalho académico da disciplina Dissertação, do curso Mestrado em Empreendorismo e Inovação Tecnológica.

Este estudo tem como objetivo a exploração do redesign do serviço numa plataforma cientifica.

Estas entrevistas serão gravadas para possibilitar a sua transcrição e análise aprofundada. Só iniciaremos a gravação após a sua concordância, expressa através da assinatura deste consentimento informado.

A informação recolhida é estritamente confidencial e será apenas utilizada no âmbito deste estudo. Os resultados serão reportados de forma agregada, sem identificar individualmente os entrevistados. Se no decorrer do estudo e do reporte dos resultados for relevante citar de forma não anónima um excerto da entrevista, tal só será efetuado após pedido por parte dos investigadores e autorização expressa por escrito por parte do entrevistado.

A sua participação neste estudo é voluntária, pelo que a poderá interromper a qualquer momento. Nesse caso toda a informação recolhida até ao momento será inutilizada.

Data ...../...../.....

Assinatura do investigador

_____

Data ...../...../.....

Assinatura do entrevistado

_____

Questões em Português

Comunicação e Visibilidade

• Como tomou conhecimento da plataforma científica?

• Qual seria a melhor estratégia para chegar aos utilizadores, na sua opinião? Como sugere divulgar a plataforma e os serviços para alcançar outros utilizadores?

• Qual é a sua opinião sobre a relação comercial estabelecida nos processos de cotação, contratação e faturação?

• O que considera sobre a presença da plataforma nas redes sociais, no site do instituto, etc.?

• Concordaria em compartilhar experiências realizadas na plataforma através das redes sociais?

• Utilizaria blogs ou "chats" online para comunicar com outros utilizadores e staff da plataforma?

• Qual a sua opinião sobre o marketing visual da plataforma (um símbolo, presença em fotografias, panfletos, etc.)?

Formação

• Qual a sua opinião sobre a formação recebida?

• (Que tipo de formação você prefere? Prefere uma foramção prática, personalizada, efetuada com amostras e incluindo um acompanhamento com o utilizador, pela primeira vez? Ou consideraria uma formação mais generalizada efetuada online, com acompanhamento fisico pelo formador? Prefere uma formação partilhada ou individual?) *fazer estas perguntas consoante respostas à pergunta anterior.*

Acesso

• Qual a sua opinião sobre o processo de acesso à plataforma?

• O que pensa sobre o acesso aos arquivos de resultados realizados na plataforma?

Agendamento

• Que mudanças/melhorias sugere para o processo de agendamento?

• (O que acha de um processo de agendamento simplificado por meio de uma aplicação móvel? *fazer esta pergunta consoante resposta à pergunta anterior.*

• Prefere usar um registo exclusivamente online para a análise em vez de um registo em papel?

Novos recursos e serviços

• O que acha de uma análise "tipo roteiro" em várias técnicas? Uma análise "tipo roteiro" é, por exemplo, uma sequência de análises na mesma amostra (se aplicável) com diferentes técnicas acessíveis na plataforma. Acha interessante oferecer uma "análise tipo roteiro" que inclua outras plataformas? De que forma?

• O que acha da posssibilidade de adquirir um pacote de ensaios para vários equipamentos?

• Falta algo na plataforma que gostaria de ver melhorado? Alguma sugestão?

• Acha que a plataforma também deveria oferecer formação como um serviço para utilziadores externos?

Tecnologia

• A tecnologia oferecida precisa de ser atualizada?

• Que tipo de tecnologia sugere ser adicionada à instalação?

• Consideraria o uso de inteligência artificial na plataforma para apoiar sua pesquisa? Alguma sugestão de como?

Pessoas (recursos humanos)

• O que acha da presença e assiduidade do staff na plataforma?

• Como utilizador não qualificado, como avalia a competência do técnico para o ensaio? (*fazer esta pergunta consoante resposta à pergunta anterior.*)

• Como utilizador qualificado, como avalia o apoio dado do técnico?

• O que pensa do número de elementos do staff? Acha que é suficiente?

Preços

• O que acha dos preços dos serviços?

• O que acha de compartilhar custos através de periodos de formação partilhada?

• O que acha de ter descontos em função do número de análises/equipamentos?

• Acha que a divulgação de preços efetuada é suficiente?

Experiência do utilizador

• Qual é o seu nível de satisfação com o serviço geral prestado?

• Recomendaria os serviços da plataforma com outras pessoas? Como partilharia ou recomendaria sua experiência?

• Onde ou a quem expõe as reclamações?

• Se fez uma reclamação, como avalia o resultado da reclamação?

Outras perguntas

• Como utilizador qualificado, como considera a disponibilidade do equipamento?

(fazer esta pergunta consoante resposta à pergunta anterior)

• Enquanto utilizador não qualificado, como considera a disponibilidade do técnico responsável pelo ensaio?

• Publicou alguma descoberta científica com dados obtidos/analisados na plataforma? Qual a importância dessas descobertas para a publicação? Como partilhou esses resultados?

• Como a agradeceu o apoio à plataforma cientifica (se aplicável)?

Estratégia

• Acha que a plataforma cientifica deve ser usada apenas para fins académicos?

• Acha que a plataforma é competitiva com outras plataformas ou empresas?

Gestão da plataforma

• Que competências e conhecimentos acha que o gestor da plataforma deve ter?

• Que nível de independência deve a plataforma ter, na sua opinião, relativamente à administração da instituto?

Qualidade

• O que acha do cumprimento de Boas Práticas de Laboratório (GPL) implementadas na unidade?

• Como classifica o nível de qualidade, no que diz respeito à confiança nos resultados, proporcionado pelas medições na plataforma?

• Confiaria mais na plataforma caso fosse certificada ou acreditada pelas normas de qualidade ISO?

Sampling of interviewees

Facility User	Age	Gender	Profession	Relation with the facility
Interview 1	29	Male	PhD student	Internal user
Interview 2	51	Male	Senior Researcher	External user
Interview 3	29	Female	PhD student	Internal user
Interview 4	27	Female	PhD student	Internal user
Interview 5	30	Female	Researcher/ Pos-Doc Representatives	Previous Internal user
Interview 6	29	Female	PhD student	Internal user
Interview 7	34	Female	R&D Project Manager	External client and Previous Internal user
Interview 8	35	Female	Project Manager / PhD Biomedical Sciences	External client and Previous Internal user
Interview 9	28	Female	PhD Biomedical Sciences / unemployed	Previous Internal user
Interview 10	31	Female	PhD researcher	Internal user
Interview 11	38	Female	Senior Researcher / Project Leader	Previous Internal user
Interview 12	41	Female	PhD / teacher /Technical researcher	External client and Previous Internal user